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About Us

Journal of Turkish Spinal Surgery (www.jtss.org), is the official publication of the Turkish Spinal Surgery Society. First journal was printed on January, in 1990. It is a double-blind peer-reviewed multidisciplinary journal for the physicians who deal with spinal diseases and publishes original studies which offer significant contributions to the development of the spinal knowledge. The journal publis¬hes original scientific research articles, invited reviews and case reports that are accepted by the Editorial Board, in English.

The journal is published once in every three months and a volume consists of four issues. Journal of Turkish Spinal Surgery is published four times a year: on January, April, July, and October.

Journal of Turkish Spinal Surgery is indexed in TÜBİTAK ULAKBİM TR Index, EBSCO, J-Gate, GALE, ProQuest, Türkiye Atıf Dizini, Index Copernicus and Europub.

The Turkish Spinal Surgery Society was established in 1989 in Izmir (Turkey) by the pioneering efforts of Prof. Dr. Emin Alıcı and other a few members. The objectives of the society were to: - establish a platform for exchange of information/ experience between Orthopedics and Traumatology Specialists and Neurosurgeons who deal with spinal surgery - increase the number of physicians involved in spinal surgery and to establish spinal surgery as a sophisticated medical discipline in Turkey - follow the advances in the field of spinal surgery and to communicate this information to members - organize international and national congresses, symposia and workshops to improve education in the field - establish standardization in training on spinal surgery - encourage scientific research on spinal surgery and publish journals and books on this field - improve the standards of spinal surgery nationally, and therefore make contributions to spinal surgery internationally.

The main objective of the Journal is to improve the level of knowledge and experience among Turkish medical society in general and among those involved with spinal surgery in particular. Also, the Journal aims at communicating the advances in the field, scientific congresses and meetings, new journals and books to its subscribers. Journal of Turkish Spinal Surgery is as old as the Turkish Spinal Surgery Society.

The first congress organized by the Society took place in Çeşme, Izmir, coincident with the publication of the first four issues. Authors were encouraged by the Society to prepare original articles from the studies presented in international congresses organized by the Society every two years, and these articles were published in the Journal. The Journal publishes clinical or basic research, invited reviews, and case presentations after approval by the Editorial Board. Articles are published after at least two reviewers review them. Editorial Board has the right to accept, to ask for revision, or to refuse manuscripts.

The Journal is issued every three months, and one volume is completed with every four issue. Associate Editors and Editor in Chief are responsible in reviewing and approving material that is published. Responsibility for the problems associated with research ethics or medico-legal issues regarding the content, information and conclusions of the articles lies with the authors, and the editor or the editorial board bears no responsibility. In line with the increasing expectations of scientific communities and the society, improved awareness about research ethics and medico-legal responsibilities forms the basis of our publication policy.

Citations must always be referenced in articles published in our journal. Our journal fully respects to the patient rights, and therefore care is exercised in completion of patient consent forms; no information about the identity of the patient is disclosed; and photographs are published with eye-bands. Ethics committee approval is a prerequisite. Any financial support must clearly be disclosed. Also, our Journal requests from the authors that sponsors do not interfere in the evaluation, selection, or editing of individual articles, and that part or whole of the article cannot be published elsewhere without written permission.

Journal of Turkish Spinal Surgery is available to the members of the society and subscribers free of charge. Membership fees, congresses, and the advertisements appearing in the journal meet the publication and distribution costs.

The advertisement fees are based on actual pricing. The Editorial Board has the right for signing contracts with one or more financial organizations for sponsorship. However, sponsors cannot interfere in the scientific content and design of the journal, and in selection, publication order, or editing of individual articles.

Journal of Turkish Spinal Surgery agrees to comply with the "Global Compact" initiative of the UN, and this has been notified to the UN. Therefore, VI our journal has a full respect to human rights in general, and patient rights in particular, in addition to animal rights in experiments; and these principles are an integral part of our publication policy.

Recent advances in clinical research necessitate more sophisticated statistical methods, well-designed research plans, and more refined reporting. Scientific articles, as in other types of articles, represent not only an accomplishment, but also a creative process.

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The quality of a report depends on the quality of the design and management of the research. Well-designed questions or hypotheses are associated with the design. Well-designed hypotheses reflect the design, and the design reflects the hypothesis. Two factors that determine the efficiency of a report are focus and shortness. Drawing the attention to limited number of subjects allows the author to focus on critical issues. Avoidance from repetitions (apart from a few exceptions), a simple language, and correct grammar are a key to preparing a concise text. Only few articles need to exceed 3000 words, and longer articles may be accepted when new methods are being reported or literature is being reviewed.

Although authors should avoid complexity, the critical information for effective communication usually means the repetition of questions (or hypotheses or key subjects). Questions must be stated in Abstract, Introduction and Discussion sections, and the answers should be mentioned in Abstract, Results, and Discussion sections. Although many journals issue written instructions for the formatting of articles, the style of the authors shows some variance, mainly due to their writing habits.

Journal of Turkish Spinal Surgery adopts the AMA style as a general instruction for formatting. However, not many authors have adequate time for learning this style. Thus, our journal is tolerant to personal style within the limitations of correct grammar and plain and efficient communication.

JOURNAL OF TURKISH SPINAL SURGERY

Instructions to Authors

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PEER REVIEW

Article is reviewed by secretaries of the journal after it is uploaded to the web site. Article type, presence of the all sections, suitability according to the number of words, name of the authors with their institutions, corresponding address, mail addresses, telephone numbers and ORCID numbers are all evaluated and shortcomings are reported to the editor. Editor request the all defect from the authors and send to vice editors and native English speaker editor after completion of the article. Vice editors edit the blinded article and this blinded copy is sent to two referees. After reviewing of the article by the referees in maximum one month, the review report evaluating all section and his decision is requested, and this blinded report is sent to the author. In fifteen days, revision of the article is requested from the authors with the appreciate explanation. Revised blinded copy is sent to the referees for the new evaluation. Editor if needed may sent the manuscript to a third referee. Editorial Board has the right to accept, revise or reject a manuscript.

-Following types of manuscripts related to the field of "Spinal Surgery" with English Abstract and Keywords are accepted for publication: I- Original clinical and experimental research studies; II- Case presentations; and III- Reviews.

AUTHOR'S RESPONSIBILITY

The manuscript submitted to the journal should not be previously published (except as an abstract or a preliminary report) or should not be under consideration for publication elsewhere. Every person listed as an author is expected to have been participated in the study to a significant extent. All authors should confirm that they have read the study and agreed to the submission to Journal of Turkish Spinal Surgery for publication. This should be notified with a separate document as shown in the "Cover Letter" in the appendix. Although the editors and referees make every effort to ensure the validity of published manuscripts, the final responsibility rests with the authors, not with the Journal, its editors, or the publisher. The source of any financial support for the study should be clearly indicated in the Cover Letter.

It is the author's responsibility to ensure that a patient's anonymity be carefully protected and to verify that any experimental investigation with human subjects reported in the manuscript was performed upon the informed consent of the patients and in accordance with all guidelines for experimental investigation on human subjects applicable at the institution(s) of all authors.

Authors should mask patients' eyes and remove patients' names from figures unless they obtain written consent to do so from the patients; and this consent should be submitted along with the manuscript.

CONFLICTS OF INTEREST

Authors must state all possible conflicts of interest in the manuscript, including financial, institutional and other relationships that might lead to bias or a conflict of interest. If there is no conflict of interest, this should also be explicitly stated as none declared. All sources of funding should be acknowledged in the manuscript. All relevant conflicts of interest and sources of funding should be included on the title page of the manuscript with the heading "Conflicts of Interest and Source of Funding".

ARTICLE WRITING

Clinically relevant scientific advances during recent years include use of contemporary outcome measures, more sophisticated statistical approaches, and increasing use and reporting of well-formulated research plans (particularly in clinical research).

Scientific writing, no less than any other form of writing, reflects a demanding creative process, not merely an act: the process of writing changes thought. The quality of a report depends on the quality of thought in the design and the rigor of conduct of the research. Well-posed questions or hypotheses interrelate with the design. Well-posed hypotheses imply design and design implies the hypotheses. The effectiveness of a report relates to brevity and focus. Drawing the attention to a few points will allow authors to focus on critical issues. Brevity is achieved in part by avoiding repetition (with a few exceptions to be noted),

clear style, and proper grammar. Few original scientific articles need to be longer than 3000 words. Longer articles may be accepted if substantially novel methods are reported, or if the article reflects a comprehensive review of the literature.

Although authors should avoid redundancy, effectively communicating critical information often requires repetition of the questions (or hypotheses/key issues) and answers. The questions should appear in the Abstract, Introduction, and Discussion, and the answers should appear in the Abstract, Results, and Discussion sections.

Although most journals publish guidelines for formatting a manuscript and many have more or less established writing styles (e.g., the American Medical Association Manual of Style), styles of writing are as numerous as authors. Journal of Turkish Spinal Surgery traditionally has used the AMA style as a general guideline. However, few scientific and medical authors have the time to learn these styles. Therefore, within the limits of proper grammar and clear, effective communication, we will allow individual styles.

Permissions: As shown in the example in the appendix (Letter of Copyright Transfer) the authors should declare in a separate statement that the study has not been previously published and is not under consideration for publication elsewhere. Also, the authors should state in the same statement that they transfer copyrights of their manuscript to our Journal. Quoted material and borrowed illustrations: if the authors have used any material that had appeared in a copyrighted publication, they are expected to obtain written permission letter and it should be submitted along with the manuscript.

Review articles: The format for reviews substantially differs from those reporting original data. However, many of the principles noted above apply. A review still requires an Abstract, an Introduction, and a Discussion. The Introduction still requires focused issues and a rationale for the study. Authors should convey to readers the unique aspects of their reviews which distinguish them from other available material (e.g., monographs, book chapters). The main subject should be emphasized in the final paragraph of the Introduction. As for an original research article, the Introduction section of a review typically need not to be longer than four paragraphs. Longer Introductions tend to lose focus, so that the reader may not be sure what novel information will be presented. The sections after the Introduction are almost always unique to the particular review, but need to be organized in a coherent fashion. Headings (and subheadings when appropriate) should follow parallel construction and reflect analogous topics (e.g., diagnostic categories, alternative methods, alternative surgical interventions). If the reader considers only the headings, the logic of the review (as reflected in the Introduction) should be clear. Discussion synthesizes the reviewed literature as a whole coherently and within the context of the novel issues stated in the Introduction.

The limitations should reflect those of the literature, however, rather than a given study. Those limitations will relate to gaps in the literature which preclude more or less definitive assessment of diagnosis or selection of treatment, for example. Controversies in the literature should be briefly explored. Only by exploring limitations will the reader appropriately place the literature in perspective. Authors should end the Discussion by abstract statements similar to those which will appear at the end of the Abstract in abbreviated form.

In general, a review requires a more extensive literature review than an original research article, although this will depend on the topic. Some topics (e.g., osteoporosis) could not be comprehensively referenced, even in an entire monograph. However, authors need to ensure that a review is representative of the entire body of literature, and when that body is large, many references are required.

Original Articles: Original articles should contain the following sections: “Title Page”, “Abstract”, “Keywords”, “Introduction”, “Materials and Methods”, “Results”, “Discussion”, “Conclusions”, and “References”. “Keywords” sections should also be added if the original article is in English.

- Title (80 characters, including spaces): Just as the Abstract is important in capturing a reader’s attention, so is the title. Titles rising or answering questions in a few brief words will far more likely do this than titles merely pointing to the topic. Furthermore, such titles as “Bisphosponates reduce bone loss” effectively convey the main message and readers will more likely remember them. Manuscripts that do not follow the protocol described here will be returned to the corresponding author for technical revision before undergoing peer review. All manuscripts in English, should be typed double-spaced on one side of a standard typewriter paper, leaving at least 2.5 cm. margin on all sides. All pages should be numbered beginning from the title page.

- Title page should include: a) informative title of the paper, b) complete names of each author with their institutional affiliations, c) name, address, fax and telephone number, e-mail of the corresponding author, d) address for the reprints if different from that of the corresponding author, e) ORCID numbers of the authors. It should also be stated in the title

page that informed consent was obtained from patients and that the study was approved by the ethics committee.

The "Level of Evidence" should certainly be indicated in the title page (see Table-1 in the appendix). Also, the field of study should be pointed out as outlined in Table-2 (maximum three fields).

- Abstract: A150 to 250 word abstract should be included at the second page. The abstract should be written in English and for all articles. The main topics to be included in Abstract section are as follows: Background Data, Purpose, Materials- Methods, Results and Conclusion. The Abstract should be identical in meaning. Generally, an Abstract should be written after the entire manuscript is completed. The reason relates to how the process of writing changes thought and perhaps even purpose. Only after careful consideration of the data and a synthesis of the literature can author(s) write an effective abstract. Many readers now access medical and scientific information via Web-based databases rather than browsing hard copy material. Since the reader's introduction occurs through titles and abstracts, substantive titles and abstracts more effectively capture a reader's attention regardless of the method of access. Whether reader will examine an entire article often will depend on an abstract with compelling information. A compelling Abstract contains the questions or purposes, the methods, the results (most often quantitative data), and the conclusions. Each of these may be conveyed in one or two statements. Comments such as "this report describes…" convey little useful information.

-Key Words: Standard wording used in scientific indexes and search engines should be preferred. The minimum number for keywords is three and the maximum is five.

- Introduction (250 – 750 words): It should contain information on historical literature data on the relevant issue; the problem should be defined; and the objective of the study along with the problem solving methods should be mentioned.

Most studies, however, are published to: (1) report entirely novel findings (frequently case reports, but sometimes substantive basic or clinical studies); (2) confirm previously reported work (eg, case reports, small preliminary series) when such confirmation remains questionable; and (3) introduce or address controversies in the literature when data and/or conclusions conflict. Apart from reviews and other special articles, one of these three purposes generally should be apparent (and often explicit) in the Introduction.

The first paragraph should introduce the general topic or problem and emphasized its importance, a second and perhaps a third paragraph should provide the rationale of the study, and a final paragraph should state the questions, hypotheses, or purposes.

One may think of formulating rationale and hypotheses as Aristotelian logic (a modal syllogism) taking the form: If A, B, and C, then D, E, or F. The premises A, B, and C, reflect accepted facts whereas D, E, or F reflect logical outcomes or predictions. The premises best come from published data, but when data are not available, published observations (typically qualitative), logical arguments or consensus of opinion can be used. The strength of these premises is roughly in descending order from data to observations or argument to opinion. D, E, or F reflects logical consequences. For any set of observations, any number of explanations (D, E, or F) logically follows. Therefore, when formulating hypotheses (explanations), researchers designing experiments and reporting results should not rely on a single explanation.

With the rare exception of truly novel material, when establishing rationale authors should generously reference representative (although not necessarily exhaustive) literature. This rationale establishes novelty and validity of the questions and places it within the body of literature. Writers should merely state the premises with relevant citations (superscripted) and avoid describing cited works and authors` names. The exceptions to this approach include a description of past methods when essential to developing rationale for a new method, or a mention of authors` names when important to establish historic precedent. Amplification of the citations may follow in the Discussion when appropriate. In establishing a rationale, new interventions of any sort are intended to solve certain problems. For example, new implants (unless conceptually novel) typically will be designed according to certain criteria to eliminate problems with previous implants. If the purpose is to report a new treatment, the premises of the study should include those explicitly stated problems (with quantitative frequencies when possible) and they should be referenced generously.

The final paragraph logically flows from the earlier ones, and should explicitly state the questions or hypotheses to be addressed in terms of the study (independent, dependent) variables. Any issue not posed in terms of study variables cannot be addressed meaningfully. Focus of the report relates to focus of these questions, and the report should avoid questions for which answers are well described in the literature (e.g., dislocation rates for an implant designed to minimize stress shielding). Only if there are new and unexpected information should data reported apart from that essential to answer the stated questions.

- Materials - Methods (1000-1500 words): Epidemiological/ demographic data regarding the study subjects; clinical and radiological investigations; surgical technique applied; evaluation methods; and statistical analyses should be described in detail.

In principle, the Materials and Methods should contain adequate detail for another investigator to replicate the study. In practice, such detail is neither practical nor desirable because many methods will have been published previously (and in greater detail), and because long descriptions make reading difficult. Nonetheless, the Materials and Methods section typically will be the longest section. When reporting clinical studies authors must state approval of the institutional review board or ethics committees according to the laws and regulations of their countries. Informed consent must be stated where appropriate. Such approval should be stated in the first paragraph of Materials and Methods. At the outset the reader should grasp the basic study design. Authors should only briefly escribe and reference previously reported methods. When authors modify those methods, the modifications require additional description.

In clinical studies, the patient population and demographics should be outlined at the outset. Clinical reports must state inclusion and exclusion criteria and whether the series is consecutive or selected; if selected, criteria for selection should be stated. The reader should understand from this description all potential sources of bias such as referral, diagnosis, exclusion, recall, or treatment bias. Given the expense and effort for substantial prospective studies, it is not surprising that most published clinical studies are retrospective.

Such studies often are criticized unfairly for being retrospective, but that does not negate the validity or value of a study. Carefully designed retrospective studies provide most of the information available to clinicians. However, authors should describe potential problems such as loss to follow-up, difficulty in matching, missing data, and the various forms of bias more common with retrospective studies.

If authors use statistical analysis, a paragraph should appear at the end of Materials and Methods stating all statistical tests used. When multiple tests are used, authors should state which tests are used for which sets of data. All statistical tests are associated with assumptions, and when it is not obvious the data would meet those assumptions, the authors either should provide the supporting data (e.g., data are normally distributed, variances in gro-ups are similar) or use alternative tests. Choice of level of significance should be justified. Although it is common to choose a level of alpha of 0.05 and a beta of 0.80, these levels are somewhat arbitrary and not always appropriate. In the case where the implications of an error are very serious (e.g., missing the diagnosis of a cancer), different alpha and beta levels might be chosen in the study design to assess clinical or biological significance.

- Results (250-750 words): "Results" section should be written in an explicit manner, and the details should be described in the tables. The results section can be divided into sub-sections for a more clear understanding.

If the questions or issues are adequately focused in the Introduction section, the Results section needs not to be long. Generally, one may need a paragraph or two to persuade the reader of the validity of the methods, one paragraph addressing each explicitly raised question or hypothesis, and finally, any paragraphs to report new and unexpected findings. The first (topic) sentence of each paragraph should state the point or answer the question. When the reader considers only the first sentence in each paragraph in Results, the logic of the authors` interpretations should be clear. Parenthetic reference to all figures and tables forces the author to textually state the interpretation of the data; the important material is the authors` interpretation of the data, not the data.

Statistical reporting of data deserves special consideration. Stating some outcome is increased or decreased(or greater or lesser) and parenthetically stating the p (or other statistical) value immediately after the comparative terms more effectively conveys information than stating something is or is not statistically significantly different from so-mething else (different in what way? the readermay ask). Additionally, avoiding the terms 'statistically different' or 'significantly different' lets the reader determine whether they will consider the statistical value biologically or clinically significant, regardless of statistical significance.

Although a matter of philosophy and style, actual p values convey more information than stating a value less than some preset level. Furthermore, as Motulsky notes, "When you read that a result is not significant, don't stop thinking... First, look at the confidence interval... Second, ask about the power of the study to find a significant difference if it were there." This approach will give the reader a much greater sense of biological or clinical significance.

- Discussion (750 - 1250 words): The Discussion section should contain specific elements: a restatement of the problem or question, an exploration of limitations and as-sumptions, a comparison and/or contrast with information (data, opinion) in the literature, and a synthesis of the comparison and the

author's new data to arrive at conclusions. The restatement of the problem or questions should only be a brief emphasis. Exploration of assumptions and limitations are preferred to be next rather than at the end of the manuscript, because interpretation of what will follow depends on these limitations. Failure to explore limitations suggests the author(s) either do not know or choose to ignore them, potentially misleading the reader. Exploration of these limitations should be brief, but all critical issues must be discussed, and the reader should be persuaded they do not jeopardize the conclusions.

Next the authors should compare and/or contrast their data with data reported in the literature. Generally, many of these reports will include those cited as rationale in the Introduction. Because of the peculiarities of a given study the data or observations might not be strictly comparable to that in the literature, it is unusual that the literature (including that cited in the Introduction as rationale) would not contain at least trends. Quantitative comparisons most effectively persuade the reader that the data in the study are "in the ballpark," and tables or figures efficiently convey that information. Discrepancies should be stated and explained when possible; when an explanation of a discrepancy is not clear that also should be stated. Conclusions based solely on data in the paper seldom are warranted because the literature almost always contains previous information.

Finally, the author(s) should interpret their data in the light of the literature. No critical data should be overlooked, because contrary data might effectively refute an argument. That is, the final conclusions must be consistent not only with the new data presented, but also that in the literature.

- Conclusion: The conclusions and recommendations by the authors should be described briefly. Sentences containing personal opinions or hypotheses that are not based on the scientific data obtained from the study should be avoided.

- References: References are numbered (Arabic numerals) consecutively in the order in which they appear in the text (note that references should not appear in the abstract) and listed double-spaced at the end of the manuscript. The preferred method for identifying citations in the text is using within parentheses. Use the form of the "Uniform Requirements for Manuscripts" (http://www.icmje.org/about-icmje/faqs/icmje-recommendations/). If number of authors exceeds seven, list first 6 authors followed by et al.

Use references found published in peer-reviewed publications that are generally accessible. Unpublished data, personal communications, statistical programs, papers presented at meetings and symposia, abstracts, letters, and manuscripts submitted for publication cannot be listed in the references. Papers accepted by peer-reviewed publications but not yet published ("in press") are not acceptable as references.

Journal titles should conform to the abbreviations used in "Cumulated Index Medicus".

Please note the following examples of journal, book and other reference styles:

Journal article:

1. Berk H, Akçalı Ö, Kıter E, Alıcı E. Does anterior spinal instrument rotation cause rethrolisthesis of the lower instrumented vertebra? J Turk Spinal Surg. 1997;8 (1):5-9.

Book chapter:

2. Wedge IH, Kirkaldy-Willis WH, Kinnard P. Lumbar spinal stenosis. Chapter 5. In: Helfet A, Grubel DM (Eds.). Disorders of the Lumbar Spine. JB Lippincott, Philadelphia 1978;pp:61-8.

Entire book:

3. Paul LW, Juhl IH (Eds.). The Essentials of Roentgen Interpretation. Second Edition, Harper and Row, New York 1965; pp:294-311.

Book with volume number:

4. Stauffer ES, Kaufer H, Kling THF. Fractures and dislocations of the spine. In: Rock-wood CA, Green DP (Eds.). Fractures in Adults. Vol. 2, JB Lippincott, Philadelphia 1984;pp:987-1092.

Journal article in press:

5. Arslantaş A, Durmaz R, Coşan E, Tel E. Aneurysmal bone cysts of the cervical spine. J Turk Spinal Surg. (In press).

Book in press:

6. Condon RH. Modalities in the treatment of acute and chronic low back pain. In: Finnison BE (Ed.). Low Back Pain. JB Lippincott (In press).

Symposium:

7. Raycroft IF, Curtis BH. Spinal curvature in myelomeningocele: natural history and etiology. Proceedings of the American Academy of Orthopaedic Surgeons Symposium on Myelomeningocele, Hartford, Connecticut, November 1970, CV Mosby, St. Louis 1972;pp:186- 201.

Papers presented at the meeting:

8. Rhoton AL. Microsurgery of the Arnold-Chiari malformation with and without hydromyelia in adults. Presented at the

Annual Meeting of the American Association of Neuro-logical Surgeons, Miami, Florida, April 7, 1975.

-Tables: They should be numbered consecutively in the text with Arabic numbers. Each table with its number and title should be typed on a separate sheet of paper. Each table must be able to stand alone; all necessary information must be contained in the caption and the table itself so that it can be understood independent from the text. Information should be presented explicitly in "Tables" so that the reader can obtain a clear idea about its content. Information presented in "Tables" should not be repeated within the text. If possible, information in "Tables" should contain statistical means, standard deviations, and t and p values for possibility. Abbreviations used in the table should be explained as a footnote.

Tables should complement not duplicate material in the text. They compactly present information, which would be difficult to describe in text form. (Material which may be succinctly described in text should rarely be placed in tables or figures.) Clinical studies for example, often contain complementary tables of demographic data, which although important for interpreting the results, are not critical for the questions raised in the paper. Well focused papers contain only one or two tables or figures for every question or hypothesis explicitly posed in the Introduction section. Additional material may be used for unexpected results. Well-constructed tables are self-explanatory and require only a title. Every column contains a header with units when appropriate.

- Figures: All figures should be numbered consecutively throughout the text. Each figure should have a label pasted on its back indicating the number of the figure, an arrow to show the top edge of the figure and the name of the first author. Black-and-white illustrations should be in the form of glossy prints (9x13 cm). The letter size on the figure should be large enough to be readable after the figure is reduced to its actual printing size. Unprofessional typewritten characters are not accepted. Legends to figures should be written on a separate sheet of paper after the references.

The journal accepts color figures for publication if they enhance the article. Authors who submit color figures will receive an estimate of the cost for color reproduction. If they decide not to pay for color reproduction, they can request that the figures be converted to black and white at no charge. For studies submitted by electronic means, the figures should be in jpeg and tiff formats with a resolution greater than 300 dpi. Figures should be numbered and must be cited in the text.

- Style: For manuscript style, American Medical Association Manual of Style (9th edition). Stedman's Medical Dictionary (27th edition) and Merriam Webster's Collegiate Dictionary (10th edition) should be used as standard references. The drugs and therapeutic agents must be referred by their accepted generic or chemical names, without abbreviations. Code numbers must be used only when a generic name is not yet available. In that case, the chemical name and a figure giving the chemical structure of the drug should be given. The trade names of drugs should be capitalized and placed in parentheses after the generic names. To comply with trademark law, the name and location (city and state/country) of the manufacturer of any drug, supply, or equipment mentioned in the manuscript should be included. The metric system must be used to express the units of measure and degrees Celsius to express temperatures, and SI units rather than conventional units should be preferred.

The abbreviations should be defined when they first appear in the text and in each table and figure. If a brand name is cited, the manufacturer's name and address (city and state/country) must be supplied.

The address, "Council of Biology Editors Style Guide" (Council of Science Editors, 9650 Rockville Pike, Bethesda, MD 20814) can be consulted for the standard list of abbrevia-tions.

-Acknowledgments: Note any non-financial acknowledgments. Begin with, "The Authors wish to thank…" All forms of support, including pharmaceutical industry support should also be stated in Acknowledgments section.

Authors are requested to apply and load including the last version of their manuscript to the manuscript submission in the official web address (www.jtss.org). The electronic file must be in Word format (Microsoft Word or Corel Word Perfect). Authors can submit their articles for publication via internet using the guidelines in the following address: www.jtss.org.

- Practical Tips:

1. Read only the first sentence in each paragraph throughout the text to ascertain whether those statements contain all critical material and the logical flow is clear.

2. Avoid in the Abstract comments such as, "… this report describes…" Such statements convey no substantive information for the reader.

3. Avoid references and statistical values in the Abstract.

4. Avoid using the names of cited authors except to establish historical precedent. Instead, indicate the point in the manuscript by providing citation by superscripting.

5. Avoid in the final paragraph of the Introduction purposes such as, "… we report our data…" Such statements fail to focus

the reader's (and author's!) attention on the critical issues (and do not mention study variables).

6. Parenthetically refer to tables and figures and avoid statements in which a table of figure is either subject or object of a sentence. Parenthetic reference places interpretation of the information in the table or figure, and not the table or figure.

7. Regularly count words from the Introduction through Discussion.

TABLE-1. LEVELS OF EVIDENCE

LEVEL- I .

1) Randomized, double-blind, controlled trials for which tests of statistical significance have been performed

2) Prospective clinical trials comparing criteria for diagnosis, treatment and prognosis with tests of statistical significance where compliance rate to study exceeds 80%

3) Prospective clinical trials where tests of statistical ignificance for consecutive subjects are based on predefined criteria and a comparison with universal (gold standard) reference is performed

4) Systematic meta-analyses which compare two or more studies with Level I evidence using pre-defined methods and statistical comparisons.

5) Multi-center, randomized, prospective studies

LEVEL –II.

1) Randomized, prospective studies where compliance rate is less than 80%

2) All Level-I studies with no randomization

3) Randomized retrospective clinical studies

4) Meta-analysis of Level-II studies

LEVEL– III.

1) Level-II studies with no randomization (prospective clinical studies etc.)

2) Clinical studies comparing non-consecutive cases (without a consistent reference range)

3) Meta-analysis of Level III studies

LEVEL- IV.

1) Case presentations

2) Case series with weak reference range and with no statistical tests of significance

LEVEL – V.

1) Expert opinion and review articles

2) Anecdotal reports of personal experience regarding a study, with no scientific basis

TABLE-2. CLINICAL AREAS

Anatomy

Morphometric analysis

Anesthesiology

Animal study

Basic Science

Biology

Biochemistry

Biomaterials

Bone mechanics

Bone regeneration

Bone graft

Bone graft sustitutes

Drugs

Disc

Disc Degeneration

Herniated Disc

Disc Pathology

Disc Replacement

IDET

Disease/Disorder

Congenital

Genetics

Degenerative disease

Destructive (Spinal Tumors)

Metabolic bone disease

Rheumatologic

Biomechanics Cervical Spine

Cervical myelopathy

Cervical reconstruction

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Cervical disc disease
Cervical Trauma
Degenerative disease
Complications
Early
Late
Postoperative
Deformity
Adolescent idiopathic scoliosis
Kyphosis
Congenital spine
Degenerative spine conditions
Diagnostics
Radiology
MRI
CT scan
Others
Epidemiology
Etiology
Examination
Experimental study
Fusion
Anterior
Posterior
Combined
With instrumentation
Infection of the spine
Postoperative
Rare infections
Spondylitis
Spondylodiscitis
Tuberculosis
Instrumentation
Meta-Analysis
Osteoporosis
Bone density
Fractures
Kyphoplasty
Medical Treatment
Surgical Treatment
Outcomes
Conservative care
Patient Care
Primary care
Quality of life research
Surgical
Pain
Chronic pain
Discogenic pain
Injections
Low back pain
Management of pain
Postoperative pain
Pain measurement
Physical Therapy
Motion Analysis
Manipulation
Non-Operative Treatment
Surgery
Minimal invasive
Others
Reconstructive surgery
Thoracic Spine
Thoracolumbar Spine
Lumbar Spine
Lumbosacral Spine
Psychology
Trauma

Fractures

Dislocations

Spinal cord

Spinal Cord Injury

Spinal stenosis

Cervical

Lumbar

Lumbosacral

Tumors

Metastatic tumors

Primary benign tumors

Primary malign tumors

APPLICATION LETTER EXAMPLE:

Editor-in-Chief

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We enclose the manuscript titled '....' for consideration to publish in Journal of Turkish Spinal Surgery.

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I confirm that all authors have seen and agree with the contents of the manuscript and agree that the work has not been submitted or published elsewhere in whole or in part.

As the Corresponding Author, I (and any other authors) understand that Journal of Turkish Spinal Surgery requires all authors to specify any contracts or agreements they might have signed with commercial third parties supporting any portion of the work. I further understand such information will be held in confidence while the paper is under review and will not influence the editorial decision, but that if the article is accepted for publication, a disclosure statement will appear with the article. I have selected the following statement(s) to reflect the relationships of myself and any other author with a commercial third party related to the study:

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JOURNAL OF TURKISH SPINAL SURGERY

Dear Colleagues,

Once again, it is my privilege to be publishing this, the 4th issue, of our professional journal this year. As you have come to expect, it includes several clinical research studies. Unfortunately, I must apologize for the fact that it is late again because of technical issues beyond our control. In spite of this, I hope that each of you will take the time to read this issue thoroughly and incorporate anything you find useful into your practice.

In this issue, there are eight clinical research studies. The first study is a study concerning the "Evaluation of Serum Thiol/Disulfide Homeostasis and Ischemia-Modified Albumin Levels in Lumbar Disc Herniation." The second is a research study entitled "Treatment of Postoperative Cerebrospinal Fluid Drainage by Blood Patch Method in Patients Undergoing Vertebra Surgery". In the third, one can read a retrospective clinical study entitled, "Laminoplasty for the Surgical Treatment of Various Spinal Canal Pathologies". The fourth article is a retrospective study, "The Results of Early Versus Late Surgery in Traumatic Cervical Facet Joint Dislocation: a Retrospective Study." The authors of the fifth study examined the "Incidence of Dysphagia after Single Level Anterior Cervical Discectomy with Prosthesis Versus Blade Cage Implantation: a Retrospective Study." The sixth study gives a clear answer to the question "Which Imaging Method is More Effective When Placement a Lateral Mass Screw: O-arm Computed Tomography or X-ray?" while, in the seventh, the authors wrote about "Evaluation of Lumbar Vertebra Fractures with Thoracolumbar Injury Classification and Severity Score." The eighth article is about "Mid-term Clinical Outcomes of Surgically Treated Malignant Sacrum tumors"

I hope you found this issue thought provoking and edifying. As always, my goal is to try to provide you with the most current information about the latest developments in our field. My mission is, and has always been, to keep all of us on top of the most cutting-edge research in our field.

With kindest regards,

Editor in Chief

Metin Özalay, M.D.

JOURNAL OF TURKISH SPINAL SURGERY

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ORIGINAL ARTICLES

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EVALUATION OF SERUM THIOL/DISULFIDE HOMEOSTASIS AND ISCHEMIA-MODIFIED ALBUMIN LEVELS IN LUMBAR DISC HERNIATION

Özgür Öcal[1], Ahmet Eren Seçen[1], Denizhan Divanlıoğlu[1], Zeynep Dağlar[1], Göksal Günerhan[1], Esra Fırat Oğuz[2], Özcan Erel[2], Ali Dalgıç[1]

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ABSTRACT

Objective: Lumbar disc herniation (LDH) is a socio-economic burden. The physiopathology of the disease is not clarified completely. This study aimed to investigate the oxidation-reduction balance in LDH via serum thiol-disulfide and ischemia-modified albumin (IMA) levels.

Materials and Methods: This prospective case-control study included 30 patients with LDH and a control group with 30 healthy volunteers. Blood samples were analyzed for total thiol (-SH+ -S-S-), native thiol (-SH), and IMA levels. Disulfide levels and native thiol/total thiol ratio were calculated. The results of the two groups were compared.

Results: Native and total thiol levels were significantly higher in the LDH group than in the control group (p=0.007 and p=0.008, respectively). IMA levels were significantly higher in the LDH group than in the control group (p=0.000). The receiver operating characteristic curve demonstrated that the IMA value of 1.41 could predict the LDH with 80% sensitivity and 80% specificity (area under curve=0.888, confidence interval: 0.802-0.974).

Conclusion: LDH influences the thiol-disulfide balance, and increased IMA levels can predict LDH.

Keywords: Lumbar disc herniation, thiol-disulfide, IMA

Introduction

Lumbar disc herniation (LDH) is a common cause of low back pain (LBP) and lumbar radiculopathy[1], resulting in a socio-economic burden. The incidence of symptomatic LDH was reported as 1-3%[2]. Despite its high incidence, the cause and physiopathology of the LDH are unclear. Two possible mechanisms underlying the LDH are increased intranuclear pressure resulting in the prolapsed intervertebral disc (IVD) and degeneration of IVD. Although there were mechanical properties of the pathology, different arguments against the mechanical theory were proposed to explain the mechanism of the pain in LDH[3-5]. The severity of the symptoms does not always correlate with the size of the defect[6]. Therefore mechanical compression can not explain the clinical symptoms adequately.

The leading cause of LDH is intervertebral disc degeneration (IDD). IDD increases with age due to the changes in collagen integrity and oxidative stress.

Previously, radiculopathy was highly correlated with biochemical mediators of inflammation, and various antioxidant molecules have been shown to increase during degenerative LDHs[7-9]. Currently, it is shown that IDD has a high association with oxidative stress and reactive oxygen species (ROS)[6,10,11].

Erel and Neselioglu[11] first described thiol-disulfide homeostasis to assess the oxidation-reduction reactions. Thiols have sulfhydryl groups that become disulfide molecules under oxidative stress conditions. The inflammation, which is correlated with IDD in LDH, is an environment characterised by oxidative stress. Ischemic events also influence the metal binding capacity of the albumin. IMA, an oxidatively modified protein, is a new marker used to detect tissue ischemia[12].

Oxidative stress is a significant factor regulating aging and degeneration; both conditions have an extensive role in the pathogenesis of radiculopathy[6,10,13]. Therefore, we aimed to evaluate the thiol-disulfide homeostasis and IMA levels in patients with LDH for the first time in the literature and compare them with healthy people.

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MATERIALS AND METHODS

This prospective case-control study was performed between November 2019- April 2020 in Ankara City Hospital, Turkey. Ethical approval was obtained from Ankara City Hospital, No. 1 Clinical Research Ethics Committee Presidency (no: E1-20-819). The study protocol was performed according to the principles of the Declaration of Helsinki, and the written informed consent containing of the details of the study was obtained from all the participants.

Among outpatient individuals, 30 patients between the ages 25-62 with LBP due to LDH resistant to conservative treatment and surgery planned, included in the study. Patients who did not benefit from medical and local analgesic treatment during six months were determined as resistant to conservative treatment. As the control group, 30 age-matched healthy people were included in the study.

Patient Selection

LDH diagnosis was made depending on the clinical symptoms and radiographic findings. A total of 30 patients between 25-62 age years old who were included operation list due to spinal magnetic resonance imaging findings (extruded or sequestrated) were included in the study (Figure 1). Among the healthy people working in the neurosurgery clinic, age and gender-matched 30 volunteer people were randomly selected for the control group. Those patients who had the systemic disease (i.e., diabetes mellitus, hypothyroidism), a detectable cause of LDH (i.e., tumor, infection), previous lumbar surgery history, severe spinal stenosis, or lumbar fracture were excluded from the study.

Blood Sampling

The antecuboidal venous blood samples were taken into the ethylenediaminetetraacetic acid including tubes, at the time of admission. Blood samples were centrifuged at 2000×g for 10 minutes. Plasma at the top of the tubes separated and kept at -80 °C until the analyzing day.

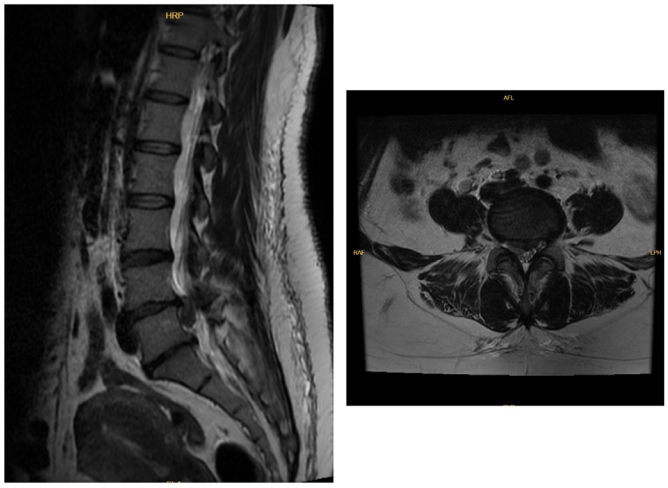

Figure 1. MRI findings of LDH
MRI: Magnetic resonance imaging, LDH: Lumbar disc herniation

Clinical chemistry analyser-Cobas 501 (Roche, Mannheim, Germany) was used to evaluate the dynamic plasma thiol/disulfide homeostasis by the automated procedure described by Erel and Neselioglu[11].

Total thiol (-SH+ -S-S-) and native thiol (-SH) were measured directly, and the disulfide levels, native thiol/total thiol ratio were calculated. With the method described by Erel and Neselioglu[11], the disulfide bonds were reduced to thiol groups containing sodium borohydride. Formaldehyde was used to remove the excess sodium borohydride to prevent further reduction of 5,5'-dithiobis (2-nitrobenzoic) acid (DTNB). DTNB reaction leads to identifying all thiol groups. The total and the native thiol levels were detected by Ellmann's and modified Ellmann's reagent. Half of the difference of the total and native thiol values was the dynamic disulfide bonds (-S-S). Additionally, albumin and IMA values were measured with the autoanalyzer (Roche, Cobas 501, Mannheim, Germany). Fifty mL of 0.1% cobalt was added to the serum samples. After 10 minutes of incubation, 50 mL 1.5 mg/mL dithiothreitol was added to the mixture. Subsequently, 1.0 mL of 0.9% sodium chloride solution was added after 2 minutes of incubation. The absorbance of the samples was measured with a spectrophotometer. The results were presented as absorbance units (kyn).

Statistical Analysis

The statistical analyses were done by using IBM SPSS Statistics version 21.0 (IBM Corp. Armonk, NY). Descriptive data were expressed as mean ± standard deviation and minimum, median, maximum values after evaluating the normality of variables by using the Kolmogorov-Smirnov test. For comparison of two groups, parametric data were estimated by using an independent sample t-test. The cut-off value for the IMA in predicting LDH was detected by the receiver operating characteristic (ROC) curve. Univariant logistic regression analyse was used to detect independent predictor factors of LDH. P-value <0.05 was interpreted as statistically significant.

RESULTS

There was no statistically significant difference between the groups in terms of age and gender. The mean ages (min-max) of the LDH and control group were 41.6 (25-62) and 40.97 (26-64), respectively (p=0.765). There were 18 women and 12 men in the LDH group, while there were 13 women and 17 men in the control group (p=0.301).

Table 1 shows the comparison of the thiol/disulfide homeostasis parameters and IMA levels of the groups. Accordingly, native and total thiol levels were significantly higher in the LDH group than in the control group (p=0.007 and p=0.008, respectively) (Figure 2). Although the disulfide/native thiol and disulfide/total thiol levels of the LDH group were higher than the control

group, the differences did not reach statistical significance (p>0.05). IMA levels were significantly higher in the LDH group than in the control group (p=0.000).

Univariate logistic regression analyse showed that native thiol, total thiol and IMA were predictors of LDH (p<0.05) (Table 2).

The ROC curve demonstrated IMA can predict the LDH with 80% and 80% specificity with the value of 1.41 (area under curve=0.888, confidence interval: 0.802-0.974) (Figure 3).

DISCUSSION

For the first time, this study evaluated the thiol-disulfide homeostasis and IMA levels in patients with LDH. Our results suggested that serum total and native thiol levels were significantly lower in patients with LDH. IMA levels were significantly higher in the LDH group indicating the hypoxic environment. IMA levels predicted the presence of LDH with

Table 1. Comparison of the groups according to the Thiol/disulfide homeostasis parameters and IMA levels

Groups Parameters	Lumbar disc hernia (n=30)		Control (n=30)		p-value*
		[Min - Max]		[Min - Max]	
Native thiol (µmol/L)	440.17±61.71	[315.0-528.0]	477.47±37.88	[387.0-574.0]	**0.007**
Total thiol (µmol/L)	481.87±66.90	[350.0-586.0]	522.37±43.17	[423.0-628.0]	**0.008**
Disulfide (µmol/L)	20.83±4.65	[12.0-29.4]	22.44±3.58	[12.5-30.0]	0.140
Disulfide/native thiol (%)	4.75±0.92	[2.8-6.7]	4.69±0.58	[3.0-5.9]	0.731
Disulfide/total thiol (%)	4.33±0.78	[2.6-5.9]	4.28±0.49	[2.8-5.2]	0.762
Native Thiol/total thiol (%)	91.34±1.55	[88.2-94.8]	91.44±0.97	[89.5-94.4]	0.768
IMA (U/mL)	1.60±0.29	[2.3-1.6]	1.18±0.25	[0.6-1.6]	**0.000**

*Independent Sample t-test
SD: Standard deviation, Min: Minimum, Max: Maximum, IMA: Ischemia-modified albumin

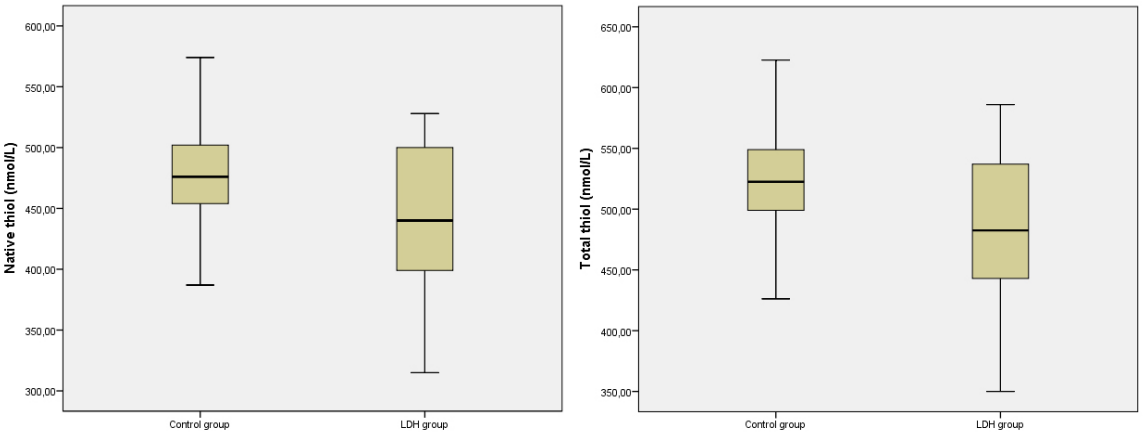

Figure 2. Native and total thiol levels of the groups
LDH: Lumbar disc herniation

Table 2. Univariate logistic regression analyse for LDH estimation

	Univariate analyses		
	p-value	Odds ratio	95% CI
Native thiol (mmol/L)	**0.012**	0.985	0.973-0.997
Total thiol (mmol/L)	**0.013**	0.987	0.976-0.997
Disulfide (mmol/L)	0.142	0.908	0.799-1.033
Disulfide/native thiol (%)	0.725	1.127	0.578-2,201
Disulfide/total thiol (%)	0.757	1.134	0.512-2,513
Native Thiol/total thiol (%)	0.763	0.941	0.632-1.401
IMA (U/mL)	**0.012**	6,016	2,294-15,780

LDH: Lumbar disc herniation, CI: Confidence interval, IMA: Ischemia-modified albumin

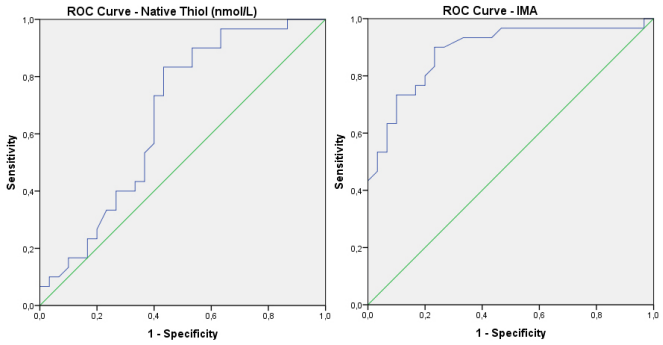

Figure 3. ROC curve of IMA levels
ROC: Receiver operating characteristic, IMA: Ischemia-modified albumin

high sensitivity and specificity (with 80% and 80% specificity with the value of 1.41).

The human organism has a dynamic balance between prooxidants and antioxidant defence systems. In the disruption of this balance, ROS occur and lead to cellular degeneration via increased lipid peroxidation, oxidative DNA damage, and cellular death[14,15]. There are many oxidative and antioxidative molecules located in intra/extracellular areas. Dynamic thiol-disulfide homeostasis is one of these oxidation-reduction reactions, a part of the non-enzymatic antioxidant system of the human body[16-18]. -SH groups of sulfur-containing amino acids are exposed to oxidation reaction in the environment with free radicals. Thiol groups of proteins consist of SH groups at the active location and are converted to the disulfide bindings in case of oxidative stress[18]. This is a bidirectional reaction. In an oxygen-rich condition, disulfide bonds may convert to the thiols again. Therefore thiol-disulfide is a dynamic balance changing according to the oxygenation of the environment. Thiols are potent antioxidant molecules that create more than half of total antioxidant capacity[19]. Therefore it may be a guide for clinical applications to evaluate the serum level of the thiols.

The degeneration of the IVD is a prerequisite for LDH. The excessive apoptosis of the cells of the nucleus pulposus is the leading cause of IVD degeneration[20]. Apoptosis is triggered by hydrogen peroxide (H_2O_2)- mediated oxidative stress[7]. An experimental study demonstrated that invitro antioxidant treatment exerted a protective effect against H_2O_2 exposure[21]. Aging is in a strict relationship with ROS, and recent data proved that aging gives rise to degeneration of the intervertebral disc cells[10,13,14]. Previously studies showed that a critical trans factor which is regulating the antioxidant genes, decreases with age[10,13,14]. The increased rate of LDH with increasing age is probably related to oxidative stress and its regulatory role in aging and degeneration. Oxidative stress is shown to disrupt the catabolism balance in IVD[22-24].

Although many articles state the association between several pathologic conditions, including neurodegenerative diseases such as Alzheimer's disease, Parkinson disease, osteoarthritis[25-27] and thiol-disulfide homeostasis, no study has indicated LDH yet. Other studies demonstrated a strong relationship between oxidative stress and IVD. Many molecules, enzymatic activity, and pro-oxidant-antioxidant balance were evaluated. Some of them are carboxymethyl-lysine, pentosidine, and peroxynitrite[9,28-31]. However, there is no study evaluating thiol levels in LDH. Depending on the reports of these studies indicating that thiols are major antioxidant molecules in plasma, we hypothesized that the level of thiols might decrease in LDH. Our results showed that thiol levels were significantly lower in the study group, as expected. Disulfide/native thiol ratios were also higher in the patients with LDH.

IMA is an ischemia marker and is primarily investigated in pathological cardiac conditions[32,33]. Simultaneously, IMA is investigated in many conditions associated with oxidative stress and found as an essential ischemia marker. During the hypoxic status, the N-termination of albumin changes and loses the metal bonding function. This modified albumin is called IMA, which occurs as a response to ROS due to ischemia. In the current study, the serum IMA levels were significantly higher in the study group compared with the control group. Morever we found a cut-off value of IMA (1.41) predicting the LDH with 80% sensitivity and 80% specificity. Therefore serum IMA levels may be an essential indicator of LDH.

Study Limitations

This study's primary limitation was the small number of patients. All of the thiol-disulfide balance markers were evaluated from the patients' serum. Confirmation of the levels of these markers in the specimen obtained during surgery would strengthen the study's impact. However, it was not possible to evaluate the tissue levels of the thiol-disulfide balance. Further, it is reported that both systemic oxidative stress and local oxidative stress are influenced by the IDD[34].

Our study's strength is this is the first study that focuses on the thiol-disulfide balance and IMA in LDH and presents a cut-off value for predicting LDH.

CONCLUSION

The thiol-disulfide balance shifts through to oxidant way during the LDH pathogenesis. The increased IMA levels seem to be the best indicator of underlying acute ischemic pathology.

Ethics

Ethics Committee Approval: Ethical approval was obtained from Ankara City Hospital, No. 1 Clinical Research Ethics Committee Presidency (no: E1-20-819).

Informed Consent: Informed consent was obtained from patients.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Concept: Ö.Ö., Design: Ö.Ö., D.D., G.G., Data Collection or Processing: Z.D., E.F.O., Ö.E., Analysis or Interpretation: Ö.Ö., A.D., Literature Search: Ö.Ö., A.E.S., Writing: Ö.Ö.

Financial Disclosure: The authors declared that this study received no financial support.

Conflict of Interest: The authors have no conflicts of interest to declare.

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TREATMENT OF POSTOPERATIVE CEREBROSPINAL FLUID LEAKAGE BY BLOOD PATCH METHOD IN PATIENTS UNDERGOING VERTEBRA SURGERY

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ABSTRACT

Objective: One of the complications in patients undergoing vertebra surgery is the prolonged cerebrospinal fluid (CSF) leakege due to incidental dura mater injury. Controlling this drainage is important in orthopedics practice with respect to vertebra surgery. Our aim was to investigate the effectiveness of widely used blood patch in the treatment of prolonged CSF leakage in patients undergoing vertebra surgery.

Materials and Methods: In this retrospective study, we reviewed medical records of patients who underwent vertebra surgery in our orthopedics and traumatology department. Among the 1385 patients examined, we included 64 of them who were performed blood patch and had ≥10 days of CSF discharge postoperatively.

Results: In 64 of 1385 patients evaluated within the scope of the study, the results of patients who had CSF leakage for 10 days or more and were treated with blood patch were investigated. The distribution of operation site in patients who received blood patch showed that the most commonly involved site was lumbar site due to isolated lumbar surgery (n=32). It was observed that the leakage stopped from the 1st hour dressing in 4 of the patients, from the 6th hour in 27 of them, and from the 24th hour in 22 of them. Leakage in 5 patients stopped between day 1 and day 5. The most common complication of the blood patch application in patients with ≥10 days of CSF leakage was local low-back pain (28.1%, n=18).

Conclusion: The blood patch seems to be an effective, practical, cheap, and successful method with low rate of complications for reducing/stopping prolonged CSF leakege after spine surgery.

Keywords: Blood patch, vertebra surgery, incidental dura injury, CSF leakage

INTRODUCTION

In spine surgery, cerebrospinal fluid (CSF) leakage after durotomy or secondary to incidental dura mater tears is a rare complication that could lead to serious consequences, requiring careful management. The incidental dura mater tears can vary greatly among surgeons, depending on the type and complexity of vertebra surgery procedures performed[1,2].

In orthopedic practice of vertebra surgery, prolonged CSF leakage may be associated with headache, nausea, vomiting, dizziness, hypotension, infection, and intracranial or intraspinal complications[3,4]. Addressing this problem is important for both vertebra surgery clinics and patients' medical and mental disorders. These complications of prolonged CSF leakage, as in all complications of vertebra surgery, cause prolonged hospitalization with additional treatment costs. Prolonged CSF leakage can be managed with several methods, including a blood patch[5,6].

Our aim was to investigate the effectiveness of blood patches in decreasing or ceasing postoperatively prolonged CSF leakage in patients undergoing vertebra surgery.

MATERIALS AND METHODS

This study was conducted in the orthopedics and traumatology clinic of the tertiary care hospital after the approval of the Non-Interventional Research Ethics Committee of Sakarya University with an approval number of: 715224730500104/32. In this study, we retrospectively evaluated the medical records of 1385 patients who underwent vertebra surgery between January 2010 and August 2013. The patients in our study were found to read and give written consent about the blood patch procedure.

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We examined 232 patients with prolonged CSF leakage that was confirmed by clinical experience and biochemical tests. Sixty-four patients who had leakage for at least 10 days and did not respond to hydration and bed rest were included in the study. Data on these patients' medical history, physical examination, laboratory findings (blood and CSF), treatment regimens, complications, amount of fluid from the leakage with its clinical appearance, and blood patch treatment outcomes were collected. Magnetic resonance (MR) images obtained at postoperative first month was assessed for pseudomeningocele for patients who received blood patch.

All patients are administered the blood patch in the prone position under sterile conditions through the drain opening. If any local pain or radiculopathy occurs then the procedure was stopped, blood patch was never applied more than 30 mL. After the application, the drainage tubes are removed, followed by tight dressing with abundant gauze sponge and pads under sterile conditions. Contaminated dressings are replaced immediately under sterile conditions. After the application of a blood patch, the prone position of the patient is maintained for 20-30 minutes under direct observation of a healthcare staff to monitor the general condition and check vital signs every 10 minutes. All patients are then instructed to be mobile as much as possible during the day. After the application, the dressing control of the patients was performed at the 1st, 6th and 24th hours. After the 24th hour, daily wound dressing control was performed. Waited 5 days to pass between repeated blood patches. If repeated blood patch application is required, the procedure was performed by the epidural needle to the likely area under scope guidance

RESULTS

In 64 of 1385 patients evaluated within the scope of the study, the results of patients who had CSF leakage for 10 days or more and were treated with blood patch were investigated. In this study, when the distribution of patients who underwent spinal surgery was examined by gender, it was seen that 596 (43%) of the patients were male and 789 (57%) were female. Considering the age distribution of these patients, it was found that the mean age for men was 34.2, while the mean age for women was 32.4. Twenty-seven (42.1%) patients were male and 37 (57.9%) were females who underwent blood patch.

The distribution of operation site in patients who received blood patch showed that the most commonly involved site was isolated lumbar surgery (n=32), followed by thoracolumbar surgery (n=23) and thoracic surgery (n=9). No blood patch treatment was applied to any patient who had cervical surgery (Figure 1).

It was found that all patients treated with blood patch underwent laminectomy. The most frequently performed procedure in these patients was posterior spinal instrumentation (PSI) + laminectomy + cage insertion (n=28), followed by PSI + laminectomy + pedicule subtraction osteotomy (n=20), PSI + laminectomy (n=11), and laminectomy alone (n=5) (Table 1).

It was observed that the leakage stopped from the 1st-hour dressing in 4 of the patients, from the 6th hour in 27 of them, and from the 24th hour in 22 of them leakage of 5 patients had stopped between day 1 and day 5. After continued to leakage on day 5, a second blood patch was applied in six patients. In the first 24 hours after the second application, leakage stopped in 4 patients. Leakage stopped 48 hours after the second application in 1 patient, and 96 hours after the second application in 1 patient.

The most common complication of the blood patch application in patients with ⩾10 days of CSF leakage was local low-back pain (28.1%, n=18). Fifteen patients were found to have nausea/vomiting, relieved with slowing or interrupting the blood patch administration followed by serum physiologic infusion and close monitoring. Twelve (18.7%) patients were detected to have dizziness and hypotensive episode, resolved by normalized blood pressure levels within ten minutes after serum physiologic infusion. As a delayed complication, four patients had pseudomeningocele, confirmed by clinical and MR imaging findings (Figure 2).

DISCUSSION

Incidental dura mater injuries are one of the important complications of vertebra surgery with an incidence rate of 1% to 14%[7-9]. Risk factors reported in dura injury include advanced age, anatomical spine variations, revision surgery, thin and weak dura layer, and surgeons with little or no experience[10].

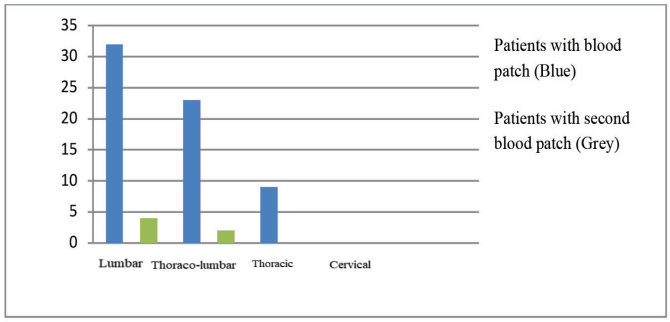

Figure 1. Blood patch application by spinal levels

Table 1. Distribution of surgical interventions in patients who were applied blood patch

Surgical procedure	Patients, n
PSI + Laminectomy + Cage insertion	28
PSI + Laminectomy + PSO	20
PSI + Laminectomy Laminectomy	11 5
Total	64

PSI: Posterior spinal instrumentation, PSO: Pedicle subtraction osteotomy

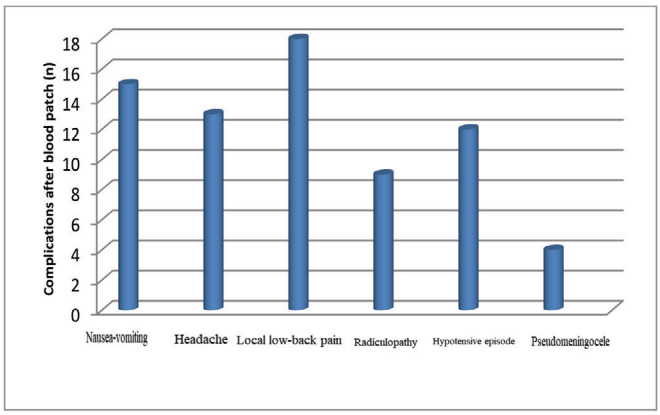

Figure 2. Complications after blood patch application

Dura tears are mostly formed in patients with adherent dura tissue, poorly planned dissections, altered anatomy, subsequently developing scar tissue, and first surgery. Since a small incision and split muscle incision reduce the potentially dead space, this approach is less likely to create persistent CSF leakage that may occur after durotomy. Spinal instrumentation creates more dead space around the dura, preventing the buffering effect of the paraspinal muscles on the dura tears. Persistent CSF leaking through the subarachnoid space causes signs and symptoms associated with dura mater tears. Persistent CSF leak may lead to cranial nerve palsy, radiculopathy-related chronic pain, and postural headache. Pseudomeningocele and cerebrospinal fistula can be seen postoperatively[11].

In the past, the CSF leakage that occurred after vertebra surgery was treated with surgical dura repair. Recently, dural materials and adhesives have been used as useful methods for dura repair. As an alternative to surgical modalities, closed subarachnoid drainage was also recommended[11].

Epidural (autologous) blood patch was first used by Gormley[12] in the treatment of headache that occurred as a result of dural puncture after spinal anesthesia in 1960. This procedure is mostly used in the treatment of headaches in patients who do not respond to conservative treatment (hydration, bed rest, pain relief medication) in anesthesiology practice. Animal and laboratory studies reported that autologous blood injection into the epidural space created blood clots in approximately 30 seconds and reduced CSF leakage[13]. Recently, this procedure has been reported to be used in the treatment of spontaneous low CSF pressure headache and in the treatment of CSF leakage in several patients (3 lumbar cases, 1 thoracic case) who underwent vertebra surgery. In the literature, bed rest for 24 to 96 hours has been recommended for patients with CSF leakage after vertebra surgery[14]. Tosun et al.[11] suggested bed rest of 48-96 hours for their patients with persistent CSF leakage after thoracolumbar vertebra surgery. In our cases, bed rest was recommended for 24-48 hours. After an epidural blood patch application, there is no need for general anesthesia and surgical re-exploration. At the same time, the clinicians have the opportunity to observe whether the CSF leakage would continue. According to previous studies infection risk is low[14].

Epidural blood patch may also be associated with several complications such as low-back pain and stiffness, radicular nerve discomfort, and subdural hematoma. Although hematoma-induced dural sac compression may occur, there is no paraplegia reported in the literature. However, surgical dura repair may be performed in rare cases where decompression is required or paraplegia occurs secondary to blood patch, or CSF leakage does not cease despite blood patch[14-17]. Than et al.[18] have recently reported successful outcomes in the management of incidental durotomy, where they treated five patients with minimal primary repair surgery.

Since the blood patch is introduced from where the leakage came from, there is a high probability that it will reach the level of the dura mater rupture with the leak. Therefore, it is much more effective in stopping CSF leakage. Compared to the blood patch applications via the injector, the method applied from the drainage tube is easy to apply and its complications such as incorrectly applied site, inability to apply adequate blood patch, dura mater injury, radiculopathy are much less. Studies reported that blood patches performed through epidural needles are effective up to about nine spinal levels[7].

The literature regarding the treatment of dura tears shows many modalities including medical treatment accompanied with bed rest, primary repair, closed subarachnoid drainage, muscle fat or fascia containing grafts, fibrin adhesives, cyanoacrylate polymer filler, gel foam application to the tear site, saline solution, dextrose solution infusion, and blood patch application[5-17]. Ylönen and Kokki[19] reported a successful outcome in their study of 40 patients; where 93% of patients responded after the first blood patch, and the remaining %7 achieved a positive outcome after the second blood patch.

In patients who develop prolonged CSF leakage after vertebra surgery, if the leakage continues despite conservative treatment, autologous blood patch is one of the treatment methods that should be considered.

Study Limitations

The limitations of our article are the lack of a comparison group and the small number of patients.

CONCLUSION

In patients undergoing vertebra surgery, prolonged CSF leakage after incidental dura mater injury may create a predisposition for many complications, have a negative impact on the patient's psychological status, and increase hospital expenditures during the prolonged length of stay.

In conclusion, the blood patch seems to be an effective, practical, cheap, and successful method with low rate of complications for reducing/stopping prolonged CSF leakage in patients who underwent vertebra surgery.

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Ethics

Ethics Committee Approval: This study was approved of the Non-Interventional Research Ethics Committee of Sakarya University with an approval number of: 715224730500104/32.
Informed Consent: The patients in our study were found to read and give written consent about blood patch procedure.
Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: S.E., E.B., F.F., Design: S.E., E.B., F.F., Data Collection or Processing: S.E., E.B., F.F., Analysis or Interpretation: S.E., E.B., F.F., Literature Search: S.E., E.B., F.F., Writing: S.E., E.B., F.F.

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LAMINOPLASTY FOR THE SURGICAL TREATMENT OF VARIOUS SPINAL CANAL PATHOLOGIES

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ABSTRACT

Objective: It was aimed to evaluate the patients who underwent laminoplasty for the various pathologies that were located in the spinal canal.

Materials and Methods: The records of the patients who underwent osteoplastic laminoplasty for various pathologies between 2014 and 2019 were analyzed retrospectively. Patient data including age, gender, preoperative and postoperative neurological conditions, type and radiographic localization of their pathologies, preoperative and postoperative deformities, involved segments, hospitalization periods and postoperative complications were gathered.

Results: Sixty-two patients were included in the study. The mean age of the patients was 44.3 years (9-80 years). Fifty-two patients had tumoral and 10 patients had non-tumoral pathologies. Grade 3 and 4 patients were predominant in the preoperative period, while grade 1 and 2 patients were predominant in the postoperative period according to Modified McCormick Scale classification of the patients. Twenty-three patients had preoperative deformity. A total of 138 laminae were reconstructed. One patient had cerebrospinal fluid leak in the long-term period and 1 patient had quadriplegia and respiratory deficiency in the postoperative period. In only 1 patient, a new-onset deformity developed and in 1 patient, progression of previous deformity was seen. However, the deformities of these patients did not require corrective surgery.

Conclusion: Laminoplasty technique has recently gained popularity and begun to replace traditional laminectomy technique. Laminoplasty is a preferred technique with the low complication rates and high patient-comfort in the postoperative period.

Keywords: Laminoplasty, spinal tumor, spinal deformity, cerebrospinal fluid leak

INTRODUCTION

Posterior approaches are the most appropriate and most commonly used methods in the surgery of lesions located in the spinal canal. Because they are easy ways to enter and widen the canal via laminae. The main purpose in these operations; to obtain adequate exposure and manipulation view and to provide adequate decompression. When performing these procedures, it should be the main goal of maintaining spinal stability by applying a minimal anatomic approach as much as possible[1,2]. However, opening an insufficient bone window may increase the complications of the surgery.

Laminectomies have been applied widely for many years for this purpose. However, due to the reasons such as the development of instability, occurence of granulation tissue, loss of normal anatomic plan and high rate of complications in reoperations, new approaches have been sought[3]. Laminoplasty techniques are now widely accepted procedures instead of laminectomy. In the present study, it is aimed to evaluate 62 patients who underwent laminoplasty due to various pathologies that are located in the spinal canal.

MATERIALS AND METHODS

The records of the patients who underwent osteoplastic laminoplasty for various pathologies in a single institution, between 2014 and 2019 were retrospectively reviewed. All study protocols were performed in accordance with the ethical rules proposed in the Helsinki Declaration. Ethics committee approval was received from Çukurova University Non-Interventional Scientific Research Ethics Committee (11.06.2021-112). Sixty-two patients who underwent laminoplasty with posterior approach were included in the study. Patient records including age, gender, preoperative and

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postoperative neurological conditions, type and radiographic localization of their pathologies, preoperative and postoperative deformities, involved segments, hospitalization periods and postoperative complications were gathered.

Surgical planning was performed according to the location of the lesions. Spinal contrast-enhanced magnetic resonance imaging (MRI) of all of the patients was performed preoperatively (Figure 1). Anteroposterior and lateral radiographs of the patients were performed. Hyperflexion and hyperextension radiographs were added in the patients with the suspicion of instability. Laminoplasty was not applied to the patients with preoperative instability and malalignment. New-onset or worsening of preoperative deformities were evaluated including loss of cervical or lumbar lordosis, cervical or thoracic kyphosis greater than 10° and scoliosis. All patients underwent a posterior approach in prone position. The laminae were cut bilaterally using a high-speed drill. Laminoplasty flaps were in the form of osteoplastic flaps and all segments were adhered to each other (Figure 2). Watertight closure of the duramater was ensured in all of the patients who had intradural pathologies. The laminoplasty flaps were fixed to their original position by using miniplates. For each lamina, 2 miniplates and 4 miniscrews were used. In all patients, Jackson-Pratt drains were placed above the laminae. During the drilling of the laminoplasty flaps, injuries of duramater or nerve roots had not been developed. The patients were medicated with prophylactic antibiotherapy (ampicillin sulbactam) peroperatively and postoperatively for 1 day. Modified McCormick Scale (MMS) was used to evaluate preoperative and postoperative neurological conditions of the patients. In the postoperative period, spinal contrast-enhanced MRI were performed in order to evaluate the lesions and operation areas and hyperflexion-hyperextension radiographs were performed in order to check for the development of instability (Figure 3).

Statistical Analysis

SPSS 25.0 (IBM Corporation, Armonk, New York, United States) program was used to analyze the variables. The Mann-Whitney

Figure 1. a) Preoperative sagittal and axial contrast-enhanced magnetic resonance images of 48-year-old female patient with T8-T9 intradural-extramedullary localized schwannoma. **b)** Postoperative sagittal and axial contrast-enhanced magnetic resonance images of the same patient revealing total resection of the tumor

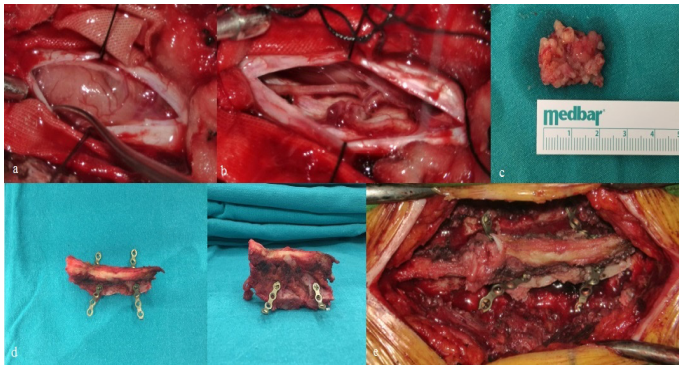

Figure 2. a) Peroperative image of the same patient revealing the intradural-extramedullary tumor. **b)** Peroperative image revealing total resection of the tumor. **c)** Image of the resected tumor. **d)** Peroperative image of the laminoplasty flap. **e)** Peroperative image revealing the fixation of the laminoplasty flap with miniplates

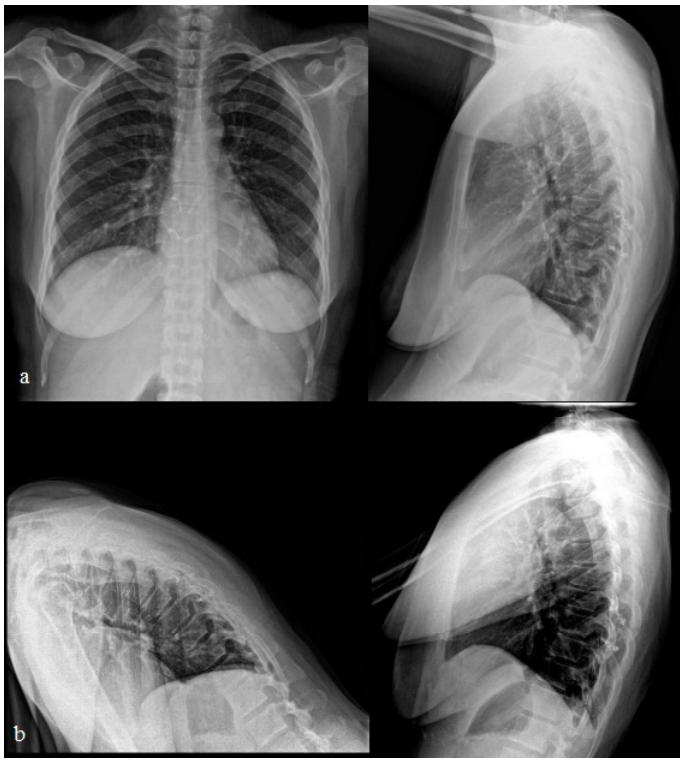

Figure 3. a) Postoperative 2-years anteroposterior and lateral radiographs of the same patient. **b)** Postoperative 2-years hyperflexion and hyperextension radiographs showing no kyphosis or instability

U test was used with the Monte Carlo results to compare the categorical variables quantitatively. The quantitative variables were described as mean ± standard deviation, and the median range (maximum-minimum), and categorical variables as n (%). The variables were examined at 95% confidence level and $p<0.05$ was considered significant.

RESULTS

Patient Profile

A total of 62 patients were included in the study. The mean age of the patients was 44.3 years (9-80 years). Thirty-seven patients (59.6%) were female and 25 patients (40.4%) were male. Two patients were in pediatric age group and 60 were adult. Fifty-two patients had tumoral lesions and 10 patients had non-tumoral pathologies. Of these 10 patients, 3 had arteriovenous malformation, 3 had cavernous malformation, 3 had spinal abscess and 1 had arachnoid cyst. In the tumoral group, 14 patients had schwannoma, 13 patients had ependymoma, 12 patients had meningioma, 5 patients had astrocytoma, 3 patients had lipomatosis, 2 patients had metastasis, 1 patient had hemangioendothelioma, 1 patient had primitive neuroectodermal tumor and 1 patient had epidermoid tumor (Table 1). Grade 3 and 4 patients were predominant in the preoperative period, while grade 1 and 2 patients were predominant in the postoperative period according to MMS classification of the patients (Figure 4).

Neuroimaging

Thirty-five patients had intradural-extramedullary, 21 patients had intramedullary and 6 patients had extradural pathologies according to their neuroimaging. Spinal localizations of the pathologies were; cervical in 4 patients, cervicothoracic in 1 patient, thoracic in 32 patients, thoracolumbar in 6 patients and lumbar in 19 patients. Twenty-three patients had preoperative deformity (Table 2).

Surgery

All of the patients underwent laminoplasty according to the length of the lesions with posterior approach in the prone position. A total of 138 laminae were reconstructed. A maximum of 5 segment laminoplasty was performed. Nine patients underwent 1 segment, 37 patients underwent 2 segments, 10 patients underwent 3 segments, 5 patients underwent 4

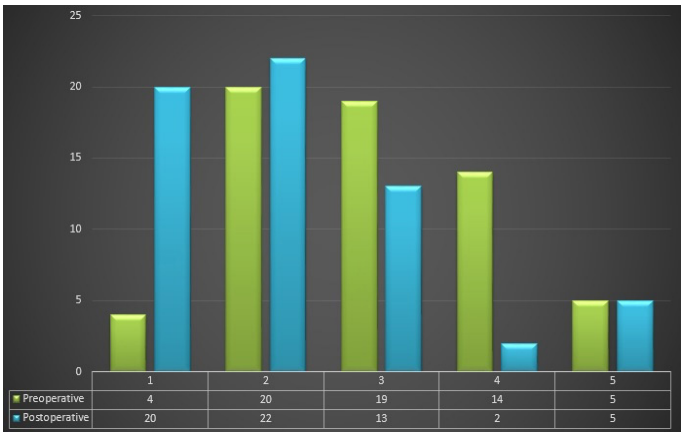

Figure 4. Distribution of the patients' preoperative and postoperative neurological conditions according to Modified McCormick Scale (X axis: Modified McCormick Scale scores, Y axis: number of patients)

Table 1. Demographic data of the patients in the study group

Characteristics		Study group n=62 (%)
Age (Mean)		44.3±4.6 (9-80 years)
Gender	Female	37 (59.6%)
	Male	25 (40.4%)
Pathology		
Tumoral	Schwannoma	14 (22.6%)
	Ependymoma	13 (21%)
	Menengioma	12 (19.6%)
	Astrocytoma	5 (8%)
	Lipomatosis	3 (4.8%)
	Metastasis	2 (3.2%)
	Hemangioendothelioma	1 (1.6%)
	PNET	1 (1.6%)
	Epidermoid tumor	1 (1.6%)
Non-tumoral	AVM	3 (4.8%)
	Cavernous malformation	3 (4.8%)
	Abscess	3 (4.8%)
	Arachnoid cyst	1 (1.6%)

PNET: Primitive neuroectodermal tumor, AVM: Arteriovenous malformation

segments and 1 patient underwent 5 segment laminoplasty (Table 2). In all patients with intradural pathologies, watertight closure of the duramater was ensured. Valsalva maneuver was performed in order to check cerebrospinal fluid (CSF) leak. The mean duration of hospitalization was 3.6 days (2-64 days interval). The mean follow-up period of the patients was 3 years (1-6 years interval).

Complications

There were some complications detected in 2 patients. One patient had CSF leak in the long-term period and 1 patient had quadriplegia and respiratory deficiency in the postoperative period (Table 2). Mortality was not developed. The patient who had CSF leak was treated with lumbar subarachnoid drainage. In the postoperative period, quadriplegia and respiratory deficiency were detected in the patient with intramedullary cavernoma in the cervical region. The patient, who was followed in the intensive care unit, was connected to the mechanical ventilator by tracheostomy and the rehabilitation process was started. In terms of the development of postoperative deformity, only 1 patient developed new-onset deformity and 1 patient had progression of previous deformity (Table 2). However, there is no indication of surgery for deformities of these patients.

DISCUSSION

The technique of cutting and replacing the laminae for surgical treatment of intraspinal pathologies was firstly established by Raimondi et al.[4] in 1976. Hirabayashi et al.[3] defined open-door laminoplasty technique in 1983 and Kurokawa et al.[5] defined French-door laminoplasty technique in 1982. Afterwards, many techniques have been developed to prevent postoperative deformity and adhesion formation in the operation area in spinal cord and cauda equina tumors[6-9]. Open-door laminoplasty method is applied by cutting one side of the laminae and pushing the block towards the other side. French-door laminoplasty method is applied by splitting the spinous processes of the vertebrae. Another method which is applied as two-sided cutting of the laminae and then fixation using miniplates is called osteoplastic laminoplasty. We applied osteoplastic laminoplasty method in the present study.

Spinal column is a dynamic system. A simple biomechanical concept of the spine is as two columns, an anterior and a posterior ones. About 80% of the axial load is absorbed by anterior column, whereas the remaining 20% is spread to posterior elements as a shearing force. The posterior column, consisting of laminae and facet joints, works as a chain of articulators. Supraspinous-interspinous ligaments and paraspinal muscles support the posterior column especially in the anterior flexion body positions[1,10]. In addition to the preservation of bone structures with the application of laminoplasty, it is also aimed to ensure the continuity of the posterior supraspinous and interspinous ligaments and to provide the re-adhesion surfaces of the paraspinal muscles.

Laminectomy is the most widely used surgical method to reveal the spinal canal. However, it has also been reported that laminectomy has very serious disadvantages such as spinal

Table 2. Neuroimaging and surgical characteristics of the patients

Characteristics		Study group n=62 (%)
Localization	Cervical	4 (6.5%)
	Cervicothoracic	1 (1.6%)
	Thoracic	32 (51.6%)
	Thoracolumbar	6 (9.6%)
	Lumbar	19 (30.7%)
Association with duramater and medulla	Intramedullary	21 (33.9%)
	Intradural extramedullary	35 (56.5%)
	Extradural	6 (9.6%)
Preoperative deformity	+	23 (37%)
	-	39 (63%)
Number of laminoplasty segments	1	9 (14.6%)
	2	37 (59.8)
	3	10 (16%)
	4	5 (8%)
	5	1 (1.6%)
Postoperative deformity	New-onset	1 (1.6%)
	Worsening	1 (1.6%)
Complications	CSF leak	1 (1.6%)
	Quadriplegia	1 (1.6%)

CSF: Cerebrospinal fluid

deformity, instability, acceleration of spondylotic changes, epidural fibrosis and formation of spinal cord and nerve root compression due to laminectomy membrane formation[2,11-15]. Laminoplasty provides significant advantages, especially in pediatric patients, avoiding such complications when applied to intraspinal lesions.

The incidence of deformities after laminectomies for spinal cord tumors has been found 10% in adult patients and 22-100% in pediatric patients in the literature[13-19]. In the study including 55 pediatric patients, patients underwent laminectomy for intramedullary spinal cord tumors and the rate of new deformities was found to be 16%. Operations extending beyond 4 spinal segments and presence of deformity before the operation were defined as the main risk factors[20]. In the study performed by Liu et al.[21], spinal instrumentation had to be added in a second session in the patients who underwent surgery extending beyond 3 spinal segments. In the literature, risk factors for postlaminectomy deformities has been defined as age, preoperative deformity, intramedullary tumors, preoperative radiotherapy treatment, increased laminectomy segments, lateral extension and destruction of facets during surgery[2,14,20].

There are studies comparing laminoplasty and laminectomy in the literature in terms of postoperative deformity development[2,18,19,22]. In the study performed by McGirt et al.[19], no significant difference was found between laminoplasty and laminectomy in terms of early postoperative deformity. Likewise, Ratliff and Cooper[22] presented no significant difference between the two methods. However, there are studies in the literature that have argued that in all age groups, especially in pediatric patients, the laminoplasty method reduces postoperative deformity development and the need for stabilization in a second session[1,2,9,18,23,24]. In the study performed by Montano et al.[2], laminectomy and laminoplasty methods were applied and compared in 43 patients. None of the patients who underwent laminoplasty, developed a new deformity and the rate of deterioration in deformity was found to be lower in the laminoplasty group than in the laminectomy group[2].

CSF leak is another important complication that develops after the resection of the mass lesions in the spinal canal. Especially in patients who underwent laminectomy, the risk of CSF leak increases despite the watertight closure of the dura in these patients due to the destruction of the normal anatomical plan, the excision of one of the barriers and the adhesions to the duramater that may occur in the postoperative period. It is also aimed to decrease the rate of CSF leak by laminoplasty application. Normally, CSF leak rates after laminectomy were presented in the range of 5.3-17.4% in the literature[2,20,25]. Montano et al.[2] presented that CSF leak was not detected in any of the patients who underwent laminoplasty. In the present study, only 1 patient had CSF leak and the rate of CSF leak was detected as 1.6%.

It is known that excessive scar tissue developing after surgery in laminectomy patients is one of the most important factors causing low back pain[1,26]. Epidural fibrosis can extend to the neural canal and cause adhesions to the duramater and nerve roots. As a result of this, low back pain and radiculopathy can occur due to traction of the neural structures[1,26]. To prevent this, vertebral lamina is the most effective, natural and safe mechanical barrier. Laminoplasty is effective against this complication by preserving the vertebral laminae[1,2,23]. Laminoplasty is also an advantages technique in recurrence surgeries that preserves the anatomical landmarks, provides the easy dissection and reduces the risk of injury to the neural structures[1,2,9].

Despite all these advantages, there are some cases where laminoplasty is not sufficient. The most important of these situations is to consider postoperative deformity in patients with large tumors including long segments, especially above 5 segments. In addition, instrumentation should be considered in surgeries where facet joints cannot be preserved. Laminae should not be reused for laminoplasty in cases with the tumoral invasion of the laminae.

Study Limitations

There are certain limitations of the present study. The most important limitation was the retrospective nature of the study. The absence of a laminectomy cohort in which we can compare the laminoplasty group is another important limitation. The patient group was not classified as pediatric and adult, and a study group of a total of 62 patients was composed.

CONCLUSION

Laminoplasty technique has many advantages in the light of the present study and the previous researches in the literature. The most important advantages of laminoplasty technique are as follows; reconstruction of the spinal canal, reduction of the spinal deformity and instability, obtaining better cosmetic results, prevention of epidural fibrosis and adhesions, facilitation of repetitive surgeries and supporting the functions of paraspinal muscles. Laminoplasty is a noticeable technique with the low complication rates and high patient-comfort in the postoperative period.

Ethics

Ethics Committee Approval: Ethics committee approval was received from Çukurova University Non-Interventional Scientific Research Ethics Committee (11.06.2021-112).

Informed Consent: Retrospective study.

Authorship Contributions

Surgical and Medical Practices: K.O., A.G., Concept: K.O., A.G., Design: K.O., A.G., Data Collection or Processing: E.G., K.M.O., N.E.C., Data analysis or Interpretation: K.O., U.E., Literature Search: K.O., K.M.O., N.E.C., Writing: K.O., U.E., Critical Revision of Manuscript: K.O., A.G., Final Approval and Accountability:

K.O., E.G., K.M.O., N.E.C., U.E., A.G., Technical or Material Support: K.O., K.M.O., N.E.C., Supervision: K.O., A.G.

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THE RESULTS OF EARLY VERSUS LATE SURGERY IN TRAUMATIC CERVICAL FACET JOINT DISLOCATION: A RETROSPECTIVE STUDY

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ABSTRACT

Objective: Various strategies are suggested for facet joint dislocations after cervical trauma. The effect of timing of surgery on neurological outcome is controversial, both early and late surgeries have advantages and disadvantages. We aimed to investigate the neurological results of early versus late surgery for traumatic subaxial cervical facet joint dislocations. We also aimed to investigate the effect of unilateral and bilateral injuries on neurological recovery.

Materials and Methods: The data of 23 consecutive patients with facet joint dislocation between 2013-2020 were retrospectively analyzed. The data of age, gender, spinal level and side, surgical strategy, surgical timing, neurological status, and prognosis were collected from medical reports. Surgery within the first 24 hours of trauma was defined as early surgery and surgery after 24 hours of trauma was defined as late surgery. The effect of timing of surgery and unilateral or bilateral nature of the injury on neurological outcome were investigated at one-year follow-up.

Results: In a total of 19 patients with neurological deficits, early surgery resulted in neurological recovery in 7 of 12 patients (p=0.001), and late surgery resulted in neurological recovery in 2 of 7 patients (p=0.135). While 8 of 12 patients with unilateral dislocation showed neurological recovery (p=0.002), only 3 of 11 patients with bilateral facet joint dislocations showed neurological recovery (p=0.061).

Conclusion: Early surgery may result in better neurological outcomes at one-year follow up than late surgery. Patients with unilateral facet joint dislocation have better prognosis than bilateral injuries in terms of neurological recovery.

Keywords: Cervical trauma, subaxial cervical spine, facet joint dislocation, early surgery, traumatic disc herniation

INTRODUCTION

Trauma to the cervical spine is commonly related to motor vehicle accidents in young patients and falls in the elderly[1]. Nearly half of the cervical spinal injuries take place at C5-C7 levels and these segments are the most commonly affected levels[2]. Cervical trauma can result in fractures, traumatic disc herniations, listhesis, facet joint dislocations, and ligamentous injuries. They may lead to cervical instability and neurological deficits which may lead to serious morbidities and even mortality. Various treatment options are suggested for facet joint dislocation in literature including closed and open reductions. While the closed reduction is non-invasive and formerly accepted as advantageous, it is believed that it may lead to worsening of neurological deficits and open surgical treatments are more commonly adopted recently[3]. The most obvious indications for surgery are cervical instability and neurological deficits[4]. Surgical treatment for subaxial cervical trauma aims to decompress the spinal cord and roots, and also restore adequate cervical alignment and stability[5]. When surgical treatment is the choice, the timing of the surgery is another controversy. Whether early surgery is better for neurological deficits is an ongoing debate. In this study, we aim to investigate the neurological results of early versus late surgery for traumatic subaxial cervical facet joint dislocations in both unilateral and bilateral cases. We also aim to investigate the effect of unilateral and bilateral injuries on neurological recovery.

MATERIALS AND METHODS

This retrospective study was performed in accordance with the "Declaration of Helsinki". This study is approved by the Local Ethics Committee of Marmara University, by decision number 09.2021.667. This study included surgically treated patients admitted to our tertiary center between 2013 and 2020, with facet joint dislocation after trauma in the subaxial cervical spine.

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Age, gender, spinal level, and side, surgical strategy, surgical timing, neurological status, and prognosis were collected retrospectively. American Spinal Cord Injury Association (ASIA) scoring[6] was used for neurological assessment at preoperatively and postoperatively at 12 months. A positive change of one level in ASIA scoring was accepted as neurological recovery. All patients were operated on using anterior, posterior, or a combination of anterior and posterior techniques aiming to achieve appropriate spinal cord decompression and alignment of the cervical spine. Early surgery was defined as the surgical procedure accomplished within the first 24 hours of trauma and late surgery was defined as the surgeries performed after 24 hours of trauma. The effect of the timing of surgery on the neurological outcome is investigated along with the unilaterality or bilaterality of the injury.

Statistical Analysis

Statistical analysis was accomplished using SPSS statistics software version SPSS 25.0 (SPSS Inc., IBM, NY, USA). ASIA scoring and uni-or-bilaterality were used as dependent variables in separate analyses, and Friedman Test was employed. P-values lower than 0.05 were considered statistically significant.

RESULTS

Twenty-three patients were included in the study. All had traumatic subaxial cervical facet joint dislocations and etiology included motor vehicle accidents, falls, and external mass hits. After careful examination, all patients were radiologically assessed using computed tomography (CT) and magnetic resonance imaging (MRI) including short tau inversion recovery. There were 16 males and 7 females, and their ages ranged between 17 and 77 (mean 49.17). Injured segments were C3-4 in one, C4-5 in 3, C5-6 in 9, and C6-7 in 10 patients. Twelve patients had unilateral and 11 patients had bilateral facet joint dislocations. There was traumatic disc herniation in 8 patients and this finding guided surgical strategy in most cases. Six of these 8 patients were operated on using the anterior approach only, and the remaining 2 patients were operated on with combined anterior and posterior approaches. One patient had an anterior approach but did not have a traumatic disc herniation. The remaining 14 patients without traumatic disc herniation were operated on using the posterior approach. One patient having ankylosing spondylitis as comorbidity, who was operated on using the anterior approach, required revision surgery due to instability one month after initial surgery, and posterior fixation was performed. Early physical therapy and rehabilitation were initiated in all patients on postoperative day 1.

ASIA scoring preoperatively was E in 4 patients, D for 5 patients, C for 5 patients, and B for 9 patients. In 4 ASIA E patients, scoring was E for all at one year follow-up. In 5 ASIA D patients, 4 had ASIA E and 1 remained ASIA D in one year follow-up. In 5 ASIA C patients, 3 had ASIA D and 2 remained ASIA C in one year follow-up. In 9 patients with ASIA B, 1 patient had ASIA E, 1 patient had ASIA C and 7 remained ASIA B at one year follow-up (Table 1).

The early surgery group included 14 patients and the late surgery group included 9 patients. Twelve of 14 patients had neurological deficits in the early surgery group and seven of these 12 patients (30% of total) showed neurological recovery. In the late surgery group, 7 of 9 patients had a neurological deficit and only 2 of them (8.6% of total) showed neurological recovery.

In total, 19 patients had neurological deficits preoperatively. The early surgery group included 12 patients and the late surgery group included 7 patients, respectively. While 7 of 12 patients (58%) in the early surgery group showed neurological recovery, only 2 of 7 patients (28%) in the late surgery group showed neurological recovery. In the early surgery group, postoperative one-year ASIA scores were significantly better than preoperative ASIA scores (p=0.001), however, in the late surgery group, there were no significant differences between pre-and postoperative ASIA scores (p=0.135) (Table 2).

While 8 of 12 patients with unilateral facet joint dislocation had neurological deficits (66%), 11 out of 11 patients with bilateral facet joint dislocation had neurological deficits (100%). In patients with unilateral facet joint dislocation with neurological deficit, 6 of 8 (75%) showed neurological recovery. Their postoperative one-year ASIA scores were significantly better than preoperative ASIA scores (p=0.002). In patients with bilateral facet joint dislocation with neurological deficit, 3 of 11 patients (27%) showed neurological recovery. There were no significant differences between preoperative and postoperative ASIA scores in this group (p=0.061) (Table 3).

DISCUSSION

Instability and neurological deficits are the main indications of surgery after traumatic facet joint dislocations in the cervical spine. While a thorough neurological examination is of paramount importance in cervical spinal trauma, imaging modalities including CT and MRI may delineate the injuries like facet joint alignment, traumatic disc herniation, posterior ligamentous disruptures, and bony fractures[7-9]. Traumatic disc herniation accompanying facet joint dislocation plays a very important role in decision making for the type of surgery, because a posterior approach in the presence of anterior disc herniation is reported to have a high risk for secondary/iatrogenic spinal cord injuries[2,4,10]. The present study included 19 patients with neurological deficits and 8 of them showed evidence of traumatic disc herniation on MRI. Two of them had combined anterior and posterior approaches and 6 had anterior-only approach. Only one patient without disc herniation was operated on using the anterior approach and the remaining 14 patients had a posterior approach. This finding also shows the importance of the presence of traumatic disc herniation in decision-making for the approach to use.

Table 1. Descriptive data for 23 patients

Patient	Age	Gender	Injury mechanism	Level	Side of dislocation	Surgery	ASIA score			Disc herniation	Timing of surgery
							Preop	At 1 month	At 12 months		
1	75	F	Fall	C5-6	Bilateral	Posterior	C	C	C	No	Late
2	42	M	Fall	C6-7	Right	Anterior	B	B	B	No	Early
3	47	M	Fall	C5-6	Left	Anterior	C	D	D	No	Early
4	17	M	Motor vehicle accident	C5-6	Left	Anterior	B	C	C	No	Early
5	62	M	Fall	C6-7	Bilateral	Posterior	B	B	B	No	Late
6	37	M	Motor vehicle accident	C5-6	Right	Anterior	E	E	E	Yes	Late
7	77	F	Fall	C6-7	Bilateral	Posterior	B	B	B	No	Early
8	34	M	Fall	C5-6	Left	Anterior	B	B	B	Yes	Late
9	50	F	Fall	C6-7	Bilateral	Posterior	B	B	B	No	Early
10	50	F	Fall	C6-7	Bilateral	Posterior	D	E	E	Yes	Early
11	32	M	Hit by mass	C6-7	Left	Anterior	E	E	E	Yes	Early
12	27	M	Fall	C5-6	Bilateral	Anterior	D	D	D	Yes	Late
13	53	M	Fall	C5-6	Bilateral	Ant + Post	B	C	E	Yes	Early
14	59	M	Fall	C6-7	Left	Posterior	D	E	E	No	Late
15	46	M	Hit by mass	C6-7	Left	Posterior	E	E	E	No	Early
16	41	M	Fall	C4-5	Right	Ant + Post	C	D	D	Yes	Early
17	49	M	Fall	C4-5	Bilateral	Posterior	C	C	C	No	Late
18	34	F	Motor vehicle accident	C6-7	Right	Posterior	E	E	E	No	Late
19	54	M	Motor vehicle accident	C4-5	Bilateral	Ant + Post	B	B	B	No	Early
20	76	F	Fall	C5-6	Bilateral	Posterior	C	D	D	No	Early
21	55	M	Motor vehicle accident	C3-4	Bilateral	Posterior	B	B	B	No	Early
22	67	M	Fall	C5-6	Left	Posterior	D	E	E	No	Early
23	47	F	Motor vehicle accident	C6-7	Left	Posterior	D	E	E	No	Late

ASIA: American Spinal Cord Injury Association, F: Female, M: Male

Table 2. The outcomes for patients having neurological deficit at one year follow-up with early and late surgeries

Timing of surgery	Total	Neurological recovery	p-value
Early surgery	12	7	0.001
Late surgery	7	2	0.135

Table 3. The outcome for patients having neurological deficit at one year follow-up with unilateral and bilateral facet joint dislocations

Side of dislocation	Total	Neurological recovery	p-value
Unilateral	8	6	0.002
Bilateral	11	3	0.061

Closed or open reduction for cervical facet joint dislocation is still a controversial topic. Closed reduction is reported to have a success rate as high as 98%[11], although it is reported with much lower success rates in bilateral cases[12]. It may lead to worsening neurological function in patients who also have traumatic disc herniation[12,13]. Although the closed reduction is regarded as a non-invasive measure, open surgeries have the advantages of being safe, reliable, easy to perform, and lesser secondary/iatrogenic injuries[14-20]. Closed reduction is suggested in one study for conscious, cooperated, neurologically intact patients without traumatic disc herniation and posterior ligamentous injury[9].

The posterior approach utilizes decompression from the posterior by removing bony fragments and disrupted ligaments, and has the advantage of direct reduction of the facet joints[10,21]. It may serve as a solid stabilization and fusion method. It also has disadvantages including more dissection of soft tissues, more segments needed for fusion, and a higher risk of complication in the presence of traumatic disc herniation or any other ventral compressions[22]. The anterior approach provides better cervical lordosis, fewer problems associated with scar tissue healing and postoperative pain[10]. It also allows decompression of traumatic disc herniation or any other ventral compressions[23]. On the other hand, the anterior approach may fail to re-align the facet joints properly and this distraction maneuver may also lead to secondary/iatrogenic injury to the spinal cord[24]. Combined anterior and posterior approaches best reduce the risk of secondary/iatrogenic injuries and are used in complex situations[10]. We did not use closed reduction in any of the patients in this study. In the case of ventral compression caused by a traumatic disc herniation or other bony fragments, an anterior approach was chosen. After successful anterior decompression, the reduction was also attempted anteriorly. In 6 patients, the anterior approach resulted in successful decompression and reduction, and surgery was completed with anterior fusion (Figure 1). However, in 3 patients, an anterior reduction attempt was failed and a posterior approach was added for reduction and appropriate cervical alignment (Figure 2). In the remaining 14 patients, there was no anterior compression and a posterior-only approach was used successfully for reduction (Figure 3).

Patients with bilateral facet joint dislocation have more serious neurological deficits than patients with unilateral facet joint dislocations[25,26]. During the trauma, higher forces and excessive hyperflexion are the causes for bilateral facet dislocation, and this is also suggested as the cause for more serious neurological injuries in bilateral facet joint dislocations than unilateral facet joints dislocations[25,26]. While there were 11 patients in our study with bilateral facet joint dislocation and all had neurological deficits, there were 12 patients with unilateral facet joint dislocation and 8 of them had neurological deficits. This is concordant with recent literature.

Early or late surgery is also another controversial issue. Some reports suggest no difference in neurological function between early and late surgeries[27]. It is also reported that in patients with complete neurological functional loss, early surgery just affects the hospital stay and has no effect on neurological function[28]. On the other hand, several reports are suggesting early decompression and stabilization are associated with favorable outcomes for neurological function[3,29-34]. In Surgical Timing in Acute Spinal Cord Injury Study, it is shown that the positive effects of early surgery within the first 24 hours of cervical trauma on neurological recovery are more commonly observed than late surgery[35]. In a multi-center study, early surgery is found to have a direct association with a good prognosis in patients with complete motor paralysis[36]. In our study, results of early surgery favor a better neurological outcome in patients with traumatic facet joint dislocations with neurological deficits. While early surgery resulted in better neurological outcomes in 7 of 12 patients (58%) at one-year follow-up, late surgery resulted in better neurological outcomes in only 2 of 7 patients (28%) at one-year follow-up.

Figure 1. Radiological imaging of a patient operated anteriorly. A) Preoperative T2-weighted sagittal MRI showing anterolisthesis at C5-6 level. Traumatic disc herniation is evident at C5-6. B) Preoperative CT showing anterolisthesis at C5-6. C) Postoperative T2-weighted MRI imaging artifact at operated level and proper decompression of spinal cord. Hyperintensity at the level indicates spinal cord injury at C5-6 levels. D) Postoperative CT shows proper alignment of cervical spine and fusion material at the operated level

MRI: Magnetic resonance imaging, CT: Computed tomography

Study Limitations

Retrospective and non-randomized nature is the main limitation of the study. The relatively small cohort is also another limitation. Although it is difficult, prospective randomized

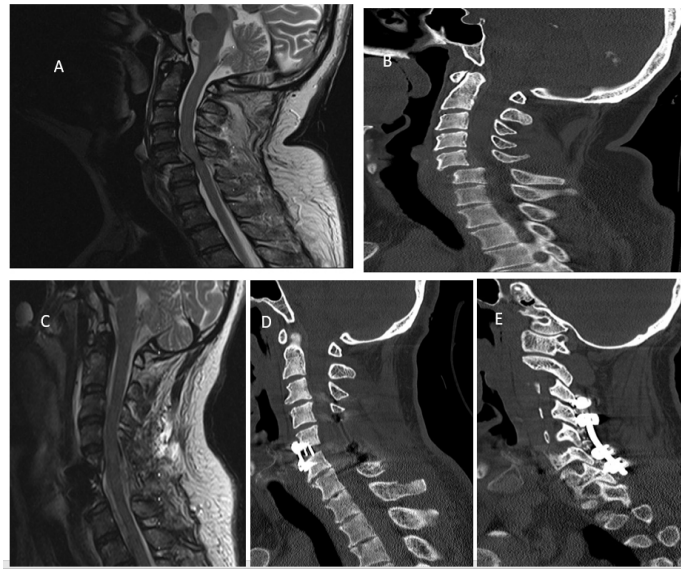

Figure 2. Radiological imaging of a patient operated both anteriorly and posteriorly. A) Preoperative T2-weighted sagittal MRI showing anterolisthesis at C5-6 level. B) Preoperative CT showing anterolisthesis at C5-6. C) Postoperative midsagittal T2-weighted MRI section shows proper decompression of apinal cord. Hyperintensity at the level indicates spinal cord injury at C5-6 levels. D) Postoperative CT shows proper alignment of cervical spine and anterior fusion material at the operated level. E) Post-operative CT shows proper alignment of cervical spine and posterior fusion material at the operated level

MRI: Magnetic resonance imaging, CT: Computed tomography

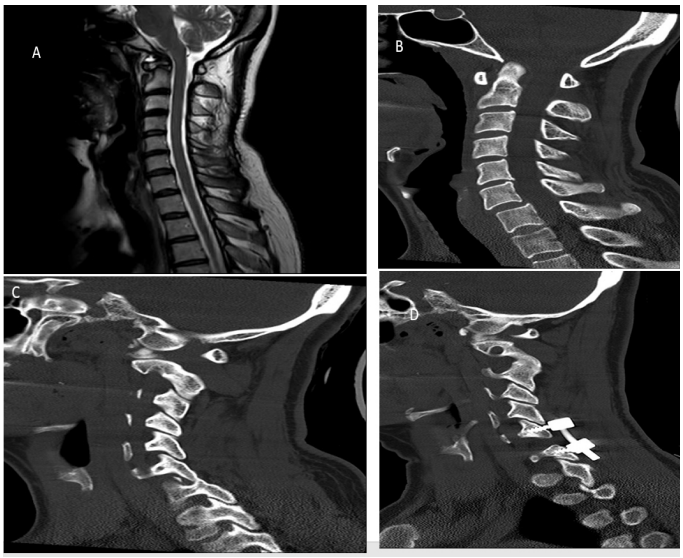

Figure 3. Radiological imaging of a patient operated posteriorly with unilateral facet joint dislocation. A) Preoperative midsagittal T2-weighted MRI section shows no abnormalities. B) Preoperative midsagittal CT section shows slight anterolisthesis. C) Preoperative sagittal CT section shows dislocated facet joint at C6-7 levels. D) Postoperative CT shows reduction of facet joints and posterior fusion material at the operated level

MRI: Magnetic resonance imaging, CT: Computed tomography

studies with larger patient numbers may thoroughly investigate the effects of early surgery in facet joint dislocation regarding the neurological outcome.

CONCLUSION

In patients with facet joint dislocation, early surgery within the first 24 hours of cervical trauma may result in better neurological outcomes in the one-year follow-up than late surgery. Patients with unilateral facet joint dislocation have a better prognosis than patients with bilateral facet joint dislocation after cervical trauma in terms of neurological recovery.

Ethics

Ethics Committee Approval: This study is approved by the Local Ethics Committee of Marmara University, by decision number 09.2021.667.

Informed Consent: Retrospective study.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Concept: M.S., Y.G., F.H., Design: M.S., Y.G., F.H., Data Collection or Processing: T.J., C.K., Analysis or Interpretation: M.S., T.J., C.K., Literature Search: T.J., C.K., Writing: M.S., T.J., C.K.

Conflict of Interest: The authors declare that they have no conflict of interest.

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INCIDENCE OF DYSPHAGIA AFTER SINGLE LEVEL ANTERIOR CERVICAL DISCECTOMY WITH PROSTHESIS VERSUS BLADE CAGE IMPLANTATION: A RETROSPECTIVE STUDY

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ABSTRACT

Objective: This study compared complaint of dysphagia in patients that underwent bladed peek cage or prosthesis implantation following single level anterior cervical discectomy.To understand that is there any risk factors of dysphagia after anterior cervical spinal surgery

Materials and Methods: Ethical approval was obtained from Üsküdar University Chair of Non-Interventional Studies Ethnics Committee with no: 61351342/AGUST 2021-01. Fourty patients who underwent bladed peek cage or prosthesis implantation after single level anterior cervical discectomy in our clinic in 2019 were enrolled in our study. Group A included 10 male and 10 female patients who underwent bladed peek cage implantation after single level anterior cervical discectomy, while group B included 10 male and 10 female patients who underwent prosthesis implantation after the same procedure.

Results: Both groups were evaluated in early postoperative period, first postoperative month and third postoperative month. There was no significant change in frequency of dysphagia between both groups in the early postoperative period, first postoperative month and third postoperative month. There were 5 female and 3 male patients (total: 8) with dysphagia in group A in the early postoperative period. Group B included 4 female and 3 male patients (total: 7) with dysphagia in the early postoperative period.

Conclusion: No difference was identified in terms of dysphagia between patient groups that underwent bladed peek cage or prosthesis implantation after single level anterior discectomy. Dysphagia complaint in both groups detected in the early postoperative period totally resolved by the end of third postoperative month.

Keywords: Anterior cervical discectomy, bladed peek cage, prosthesis, dysphagia

INTRODUCTION

Several risk factors have been reported regarding development of dysphagia after anterior cervical spinal surgery; however, almost all of them are controversial[1].

The results of a meta-analysis study indicated that anterior cervical plate use, multiple surgical levels, upper cervical spinal surgery and rhBMP-2 use in women are risk factors for development of dysphagia after anterior cervical spinal surgery. Normal swallowing function involves more than 30 muscles, which can be performed up to 600 times daily. Dysphagia may occur at any stage of swallowing. These are oral preparation and transport stage, which includes sucking, chewing and transport of liquid or solid foods; pharyngeal phase, including initiation of swallowing reflex, transport of foods downwards, closure of airway to prevent suffacation or aspiration of food, and the esopgaheal phase composed of loosening and contraction of the openings in upper and lower sections of esophagus in order to transport food to stomach[2,3].

Being aware of the patients with dysphagia in our rehabilittaion programs, we followed-up patients, who underwent single level discectomy surgery, for 3 months and aimed to observe how the surgery, materials used in surgery and different peroperative methods reflected in the outcome.

MATERIALS AND METHODS

Ethical approval was obtained from Üsküdar University Chair of Non-Interventional Studies Ethics Committee with no: 61351342/AUGUST 2021-01.

Retrospective questioning of the 40 patients (20 male, 20 female), who underwent single cervical disc hernia surgery followed by bladed peek cage or prosthesis placement as a part of anterior discectomy, in the year 2019 in our spine center. Patients were divided into 2 groups. Group A included 10 male and 10 female patients with bladed peek cage implantation after single level anterior cervical discectomy, while group B included 10 male and 10 female patients who underwent

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prosthesis implantation after the same procedure. Dysphagia was questioned by an independent investigator by asking the patient 5 questions on the first postoperative day. Dysphagia was categorized into 4 degrees by weighting (Bazaz Yoo dysphagia severity scale). The same test was repeated with an independent investigator in the first and third postoperative months. Results were collected and analyzed by using IBM SPSS Statistics Version 25. Normality analysis were performed by using Kolmogorov-Smirnov test, Shapiro-Wilk test, Histogram and Variance coefficient. Related groups were compared by using Wilcoxon test. P<0.05 was considered significant (Table 1)[4,5].

RESULTS

Both groups were evaluated in early postoperative period, first postoperative month and third postoperative month (Table 2). There was no significant change in frequency of dysphagia between both groups in the early postoperative period, first postoperative month and third postoperative month. There were 5 female and 3 male patients (total: 8) in group A in the early postoperative period. Group B included 4 female and 3 male patients (total: 7) with dysphagia in the early postoperative period. There were no patients with dysphagia at the end of 3 months, which concludes that all patients with dysphagia in both groups had spontaneously recovered.

Statistical Analysis

Data were collected and analyzed by using IBM SPSS Statistics Version 25. Normality analysis were performed by using Kolmogorov-Smirnov test, Shapiro-Wilk test, Histogram and Variance coefficient. Related groups were compared by using Wilcoxon test. P<0.05 was considered significant (Table 3).

Data is analyzed by using IBM SPSS Statistics version 25. Homogenicity of variants was evaluated with Levene's test for Equality of Variances. Normality analysis were performed by using Shapiro-Wilk test, Shapiro-Wilk test, Histogram and Variance coefficient. Comparison of independent groups was performed with Mann-Whitney U non-parametric test. P<0.05 was considered significant.

DISCUSSION

Dysphagia is the most common postoperative complaint of anterior spinal surgery, and is usually transient. It most frequently starts in the immediate postoperative period; however, it can also develop 1 month after the surgery. Dysphagia incidence has a wide spectrum in the first postoperative week, varying between 1% and 79%. Moderate and long-term postoperative (1 week to 6 weeks) rates of incidence are 28% to 57%. Meta-analysis and case reports indicated higher rates[5]. The meta-analysis by Bazaz et al.[4] reported a postoperative dysphagia incidence of max. 71% within the first two postoperative weeks; however, it decreases in the following months. Nonetheless, 12% and 14% of patients may encounter permanent dysphagia 1 year after the surgery.

Our patients with dysphagia in the beginning described gradually improving condition within 2 months, and all patients denied dysphagia by the end of third month.

The cause of postoperative dysphagia is not clearly uncovered. Various causes are suggested. These should be questioned in order. Peroperative retraction may cause edema. When vessel and nerve packets are separated and prevertebral fascia is reached, the retractors used for exposing the surgical site work by medially retracting the esophagus and trachea. Even when the surgery lasts short, the esophageal edema may cause dysphagia[6,7]. When retractors are evaluated, the commonly Cloward[9] retractors may lead to edema with this mechanism. Similarly, the Casper[10] et al. retractors, designed to maintain a better sight of the area, which are still commonly used, push the medial wall, probably causing edema in the same fashion[8-10]. The Ozer[11] retractor used in our hospital does not cause a continuous compression, resulting in less edema and is more suitable for use. In this respect, it is less traumatic and useful in anterior cervical surgery.

Arthritic changes, anterior cervical osteophytic formations secondary to diffuse idiopathic skeletal hyper-osteosis or anterior cervical hyper-osteophytosis, mechanical compression on esophagus or inflammation causing fibrosis and adhesions may lead to dysphagia. The removal of anterior osteophytes during surgery highly reduces dysphagia incidence[12,13]. Two prospective comparative and one prospective study has investigated whether the plates used in anterior cervical discectomy cause dysphagia with similar mechanisms[14-16]. A non-randomized prospective study reported that thicker plates are significant associated with dysphagia[14]. The other study revealed smaller dysphagia incidence with non-compressive

Table 1. Bazaz-Yoo scoring in patients with dyaphagia[4,5]

	Dysphagia episode (as stated by the patient)	
Dysphagia	**Liquid**	**Solid**
None	None	None
Mild	None	Mild
Moderate	None/mild	Intermittently (with some foods like meat or bread)
Severe	Yes	Frequent (most of solid foods)

Table 2. Patients and groups enrolled in the study with their dysphagia scores

Groups	Patient no	Gender	Dyspagia after surgery?	How long	Score	Dysphagia 3 months later?	Eresion barrier?	Operation
	1	F	(-)			(-)	No	Bladed peek cage
	2	F	(+)	1 Month	1	(-)	Yes	Bladed peek cage
	3	F	(+)	2 Month	2	(-)	Yes	Bladed peek cage
	4	M	(-)			(-)	No	Bladed peek cage
	5	M	(-)			(-)	No	Bladed peek cage
	6	F	(-)			(-)	No	Bladed peek cage
	7	F	(+)	3 Month	3	(-)	No	Bladed peek cage
	8	M	(+)	4 Month	4	(-)	Yes	Bladed peek cage
	9	M	(-)			(-)	Yes	Bladed peek cage
Group A	10	M	(-)			(-)	Yes	Bladed peek cage
	11	M	(-)			(-)	No	Bladed peek cage
	12	F	(+)	3 Days	1	(-)	No	Bladed peek cage
	13	F	(+)	2 Weeks	4	(-)	Yes	Bladed peek cage
	14	M	(+)	1 Month	3	(-)	No	Bladed peek cage
	15	F	(-)			(-)	No	Bladed peek cage
	16	M	(+)	2 Weeks	3	(-)	No	Bladed peek cage
	17	F	(-)			(-)	Yes	Bladed peek cage
	18	F	(-)			(-)	No	Bladed peek cage
	19	M	(-)			(-)	No	Bladed peek cage
	20	M	(-)			(-)	No	Bladed peek cage
	1	M	(-)			(-)	Yes	ACDF prosthesis
	2	F	(+)	1 Week	4	(-)	No	ACDF prosthesis
	3	M	(-)			(-)	No	ACDF prosthesis
	4	M	(-)			(-)	No	ACDF prosthesis
	5	M	(+)	2 Weeks	4	(-)	No	ACDF prosthesis
	6	F	(-)			(-)	No	ACDF prosthesis
	7	M	(+)	2 Weeks	2	(-)	Yes	ACDF prosthesis
	8	M	(+)	6 Month	2	(-)	No	ACDF prosthesis
	9	M	(-)			(-)	No	ACDF prosthesis
Group B	10	F	(-)			(-)	No	ACDF prosthesis
	11	F	(-)			(-)	No	ACDF prosthesis
	12	M	(-)			(-)	Yes	ACDF prosthesis
	13	F	(+)	3 Weeks	4	(-)	Yes	ACDF prosthesis
	14	F	(+)	1 Week	2	(-)	No	ACDF prosthesis
	15	M	(-)			(-)	No	ACDF prosthesis
	16	F	(+)	3 Days	3	(-)	Yes	ACDF prosthesis
	17	F	(-)			(-)	No	ACDF prosthesis
	18	F	(-)			(-)	No	ACDF prosthesis
	19	F	(-)			(-)	Yes	ACDF prosthesis
	20	M	(-)			(-)	Yes	ACDF prosthesis

M: Male, F: Female, ACDF: Anterior cervical discectomy and fusion

Table 3. Statistic results for both groups

Test statistics	
	Dysphagia score
Mann-Whitney U	195,000
Wilcoxon W	405,000
Z	-0.156
Asymp. Sig. (2-tailed)	0.876
Exact Sig. [2*(1-tailed Sig.)]	0.904
a. Grouping Variable: Group	
b. Not corrected for ties.	
There is no significant difference between both groups (p>0.05)	

zero-profile plates[16]. No plate is used in our patient series, only stand-alone cage is utilized. This may have led to better outcome.

The use of bone morphogenic protein has been proposed to cause dysphagia by inflammation. Two retrospective and one prospective non-randomized controlled study investigated the risk regarding use of rhBMP-2 for postoperative dysphagia. rhBMP-2 has been suggested to cause increase in esophageal motility and dysphagia by inducing inflammation and edema in esophagus and surrounding soft tissues[17-20]. In this respect, rhBMP-2 use has the potential to cause more severe consequences like edema, airway stenosis or nerve entrapment and United States Food & Drug Administration has warned against its use in anterior cervical surgery. rh-BMP-2 is not used in any of our patients, and according to operative reports, the osteophytes have been placed inside the cage by pressing and use of autograft. This way, the induction of inflammatory events by rhBMP-2 was avoided, leading to better outcomes.

Prospective cohort studies of Lee et al.[21] and Bazaz et al.[4] reported that gender is an important risk factor when they identified women with complaint of dysphagia described 6 months after the surgery. On the contrary, a smaller prospective comparative study by Rihn et al.[22] and a retrospective study by Riley et al.[23] did not reveal gender as an important risk factor. Gender was also not an important risk factor in our study.

Graft loss, infection and hematoma are important causes of dysphagia; however, they are not included in this study.

Covering the exposed surfaces during spinal decompression surgery, adhesion barriers constitute a transient, protective physical barrier by isolating the exposed nerve fibers and dura mater from surrounding tissue. They prevent entrapment of nerve fibers by stopping the development of adhesions with epidural fibrosis. They also may limit peroperative exposure of nerve fibers and main dura mater to biochemical irritants. However, no difference was identified with or without using adhesion barriers in early or late postoperative period, we do not consider them useful, especially in single level discectomy.

CONCLUSION

As a result, autograft use with cage leads to successful outcomes in single level anterior cervical discectomy. Use of adhesion barrier has no positive or negative effects. The early postoperative dysphagia gradually improves and lasts for 3 months, and disappears by the end of 3 months.

Ethics

Ethics Committee Approval: Ethical approval was obtained from Üsküdar University Chair of Non-Interventional Studies Ethnics Committee with no: 61351342/AUGUST 2021-01.

Informed Consent: Retrospective study.

Peer-review: Internally peer-reviewed.

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WHICH IMAGING METHOD IS MORE EFFECTIVE IN LATERAL MASS SCREW PLACEMENT: O-ARM COMPUTED TOMOGRAPHY OR X-RAY?

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ABSTRACT

Objective: Although various surgical techniques have been described in the posterior cervical fixation, the lateral mass fixation method is the most preferred method. This study was conducted to examine the difference of imaging methods in order to detect and minimize important problems such as lateral mass fracture, vertebral artery foramen violation, and screw malposition intraoperatively during lateral mass fixation.

Materials and Methods: Age, gender, etiological factors, intraoperative imaging method, number of fixed segments, and intraoperative-postoperative complications related to the surgical method of 41 patients were collected from the registered documents.

Results: Lateral mass fixation was performed in 41 patients. Of the patients 29.3% (n=12) were female and 70.7% (n=29) were male. When the etiological factors were examined, the most common cause was cervical spinal stenosis (68.3%, n=28). The patients were evaluated in two groups (A, B). A total of 280 lateral mass screws were placed in the patients in both groups. One hundred and twenty-nine (46.1%) lateral mass screws were used in group A. One hundred and fifty-one (53.9%) lateral mass screws were performed to 22 (53.7%) patients in group B. Intraoperative screw revision rates were compared between the two groups using the chi-square test using SPSS 15.0 and no significant difference was found ($p<0.524$).

Conclusion: No significant difference was found between X-ray and o-arm CT in terms of intraoperative screw revision. Both imaging methods can be used in lateral mass fixation. X-rays are inexpensive and readily available. However, tomography is expensive and requires experienced personnel, and it also increases the surgical time.

Keywords: Lateral mass fixation, O-arm CT, X-ray, cervical fixation

INTRODUCTION

Posterior cervical spine fixation is a key component in posterior cervical arthrodesis, which is commonly performed to treat various degenerative, neoplastic, inflammatory and traumatic conditions affecting the cervical spine[1]. Posterior cervical fixation was based on wiring techniques in history. Wiring only offers stabilization for flexion, but does not immobilize the spine against the extension, lateral bending or rotation forces, which may put the fixation at high risk for mechanical failure[1]. Over time, more reliable methods such as interlaminar fixation, transfacet fixation, lateral mass fixation (LMF) and transpedicular fixation have been developed[1-3]. The most known method in posterior fixation is the LMF method[4,5]. The lateral mass screw fixation technique is commonly used for fixation of an unstable cervical spine caused by trauma, degenerative disorders, neoplasms, rheumatoid arthritis, and destructive spondyloarthropathy[6-9]. The LMF technique has emerged as a more reliable and easily applicable method compared to other methods[5]. Thereafter, several modifications have been suggested by many authors[10]. Currently, there is no standardized intraoperative method to estimate the trajectory angle of insertion of a lateral mass screw as proposed by the techniques described by An, Anderson, Magerl, or Roy-Camille[11]. All these modifications aimed to improve the safety margin of this technique[10]. Their main considerations were vertebral artery injury, nerve root injury, facet joint violation, and fusion[12]. Fixation with a lateral mass screw also has its own difficulties. The anatomic structures at risk during lateral mass screwing of the cervical spine are the nerve roots, the vertebral artery, and the adjacent lateral masses[6,13-18]. Fluoroscopy, X-ray and O-arm computed tomography (CT) are used to evaluate intraoperative screw placement and malpositions during surgery. The importance of intraoperative O-arm CT is increasing in order to avoid complications such as cervical nerve roots, spinal cord and vertebral artery damage,

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especially due to screw malposition. We compared the patients who underwent LMF with intraoperative X-ray and O-arm CT in our clinic and examined the differences between the two intraoperative imaging methods.

MATERIALS AND METHODS

This study was approved by the University of Health Sciences Turkey, Gülhane Scientific Research Ethics Committee (number: 2021-238, date: 20.05.2021).

Patient population

In our study, patients who applied to our clinic with different etiologies and underwent posterior cervical fixation between September 1, 2016 and May 31, 2021 were examined. Demographic characteristics, clinical status, etiology, preoperative imaging, surgical method, and intra-postoperative complications of the patients were reviewed retrospectively.

Patients aged 18-80 years, who had posterior cervical instrumentation in our department were included in the study. Patients who had previous posterior cervical instrumentation, were outside the age range of 18-80 years and were re-operated due to post-surgical trauma or infection were excluded.

Age, gender, etiological factors, intraoperative imaging method, number of fixed segments, intraoperative-postoperative complications related to the surgical method of 41 patients were determined from the patient files. The patients were evaluated in two groups (A, B).

Intraoperative İmaging

Intraoperative O-arm-CT or X-ray was used to examine conditions such as screw malposition, lateral mass fracture, and vertebral foramen violation in all cases, and the problematic cases were intervened again.

Surgical Technique

All patients were placed in prone position with the chest elevated 15° to reduce venous bleeding and the neck in a neutral position to avoid fusion in rotation. The head is fixed into a three-pin head-holder allowing strong immobilization during screw placement. Lateral fluoroscopy is performed to confirm the level[19].

After the lateral masses were revealed in all patients, the entry site was determined with the modified Magerl technique. Screw tracing was prepared with the help of high-speed drill. After the screw tracing was checked with the help of the guide, the screws with self-tapping feature were sent at an appropriate angle. We avoided placing the screws with the free-hand technique.

Screw position after delivery of lateral mass screws; It was checked with O-arm-CT in patients in group A, and with X-rays in patients in group B. After evaluating the vertebral foramen, the tracing of the screws, and the condition of the lateral masses, suspicious or problematic situations were intervened. We did not use navigation in any of our cases.

RESULTS

29.3% (n=12) of the cases were female and 70.7% (n=29) were male. The mean age of the cases was 53.2 years (19-76). When the etiological factors were examined, the most common cause was cervical spinal stenosis (68.3%, n=28). Apart from this, there were traumatic fractures and dislocations in 22% (n=9), tumor in 7.3% (n=3), and basilar invagination in 2.4% (n=1) (Table 1). Long segment (≥3 segments) instrumentation was performed in 33 patients (80.5%) and short segment (<3 segments) in 8 patients (19.5%). A total of 280 lateral mass screws were placed in the patients in both groups at the first stage.

In the first stage, 129 lateral mass screws (46.1%) were placed in 19 patients in group A (46.3%). After control with intraoperative O-arm-CT, a total of 2 screw malpositions (1.6%) and 5 lateral mass fractures (3.9%) were detected in 6 patients in this group, and the malpositioned screws were revised intraoperatively (Table 2). In this group, root damage was detected in 1 patient (5.3%) in the postoperative period. Again in this group, an additional occipitocervical fusion was performed in 1 patient (5.3%) to eliminate instability after screw malposition. No additional complications occurred in the patients in group A. In group A, intraoperative O-arm CT control was taken after the pins were placed in the segments to be fixed. The placement tracing of the screws was determined. Then the screw was placed. During screw placement, O-arm CT was taken again depending on the lateral mass status, superior and lateral angle of the screw, and the surgeon's experience. Revisions were made when necessary. Control CT was taken after all screws were placed. Fixation was completed.

In the first stage, 151 lateral mass screws (53.9%) were placed in 22 patients in group B (53.7%). After the control with intraoperative X-ray, a total of 1 screw malposition (0.7%) was detected. And 5 lateral mass fractures (3.3%) were suspected in 5 patients and revision was performed (Table 2). In this group, root damage was detected in 1 patient (4.5%) in the postoperative period. An additional occipitocervical fusion was performed in 1 patient (4.5%) to eliminate instability after screw malposition. No additional complications occurred in the patients in group B. For patients in group B, unilateral screws were placed in the segments to be fixed first. Superior

Table 1. Demographic and etiological factors of the cases

Characteristics	Number	%
Sex		
Men	29	70.7
Women	12	29.3
Etiology		
Cervical stenosis	28	28
Traumatic fracture	9	22
Tumor	3	7.3
Basilar invagination	1	2.4

Table 2. Intraoperative and postoperative results of the cases

Imaging method	Number of paitents	Number of screw	Dural tear	Root injury	Vertebral artery violation	Screw malposition	Facet fracture	İntraoperative screw revision	Revision surgery via fixation failure
Tomography (A)	19 (46.3%) Men: 11 (57.9%) Women: 8 (42.1%)	129	0	1	0	2	5	7	1
X-Ray (B)	22 (53.7%) Men: 18 (81.9%) Women: 4 (19.1%)	151	0	1	0	1	5	6	1
Total	41 (100%)	280	0	2	0	3	10	13	2

angles, lateral angles and lateral masses of the screws were checked with lateral and oblique X-rays. Revisions were made when necessary. Then, screws were placed on the opposite side of the same segments and similar procedures were repeated, and fixation was performed by completing bilateral screw placement.

A total of 10 lateral mass fractures (3.6%) were detected in both groups due to screw placement. Of the 280 lateral mass screws placed, 13 screws (4.6%) were revised due to intraoperative lateral mass fracture or screw malposition, root damage was detected in 2 patients (4.9%), and occipitocervical fusion was performed in 2 patients (4.9%) to ensure stability after screw malposition (Table 2). No additional complications developed in any of the patients apart from the stated complications.

In both groups, CT was taken within the first 4 hours postoperatively (Figure 1, 2). Neural foramen, vertebral artery foramen, spinal canal, lateral mass status and screw angle were evaluated by performing 3-D reconstruction. No problem requiring revision was detected in the CT taken in the postoperative period.

Statistical Analysis

Intraoperative screw revision was performed in 7 (5.4%) of 129 lateral mass screws in 19 patients operated with O-arm, and in 6 (4%) of 151 screws in 22 patients operated using X-ray. Intraoperative screw revision rates between the two groups were evaluated with the chi-square test using SPSS 15.0, no significant difference was found between the two groups ($p<0.524$).

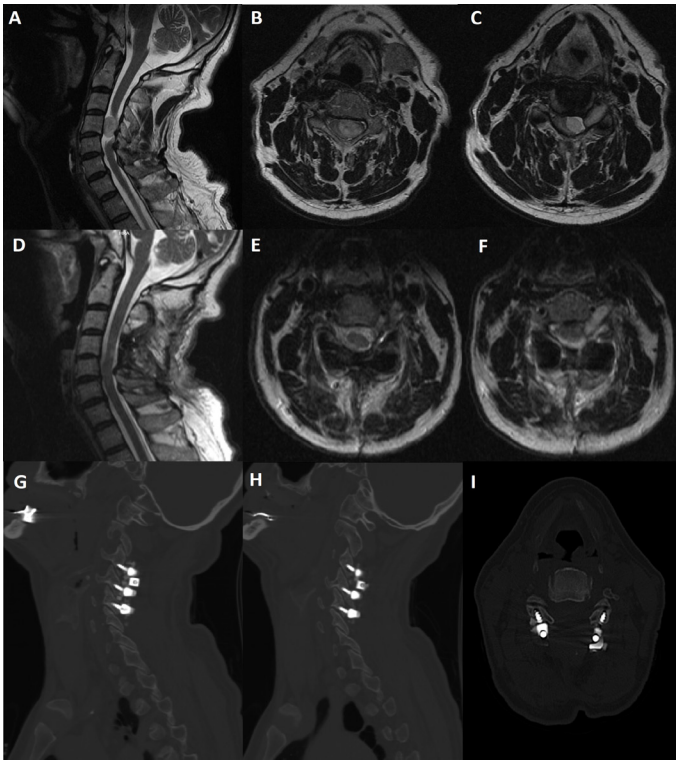

Figure 1. T2-weighted sagittal and axial images show a intradural extramedullary mass lesion which was histopathologically diagnosed as schwannoma at C4 level (A, B) with foraminal extension (C). Postoperative MRI images reveal adequate decompression and total excision of the tumor inside the spinal canal (D, E). Residual lesion and slight root edema is also shown (F). Proper lateral mass screw position which was checked intraoperatively through X-ray was confirmed with computerized tomography images postoperatively (G, H, I)

MRI: Magnetic resonance imaging

DISCUSSION

Posterior cervical fixation with lateral mass screws was first introduced by Roy-Camille in 1979; it has been increasingly used since that time to treat a wide range of cervical spine disorders[20]. The vast majority of surgeons hold the opinion that the LMF technique is the most optimal method for providing cervical stabilization after long segment decompression[21]. Lateral mass screw fixation has advantages over standard posterior wiring techniques; it can be done easily for many levels on patients with laminectomy and it can preserve the biomechanical forces[22]. Although the LMF method is the most reliable and frequently preferred method among surgeons, it has significant complications. Lateral mass plate and screw devices have proven to be safe despite their proximity to neurovascular structures. However, posterior plate-screw techniques can be associated with potential problems, including injury to the vertebral artery, nerve roots, facet joints and spinal cord[6,14-18].

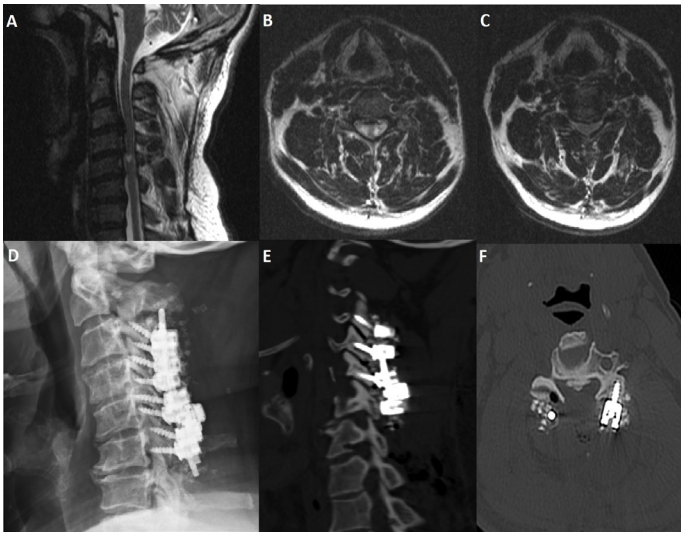

Figure 2. Loss of cervical lordosis, multi-level degenerative disc disease, cervical spinal stenosis and myelomalacia at C5 level can be seen T2-weighted sagittal and axial images (A, B, C). The patient underwent multi-level cervical laminectomy and lateral mass screw fixation surgery. O-arm imaging system was used to confirm screw placements intraoperatively. Plain radiography and computerized tomography images revealed that the screw placements were accurate (D, E, F)

In the literature, the rate of intraoperative lateral mass fracture has been reported as 1.6-4.7%[6]. Inoue et al.[4] Reported the overall incidence of lateral mass fracture was 4.7% in his retrospective study of 117 consecutive patients undergoing lateral mass screw fixation by a modified Magerl's technique. In our study, the rate of lateral mass fracture was found to be 3.6%. Another complication encountered in posterior cervical fusion surgeries where lateral mass screws are used is damage to the cervical nerve roots. The anatomic study of An et al.[6] observed that the nerve root's exit point was at the anterolateral portion of the superior facet. According to the LMF technique used, the rate of damage to the cervical roots differs. Heller et al.[23] is compared the anatomic risks between the Roy-Camille and Magerl techniques. They found that the Roy-Camille screws were associated with less risk of nerve root injury, but more chance of facet joint violation. In contrast, the Magerl screws were associated with more risk of nerve root injury, but less chance of facet joint violation[23]. Baek et al.[24] reported one nerve root injury was observed in each cervical spine segment using the Roy-Camille method (8.3%) and the Magerl method (5.6%) in his cadaveric study. Jeanneret et al.[9] has reported only two cases of nerve root-related problems in their total 51 patients. In our study, cervical root damage was detected in only 2 patients (4.9%) out of 41 patients 1 in group A (5.3%) and 1 in group B (4.5%). When the postoperative CT images of the patients with root damage in both groups were examined, it was observed that the screws did not protrude beyond the lateral mass and into the neural foramen, and it was concluded that they were independent of the screw trajectory.

Vertebral artery injury remains a major concern; however, the reported prevalence rate is negligible[16,17,25]. Kim et al.[26] reported in a prospective study on the evaluation of 1256 lateral mass screws positioned in 178 consecutive patients at their institution. One screw revealed in the follow-up CT violating the foramen transversarium without penetrating the vertebral artery required no further intervention[26]. Ebraheim et al.[27] reported his study, C6 has a greater risk for vertebral artery injury. In our study, intraoperative vertebral artery damage was not detected in any patient. Considering that LMF is frequently used today, it is clear that the complications that will occur are directly related to the increasing number of cases.

There are many advantages to using O arm CT during intraoperative imaging. That provides us with various parameters including trajectory, diameter and lengths of virtual screws. Screw placement in cases is performed with direct guidance without the need to rely only on anatomical signs. However, it is difficult to implement because it is expensive, requires experienced personnel and is not available in every center. In repeated imaging, the amount of radiation received by the patient and the surgical team increases[28].

Intraoperative X-ray imaging is an easily applicable and ubiquitous method without prolonging the operation time. The amount of radiation received by the patient and the surgical team is lower compared to O-arm CT. However, it is difficult to provide effective intraoperative imaging in patients with overweight, short neck and cervical spine degeneration[25-27].

In our study, we tried to determine the safer imaging method by examining the relationship between intraoperative imaging method and possible complications in cases with LMF and to determine the differences between the two imaging methods we preferred. Also, we have not encountered a study in the literature examining the differences between O arm CT and X-ray supported lateral mass screw placement. In both groups, we found that revision was not required after postoperative CT in the early period. Postoperative CT controls of patients using X-ray when compared to postoperative CT control of patients using O-arm CT, the rates of lateral mass fracture, vertebral artery foramen and neural foramen violation were found to be similar.

Study Limitations

There are some limitations in our study. The first is the low number of cases. Secondly, since it is a retrospective study, the data were analyzed over the files and the unsaved data of the patients could not be reached. Another limitation is that the BMD status of the patients was not known, so it could not be clearly evaluated whether the facet fracture was due to technical reasons or low bone quality.

CONCLUSION

Cervical posterior fusion surgery using a lateral mass screw is one of the most used methods in posterior cervical instrumentation. In order to minimize intraoperative risks,

intraoperative screw positions should be visualized in the most optimal way. For this reason, it is used both as an O-arm-CT and X-ray imaging method in the intraoperative process. Because of its ubiquity and inexpensive access, X-ray is used more frequently than O-arm-CT, which is more expensive and can be time-consuming to set up intraoperatively. However, they are similar in effectiveness.

Ethics

Ethics Committee Approval: This study was approved by the University of Health Sciences Turkey, Gülhane Scientific Research Ethics Committee (number: 2021-238, date: 20.05.2021).

Informed Consent: Retrospective study.

Peer-reviewed: Internally peer-reviewed.

Authorship Contributions

Concept: M.O.D., M.C.E., G.K., Design: M.C.E., Data Collection or Processing: M.C.E., Analysis or Interpretation: G.K., Literature Search: M.O.D., A.D., Writing: G.K., A.D.

Conflict of Interest: There is no conflict of interest was declared by the authors.

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EVALUATION OF LUMBAR VERTEBRA FRACTURES WITH THORACOLUMBAR INJURY CLASSIFICATION AND SEVERITY SCORE

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ABSTRACT

Objective: To investigate whether there was a correlation between Thoracolumbar Injury Classification and Severity (TLICS) score and surgical outcome of lumbar fractures.

Materials and Methods: Medical records of 30 patients with traumatic lumbar fracture who were treated surgically in the neurosurgery department of a tertiary care center between April 2004 and July 2011 were retrospectively reviewed. Clinical and radiological data were assessed in conjunction with therapeutic outcomes.

Results: The average age of 30 patients (3 females, 10%; 27 males, 90%) was 36.4±10.2 (range, 20 to 57) years. The most common levels of fracture were L1 (n=12, 40%), L2 (n=7, 23.3%) and L4 (n=5, 16.7%). Local kyphosis angle, wedging angle, compression ratio, lumbar lordosis angle and sagittal indices changed significantly after the surgical intervention (p<0.001). American Spinal Injury Association scores displayed significant improvement after surgery (p=0.014).

Conclusion: Results of the current study demonstrate that TLICS score seems to reflect the outcome of patients treated surgically for lumbar fracture.

Keywords: Spine, fracture, trauma, lumbar, classification, treatment

INTRODUCTION

High-energy multiple traumas are likely the cause of spinal injuries, particularly on the lumbar vertebra[1]. More than 40% of vertebral fractures occur in the thoracic and lumbar regions and 2/3 of these cases do not display any neurological signs or symptoms. Improvement of neurological outcomes can be accomplished by decompression of neural structures, preservation of proper anatomic configuration, fusion together with rigid stabilization to avoid late neural injury, early mobilization and rehabilitation with the early intervention. Spinal instruments allow a better stabilization until a satisfactory bone fusion is achieved[2].

Some of the thoracolumbar and lumbar burst fractures with intact neurological status can be treated conservatively. However, the presence of spinal instability and neurological disorders should be treated surgically in order to determine the appropriate surgical approach[3]. In spite of technological and medical development, there are still many obscure points for the selection of optimal treatment modality. Treatment decisions in spinal injury patients must be made on the basis of a full assessment of neurological status and identification of the spinal instability[1-3]. Even though there is no consensus on the standard international classification system for determining the optimal management modality for patients with thoracolumbar fracture, Thoracolumbar Injury Classification and Severity Score (TLICS) is a valid and reliable method used in the management of thoracolumbar injuries[4].

The aim of the current study was to investigate the efficacy of TLICS to predict the therapeutic outcomes of the surgical management of lumbar fractures.

MATERIALS AND METHODS

Study Design

This retrospective study was approved by the local Institutional Review Board (2012/70). Written informed consent for the

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usage of data in medical files has been routinely obtained from all subjects, a legal surrogate, the parents or legal guardians. The medical records from files of 30 patients suffering from traumatic lumbar vertebral fracture that had been surgically treated in the neurosurgery department of our tertiary center, between April 2004 and July 2011 were retrospectively reviewed. Fractures of non-traumatic aetiology (osteoporosis, malignancy etc.) were excluded. Routine blood tests, plain radiographs viewing cranial, cervical and lumbar regions, computerized tomography scans and magnetic resonance images were obtained before and after the surgery. This study has been approved by the Balıkesir University Faculty of Medicine, Clinical Research Ethics Committee (date: 22.06.2021, number: 13743348/020/42491) and have been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments (2021/136).

The sliding, angulation, compression and distance between pedicles were measured at the site of lumbar fractures on the anteroposterior and lateral views of radiographs. Angles of lumbar lordosis, wedging and local kyphosis were calculated and compression ratios were assessed. The sagittal index was calculated by subtracting physiological kyphosis angle from local kyphosis angle. Assessment of fractures was made radiologically with respect to Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification[5-7]. The initial neurological examination included evaluation of sensory and motor functions, Achilles, patellar tendon and Babinski reflexes, as well as anal tonus, perianal sensation, bulbocavernosus reflex and abdominal skin reflexes. Findings obtained from the neurological evaluation were classified with respect to the American Spinal Injury Association (ASIA) impairment scale[8].

Thoracostomy tubes were applied to patients operated via the anterior approach. Postoperative antibiotic prophylaxis was initiated and respiratory exercises were instructed routinely. Sutures were removed on the 12th postoperative day. Patients were controlled on the 4th week, 6th and 12th months.

Outcome Parameters

Descriptive parameters were recorded and sites of fracture, angles of lumbar lordosis, wedging and local kyphosis; compression ratios and sagittal indices were determined for every patient. Patients were classified according to AO classification, ASIA impairment scale and TLICS. Clinical and radiological alterations after surgery were noted and compared with respect to these aforementioned classifications.

Radiological parameters were defined as follows:

1. Lumbar lordosis angle: The angle formed by the intersection of the lines drawn parallel to the upper margin of the first lumbar and first sacral vertebra (Figure 1).

2. Wedging angle: The angle between lines passing in parallel through the upper and lower plates of the injured vertebra, Angle A (Figure 2).

3. Local kyphosis angle: It is formed by the intersection of lines passing in parallel through the intact upper plate of the uninjured vertebra above and the lower intact plate of the uninjured vertebra below, Angle B (Figure 2).

4. Compression ratio: The anterior height of the corpus of the injured vertebra is termed as A and the anterior height of the corpus of the uninjured vertebra below is termed as B. Compression ratio is calculated according to the formula, (1-B/A)X100.

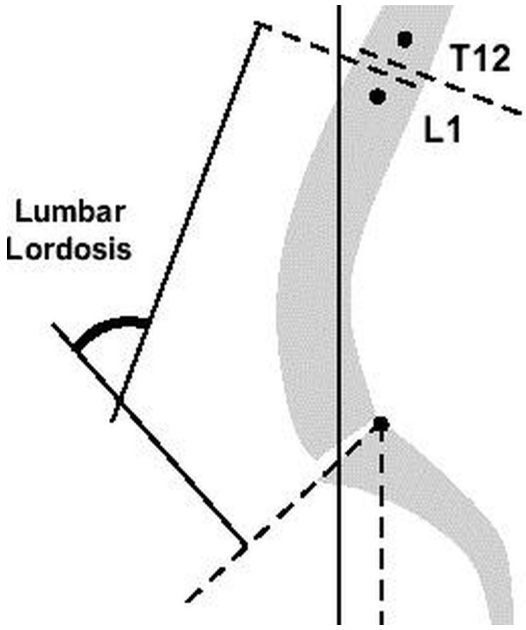

Figure 1. Lumbar lordosis angle is formed by the intersection of the lines drawn parallel to the upper margin of first lumbar and first sacral vertebra

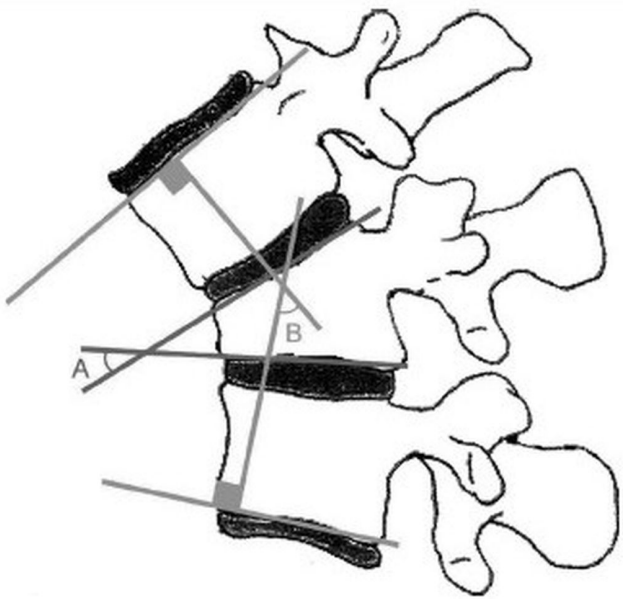

Figure 2. A) Wedging angle exists between lines passing in parallel through the upper and lower plates of the injured vertebra; **B)** Local kyphosis angle formed by the intersection of lines passing in parallel through the upper intact plate of the uninjured vertebra above and the lower intact plate of the uninjured vertebra below

5. Sagittal index: It is calculated by subtraction of the physiological kyphosis angle from the local kyphosis angle measured. The normal physiological kyphosis angles are 5° for vertebra between T1-T12, 0° for vertebra between T12-L1 and -10° for the level between L2 and L5[9]. The normal value of the sagittal index varies between 15-20, increase beyond these boundaries constitute a surgical indication[10].

Statistical Analysis

Data were analysed using the Statistical Package for Social Sciences software (version 15.0 for Windows). All differences associated with a chance probability of 0.05 or less were considered statistically significant. Continuous variables are presented as mean ± standard deviation. Since variables did not display normal distribution, non-parametric methods were used. Independent groups were compared using the Mann-Whitney test, while matched groups were compared via Wilcoxon signed-rank test. Type 1 error ratio (α) was selected as 0.05 and two-way analysis was performed. The level of statistical significance was set at $p<0.05$.

RESULTS

Thirty patients with lumbar vertebral fractures met the eligibility criteria for the study. Twenty-seven out of 30 patients were male with an average age of 36.4±10.2 (range, 20 to 57) years. The average duration of hospitalization was 12.1 days (range: 4-22). The level of fracture was L1 (12 cases, 40%), L2 (7 cases, 23.3%), L4 (5 cases, 16.7%), L3 (4 cases, 13.3%) and L5 (2 cases, 6.7%). Categorization of patients according to AO classification yielded that 21 cases (70%) had type B and 9 patients (30%) type C fractures. The types of injury leading to lumbar fracture were falling from height (60%), traffic accidents (26.7%) and other causes (13.3%).

Revision surgery was required in one patient (3.3%) with L3 fracture and replacement of pedicle screw was accomplished eventually. No serious complications such as wound infection, cerebrospinal fluid leakage and pulmonary thromboembolism were identified.

Comparison of preoperative and postoperative ASIA scores indicated a significant improvement after surgical intervention (p=0.014) (Table 1).

When the patients were grouped into two according to TLICS scores, it was observed that patients with TLICS scores <5 had higher preoperative (p=0.002) and postoperative ASIA scores (p=0.001) (Table 1). There were statistically significant changes in all radiological indices after the surgical intervention (p<0.001 for all variables) (Table 2).

Table 1. Comparison of descriptive and radiological parameters in patients with TLICS <5 and TLICS ⩾5

Parameter		TLICS <5	TLICS ⩾5	Total	%
Age (years)	20-29	4	6	10	33.3
	30-39	3	5	8	26.7
	40-49	5	3	8	26.7
	50-59	2	2	4	13.3
Level	L1	4	8	12	40
	L2	4	3	7	23.3
	L3	3	1	4	13.3
	L4	1	4	5	16.7
	L5	2	0	2	6.7
AO fracture type	B	14	7	21	70
	C	0	9	9	30
Preoperative ASIA impairment scale	A	0	2	2	6.7
	C	0	4	4	13.3
	D	2	5	7	23.3
	E	12	5	17	56.7
Postoperative ASIA impairment scale	A	0	2	2	6.7
	C	0	2	2	6.7
	D	0	5	5	16.6
	E	14	7	21	70

TLICS: Thoracolumbar injury classification and severity score, AO: Arbeitsgemeinschaft für Osteosynthesefragen Spine System, ASIA: American Spinal Injury Association

Table 2. Comparison of alterations in radiological parameters before and after the surgery

		Median	Range (min - max)	p-value
Compression ratio	Preoperative	48.5	10-72	<0.001*
	Postoperative	24.5	0-52	
Wedging angle	Preoperative	18.0	0-38	<0.001*
	Postoperative	10.0	0-18	
Local kyphosis angle	Preoperative	15.5	4-33	<0.001*
	Postoperative	10.0	1-29	
Lumbar lordosis angle	Preoperative	43.0	19-68	<0.001*
	Postoperative	37.5	21-69	
Sagittal index	Preoperative	22.0	11-43	<0.001*
	Postoperative	17.5	1-39	

*: Statistically significant, min: Minimum, max: Maximum

The clinical and radiological findings of a case from our cohort are shared in Figures 3 and 4.

DISCUSSION

In this study, we determined that TLICS is a good indicator to predict the therapeutic outcomes for patients who were treated surgically due to traumatic lumbar fractures.

More than half of the cases presenting with vertebral fractures involving the thoracolumbar region do not result in any neurological findings, and therefore would not be good candidates for surgical interventions[3]. The decision for therapeutic approach necessitates a prompt neurological examination and definition of the presence of spinal instability[11]. Despite the development of many classification systems to guide the determination of optimal therapeutic approach, there is no consensus yet[2,3]. The management of a patient with a vertebral injury must be started at the site of the event and any patient claiming pain on vertebral column or any unconscious patient must be presumably considered as a vertebral fracture until the diagnosis is ruled out[12]. Since vertebral fractures may be accompanied by injuries of other parts of the body including the head, thorax, abdomen and pelvis as well, the patients exposed to multiple traumas must be handled on a multi-disciplinary basis and an algorithm must be planned with respect to the priority of vital organs[2].

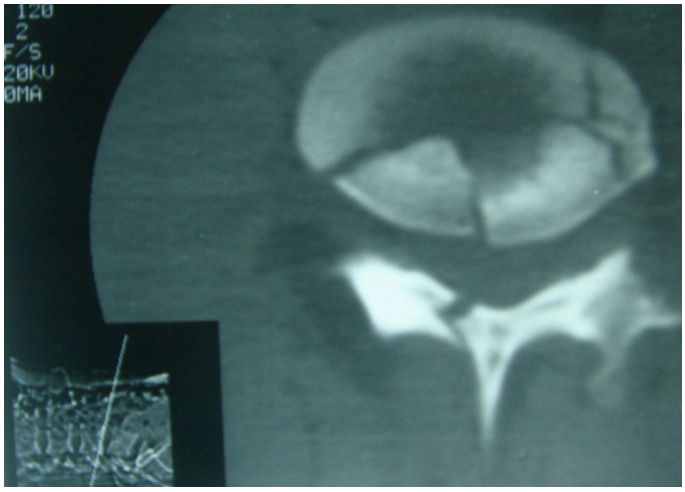

Figure 3. A case from our cohort: A 25-year-old male patient was brought to the emergency room with both legs paralyzed after a traffic accident. In addition to instrumentation and fusion procedures, this patient underwent L4 total laminectomy and primary dural repair. Postoperative ASIA score increased from C to D. Lumbar CT axial image demonstrate L4 burst fracture

CT: Computed tomography, ASIA: American Spinal Injury Association

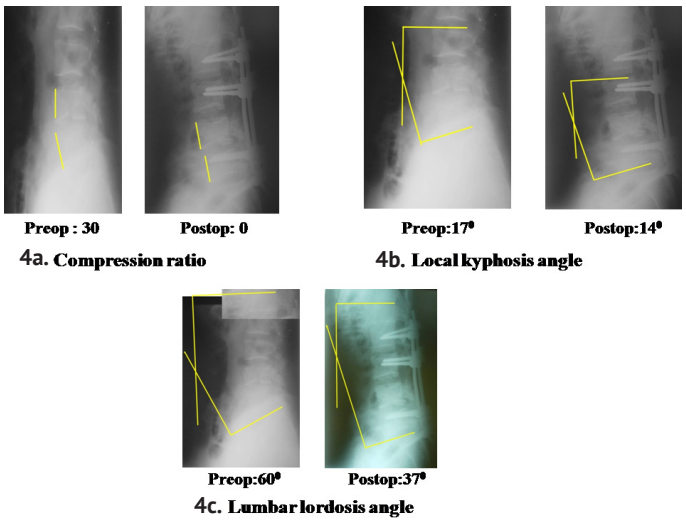

Figure 4. The patient's radiological measurements are demonstrate in the lumbar X-ray images

Preop: Preoperative, Postop: Postoperative

AO classification is commonly used in clinical practice for vertebral fractures; however, it possesses some limitations in terms of prognostic and morphologic aspects[5-7]. Vaccaro et al.[4] has proposed a novel scoring system, TLICS, that permits a better evaluation in terms of anatomical structure and neurologic state[13,14]. Type of injury (compression, rotation or distraction), neuronal root involvement and extent of conus medullaris injury are taken into account in TLICS. Posterior ligamentous complex (PLC) injury requires the addition of 3 points to the score. Conservative approach is advocated for cases with TLICS ⩽3, either surgery or conservative approach can be preferred for patients with TLICS of 4 and surgical intervention is advocated for TLICS ⩾5[4,15,16]. Recent publications have documented the validity and reliability of TLICS[14-17].

There is a debate on the treatment protocol of burst fractures that do not cause any neurological deficits and PLC injury. Since the conservative approach is associated with an increased likelihood of further problems like post-traumatic kyphosis and neurological defects, surgery was found to be superior[1,2]. Criteria that favour surgical treatment include stenosis of vertebral canal >50%, local kyphosis angle >20°, collapse >50% on the anterior column, progressive incomplete paraplegia and tear on PLC[18].

Analysis of our results demonstrated that most patients presenting with lumbar fracture were at 4th decade and the most common ethology was fall from height. The most common site of injury was L1 (40%) and the most frequent type of fracture was burst (70%). In 2 cases (6.7%), there was complete neurological deficit (ASIA A), while 11 patients (36.6%) presented with incomplete neurological injury (ASIA B-D). Six of the 11 patients presenting with incomplete neurological injury had recovery in the early postoperative period. Nevertheless, there was no improvement in two patients with presenting with complete neurological deficit. All patients were treated surgically and no mortality was detected in our series. In seven cases (23.3%), there were additional injuries else than lumbar fracture. TLICS scores seem to reflect the prognostic outcome for patients with lumbar fractures. Therefore, we suggest that TLICS constitutes a valid and reliable guide for

the preoperative assessment, management plan and disability decision of patients with traumatic lumbar fracture.

Study Limitations

Limitations of our study are the retrospective design and the relatively small size of our series. Moreover, personal, metabolic, genetic and environmental factors prone to affect the outcomes may be ignored during gathering data from the files. Due to these restrictions, associations should be interpreted with caution. However, we hope that this study will pioneer further studies on this method.

CONCLUSION

To conclude, the results of the current study demonstrated that TLICS is a good scoring method to reflect the therapeutic success and prognostic outcomes of patients who undergoing surgical intervention for traumatic lumbar fracture.

Ethics

Ethics Committee Approval: This study has been approved by the Balıkesir University Faculty of Medicine, Clinical Research Ethics Committee (date: 22.06.2021, number: 13743348/020/42491).

Informed Consent: Written informed consent for the usage of data in medical files has been routinely obtained from all subjects, a legal surrogate, the parents or legal guardians.

Authorship Contributions

Surgical and Medical Practices: M.F.S., V.Ç., A.K., Concept: M.F.S., V.Ç., A.K., Design: M.F.S., V.Ç., A.K., Data Collection or Processing: M.F.S., V.Ç., A.K., Data analysis or Interpretation: M.F.S., V.Ç., A.K., Literature Search: M.F.S., V.Ç., A.K., Writing: M.F.S., V.Ç., A.K.

Peer-review: Internally peer-reviewed.

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Conflict of Interest: The authors have no conflicts of interest to declare.

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MID-TERM CLINICAL OUTCOMES OF SURGICALLY TREATED MALIGNANT SACRUM TUMORS

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ABSTRACT

Objective: There are limited studies in the literature reporting clinical outcomes of malignant sacrum tumors due to their rarity. The aim of this study was to evaluate mid-term clinical outcomes of malignant sacrum lesions surgically treated by a single surgeon.

Materials and Methods: Patients who were surgically treated with the diagnosis of sacrum tumor were retrospectively analyzed. Patients who underwent surgical resection of malignant sacrum tumors were included. Exclusion criteria were incomplete medical records and follow-ups. Patients' demographics, type of the tumor, histopathological diagnosis, presence of neurologic deficit, type of approach, type of resection, presence of lumbopelvic fixation, postoperative complications, and recurrence rates were noted from our medical records.

Results: A total of 15 patients (7 females, 8 males) with a mean age of 43.3 years participated in the study. The most common histopathological diagnosis of the malignant sacrum tumor was chordoma that was seen in 10 of 15 patients (67%). Soft-tissue tumors (leiomyosarcoma and malignant mesenchymal tumor) were seen in 2 patients (13%), metastatic tumors (renal cell carcinoma and malignant melanoma) in 2 patients (13%), and primary osteogenic tumor (chondrosarcoma) in 1 patient (7%). Perioperative and postoperative complications were encountered in 7 of 15 patients (47%).

Conclusion: Chordoma was the most encountered malignant tumor of the sacrum according to our findings. Recurrence of the malignant sacrum tumor was so common that half of our patients had a history of previous treatment. It was remarkable that perioperative and postoperative complications were also common.

Keywords: Sacrum, malignant, tumor, surgery, spine

INTRODUCTION

Malignant tumors of the sacrum are a rare clinical entity. Most malignant sacrum tumors are low-grade malignancies, such as chondrosarcomas and chordomas, and a few are high-grade, such as sarcomas and osteosarcomas[1-3]. Treatment of these tumors requires a multidisciplinary approach. Oncologists, radiologists, radiotherapists, and spine surgeons must collaborate in diagnosis and treatment. After clinical, morphologic, functional, and laboratory examinations, it is essential to perform a biopsy for diagnosis[4,5]. After histological diagnosis, the team decides on personalized treatment.

Treatment protocols may constantly be changing. While the first treatment approach for Ewing's sarcoma was the surgery about ten years ago, it has become the next option after chemotherapy with new chemotherapeutic agents. For chordoma and chondrosarcoma, the surgical approach is still the first choice. While in some cases, en-bloc surgery is sufficient, in others, wide resection is required for long-term survival. The reason for the high number of local recurrences in the complex anatomy of the region, which makes it difficult to surgically reach the entire tumor[1-7].

There are limited studies in the literature reporting clinical outcomes of malignant sacrum tumors due to their rarity. It is important to share information about this rare clinical entity in order to guide orthopedic surgeons. Therefore, the aim of this study was to evaluate mid-term clinical outcomes of malignant sacrum lesions surgically treated by a single surgeon.

MATERIALS AND METHODS

This retrospective case-series study was performed under the approval of İstanbul Atlas University Ethical Review Board (ID: E-22686390-050.01.04-9540) and conducted in accordance with the Declaration of Helsinki. Informed consent was

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obtained for each patient. Patients who were surgically treated with the diagnosis of sacrum tumors between 2011 and 2019 were retrospectively analyzed. Patients who underwent surgical resection of malignant sacrum tumors were included in the study. Exclusion criteria were incomplete medical records and follow-ups.

Patients' demographics (age, gender), type of the tumor (congenital tumor, primary neurogenic tumor, primary bone tumor, primary soft-tissue tumor, metastatic tumor), histopathological diagnosis, presence of neurologic deficit, type of approach (anterior, posterior, lateral), type of sacrum resection (total, hemicorporectomy, partial, hemisacrectomy), presence of lumbopelvic fixation, postoperative complications and recurrence rates were noted from our medical records.

Statistical Analysis

Descriptive statistical analysis was performed by using SPSS 25.0 software (SPSS Inc., IBM, NY, USA). Numerical variables were given as means and standard deviations, and categorical variables were given as frequencies and percentages.

RESULTS

A total of 15 patients (7 females, 8 males) were participated in the current study. The mean age of the patients was 43.3±16.6 years old (ranges, 20 to 69 years old). The mean follow-up time was 5.2±2.9 years (ranges, 3 to 11 years). The most common histopathological diagnosis of the malignant sacrum tumor was chordoma.

Chordoma, was seen in 10 of 15 patients (67%). Soft-tissue tumors (leiomyosarcoma and malignant mesenchymal tumor) were seen in 2 patients (13%), metastatic tumors (renal cell carcinoma and malignant melanoma) were seen in 2 patients (13%), and primary osteogenic tumor (chondrosarcoma) was seen in 1 patient (7%).

Eight of 15 patients (53%) had a history of previous treatment for the diagnosis of malignant sacrum tumor that revealed these patients underwent resection of the recurrent malignant sacrum tumor. The neurogenic deficit was present in 5 of 15 patients (33%) preoperatively. Operative data of the patients were demonstrated in Table 1.

Perioperative and postoperative complications were encountered in 7 of 15 patients (47%). The most common perioperative complication was rectum perforation which occurred in 2 of 15 patients. These two patients underwent primary repair by the general surgeon. One patient had a dura mater tear during surgery and it was primarily repaired. The most common of postoperative complication was prolonged drainage and closure defect of the wound that occurred in 3 patients. These patients underwent wound debridement and vacuum-assisted closure treatment. Postoperatively one patient had a neurologic deficit and this patient underwent revision of the screw fixation. During follow-ups, 3 patients had recurrence of the tumor (2 chordoma and 1 malignant mesenchymal tumor).

Table 1. Operative data of the patients

Patient	Gender	Age	Histopathologic diagnosis	Approach	Sacrectomy level	Resection type	Nerve sacrification	Lumbo-pelvic fixation
1	Male	44	Chondrosarcoma	Lateral	Upper	Hemisacrectomy	None	Yes
2	Male	40	Leiomyosarcoma	Lateral	Middle	Hemicorporectomy	None	Yes
3	Female	47	Chordoma	Posterior		No resection	None	No
4	Female	67	Chordoma	Posterior	Upper	Partial	None	No
5	Female	62	Chordoma	Posterior		No resection	None	No
6	Female	41	Malignant melanoma	Ant. + Post.	Upper	Partial	None	Yes
7	Female	35	Chordoma	Posterior		No resection	None	No
8	Male	38	Malignant mesenchimal tumor	Posterior	Upper	Partial	None	Yes
9	Female	53	Chordoma	Posterior	Middle	Partial	None	No
10	Female	20	Chordoma	Posterior	Middle	Partial	None	No
11	Female	62	Renal cell carcinoma	Ant. + Post.	Upper and middle	Partial	None	Yes
12	Male	20	Chordoma	Posterior		No resection	None	No
13	Male	69	Chordoma	Lateral	Middle	Partial	None	No
14	Male	21	Chordoma	Ant. + Post.		Total	L5	Yes
15	Male	31	Chordoma	Lateral		No resection	None	No

Ant.: Anterior, Post.: Posterior

DISCUSSION

Chordomas are the most common histopathological form in sacral tumors. They constitute approximately 40% of all malignant sacral tumors. Less frequently, sarcomas and other metastatic tumors. In our series, 10 of 15 cases were chordomas (67%). This tumor originates from the notochord and is aggressive. Although it is considered a tumor, grows slowly[5]. The most prominent symptom is hip and leg pain. Pain occurs when the tumoral tissue compresses the surrounding tissues. Neurological symptoms are independent of pain[7,8].

Combined techniques are generally used in the treatment. The tumor size, localization, borders, and character of the tumor play a role in the selection of treatment. Chordomas and chondrosarcomas are tumors that are resistant to radiotherapy and chemotherapy, but radiotherapy and chemotherapy are applied as adjuvant treatment after resection surgery. Especially after partial and subtotal resections, the success of the treatment, and longer survival without long-term recurrence, adjuvant therapy is necessary[1,7,8]. In our series, all our patients received adjuvant radiotherapy and chemotherapy. New chemotherapeutic agents are effective both in increasing the effectiveness of surgery and in obtaining more successful results in cases where surgery cannot be performed[3,9,10].

Surgical approaches are classically anterior, posterior, lateral, and combined approaches. Combined approaches are preferred for more successful results and long-term survival. An anterior approach is required if the tumor has invaded the pelvic organs. If spinopelvic fixation is required, posterior and combined approaches are recommended. In our series, a posterior approach was required in 8 cases, a lateral approach in 4 cases, and a combined approach in 3 cases. Depending on the location of the tumor, sacrectomy levels vary, and nerve root sacrification may sometimes be inevitable in more proximal tumors. Stabilization may be necessary in cases where lumbosacral instability develops[11,12]. Lumbosacral fixation also provides an advantage in terms of postoperative quality of life for the patient[12]. We performed lumbosacral stabilization in a case where the tumor borders exceeded the lumbosacral junction and we had to sacrifice the L5 nerve root. If more than 50% of the sacroiliac joint is removed and lumbosacral instability occurs, stabilization is required[11-14].

In cases where the resection is large, a rectus abdominis myocutaneous flap is used to close the defect area. We used the rectus flap for defect closure in two of our cases where we performed high sacrectomy with the anterior-posterior combined approach, and we achieved successful results. Early postoperative surgical site infection is one of the most common complications. Being close to the perineum facilitates infection. Wide resection and cavity formation also pave the way for infection. The early infection rate in the literature is between 25% and 50%. In our series, early infection was found to be 36%, similar to the literature. The infection rate in intralesional resections is significantly lower. In addition, lumbopelvic fixation can prevent instability and reduce infection formation[15-17].

For postoperative rehabilitation and ambulation, the preservation of the L5-S1 nerve root and the preservation of the S2 nerve root are necessary and important for sphincter function. While the preservation of the nerve roots is necessary for the functions, on the other hand, sacrificing the nerve root and performing wider resection is important in preventing local recurrences[16,17]. In our series, the L5 nerve root was sacrificed in only 1 case. Our view is to preserve the L5 nerve root as much as possible for functional results. We tried to resection from the widest possible border while trying to preserve the nerve root as much as possible.

Study Limitations

The main limitations of our study were its the limited number of cases and retrospective design. However, we reported outcomes of a rare clinical entity, the surgical treatment of malignant sacrum tumor, in which outcomes of treatments as well as giving information about potential complications are very important for spine surgeons. Further studies with larger cohorts are needed in order to better assess outcomes, complications, and recurrence rates.

CONCLUSION

Chordoma is the most encountered malignant tumor of the sacrum according to our findings. Recurrence of the malignant sacrum tumor was so common that half of our patients had a history of previous treatment. It is remarkable that perioperative and postoperative complications were also common in our series, even if surgical treatment had been performed by an experienced spine surgeon.

Ethics

Ethics Committee Approval: Ethics committee approval was obtained from İstanbul Atlas University Ethical Review Board (ID: E-22686390-050.01.04-9540).

Informed Consent: Informed consent was obtained for each patient.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: U.A., Concept: K.T., U.A., Design: K.T., U.A., Data Collection or Processing: Y.U., Y.O.K., M.K., Analysis or Interpretation: K.T., Y.U., Y.O.K., M.K., A.T., Literature Search: A.T., Writing: K.T.

Financial Disclosure: The authors declared that this study received no financial support.

Conflict of Interest: The authors have no conflicts of interest to declare.

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ERRATUM
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The changes made in the article titled "EFFICIENCY OF SILVER-COATED TITANIUM ALLOY SCREWS IN THE PREVENTION OF IMPLANT-ASSOCIATED INFECTIONS" in the original articles section published in JTSS 2021 32(2) are as follows.

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"The mistakes made by the author in that article; is on lines 5 and 7 under the heading "MATERIALS AND METHODS" on page 85. It was written as "(Norm, Turkey)." and these mistakes have been corrected as "(Tasarımmed, Turkey)."

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ERRATUM
180

The changes made in the article titled "BIOCHEMICAL ANALYSIS FOR NEUROPROTECTIVE EFFECTS OF GANODERMA LUCIDUM IN EXPERIMENTAL RAT SPINAL CORD TRAUMA MODEL" in the original articles section published in JTSS 2021 32(3) are as follows.

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Some corrections have been requested by the author of the article in the Copyright form of the article numbered 99608 published in the 3rd issue of the Journal of Turkish Spinal Surgery 2021 and within the article."

The corrected sections are listed below.

- The author named "Sevgi Akaydın" and her signature have been added to the 8th line among the authors in the Copyright form.

- The list of author names on the first page of the article is replaced by "Denizhan Divanlıoğlu, Ece Miser Salihoğlu, Murat Korkmaz, Ahmet Eren Seçen, Özgür Öcal, Göksal Günerhan, A. Deniz Belen, Sevgi Akaydın, Ali Dalgıç" instead of "Denizhan Divanlıoğlu, Ece Miser Salihoğlu, Murat Korkmaz, Ahmet Eren Seçen, Özgür Öcal, Göksal Günerhan, A. Deniz Belen, Ali Dalgıç". The institution information of the added author is the same as the other authors. No changes have been made to the institution information.

- The order in the "Author Contributions" section on page 120 of the article is arranged as "Design: D.D., E.M.S., M.K., D.B., S.A., A.D., Data Collection or Processing: D.D., E.M.S., M.K., G.G., S.A., D.B., A.D., Analysis or Interpretation: D.D., E.M.S., A.E.S., Ö.Ö., G.G., S.A., D.B., A.D." instead of, "Design: D.D., E.M.S., M.K., D.B., A.D., Data Collection or Processing: D.D., E.M.S., M.K., G.G., D.B., A.D., Analysis or Interpretation: D.D., E.M.S., A.E.S., Ö.Ö., G.G., D.B., A.D.,".

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