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Journal of Turkish Spinal Surgery (www.jtss.org), is the official publication of the Turkish Spinal Surgery Society. The 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 developing of the spinal knowledge. The journal publishes original scientific research articles, invited reviews and case reports accepted by the Editorial Board, in English.

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Official abbreviation: J Turk Spinal Surg

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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 participating in the study to a significant extent. All authors should confirm that they have read the study and agreed to the submission to the 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.

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Preparation of research articles, systematic reviews and meta-analyses must comply with study design guidelines:

CONSORT statement for randomized controlled trials (Moher D, Schultz KF, Altman D, for the CONSORT Group. The CONSORT statement revised recommendations for improving the quality of reports of parallel-group randomized trials. JAMA 2001; 285: 1987-91) (http://www.consort-statement.org/);

PRISMA statement of preferred reporting items for systematic reviews and meta-analyses (Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 2009; 6(7): e1000097.) (http://www.prisma-statement.org/);

STARD checklist for the reporting of studies of diagnostic accuracy (Bossuyt PM, Reitsma JB, Bruns DE, Gatsonis CA, Glasziou PP, Irwig LM, et al., for the STARD Group. Towards complete and accurate reporting of studies of diagnostic accuracy: the STARD initiative. Ann Intern Med 2003;138:40-4.) (http://www.stard-statement.org/);

STROBE statement, a checklist of items that should be included in reports of observational studies (http://www.strobe-statement.org/);

MOOSE guidelines for meta-analysis and systemic reviews of observational studies (Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting Meta-analysis of observational Studies in Epidemiology (MOOSE) group. JAMA 2000; 283: 2008-12).

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ARTICLE WRITING

Clinically relevant scientific advances during recent years include the 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 rigour of the 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 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 a written permission letter, and it should be submitted along with the manuscript.

Review articles: The format for reviews substantially differ from those reporting original data. However, many of the principles noted above apply. A review still requires an

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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 that 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 with 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.

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

INSTRUCTIONS to AUTHORS

- 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 emphasize 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 the 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 historical 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 be 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 describe 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 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 belong. 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 something else (different in what way? the reader may 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 the 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 a 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

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are warranted because the literature almost always contains previous information.

Finally, the author(s) should interpret their data in 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.

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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;8:5-9.

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 Neurological 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

INSTRUCTIONS to AUTHORS

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.

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• 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 the 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.

INSTRUCTIONS to AUTHORS

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 significance 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 substitutes
- 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
- Cervical disc disease
- Cervical Trauma
- Degenerative disease

INSTRUCTIONS to AUTHORS

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

INSTRUCTIONS to AUTHORS

Spinal cord

- Spinal Cord Injury

Spinal stenosis

- Cervical
- Lumbar
- Lumbosacral

Tumors

- Metastatic tumors
- Primary benign tumors
- Primary malign tumors

APPLICATION LETTER EXAMPLE:

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JOURNAL OF TURKISH SPINAL SURGERY

PEER REVIEW, PUBLICATION ETHICS and MALPRACTICE STATEMENT

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JOURNAL OF TURKISH SPINAL SURGERY

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ORIGINAL ARTICLES

LETTER TO THE EDITOR

JOURNAL OF TURKISH SPINAL SURGERY

EDITORIAL

Dear Colleagues,

Once again, it is my privilege to be publishing the 1st issue of our professional journal this year. As always, it includes clinical research studies intended to provide you with up to the minute research findings you can immediately apply in your various fields.

There are seven clinical research studies, and one letter to the editor in this issue. The first study concerns the "Modeling Posterior Cervical Foraminotomy and Discectomy Approach in Sheep Cadaver Cervical Spine". The second is a "Comparison of the Results of Single Level Cervical Disc Arthroplasty Versus Anterior Cervical Discectomy in Short to Mid-term Follow-up". In the third article, one can read a retrospective clinical study entitled, "Biomechanical Changes in the Cervical Spine Alignment after Lumbar Dynamic Stabilization". The fourth study is an "Evaluation of Mid-Phase Clinical Results in Patients with Full Endoscopic Transforaminal and Interlaminar Discectomy". The authors of the fifth study examined "MIS TLIF Among Geriatric Patients With Degenerative Spondylolisthesis ". The sixth is entitled "The Relationship of the Clinical Results of the Patients Undergoing Transforaminal Epidural Injection with Preoperative Magnetic Resonance Imaging Findings" while, in the seventh, the authors wrote about "The Effect of COVID-19 Pandemic on the Frequency of Spinal Trauma: An Epidemiological Study". The eighth article is a letter to the editor about "New Era in Postoperative Analgesia in Spinal Surgery: Thoracolumbar Interfascial Plane (TLIP) Block"

I hope you found this issue thought-provoking and edifying. My primary goal is to provide you with the most current information available so that we are all abreast of the latest cutting edge developments in our fields.

I wish all our Turkish spinal surgeons and their families a healthy, peaceful, and prosperous year.

With kindest regards,

Editor in Chief
Metin Özalay, M.D.

J Turk Spinal Surg 2022;33(1):1-4
DOI: 10.4274/jtss.galenos.2022.69875

ORIGINAL ARTICLE
1

MODELING POSTERIOR CERVICAL FORAMINOTOMY AND DISCECTOMY APPROACH IN SHEEP CADAVER CERVICAL SPINE

Tuncer Taşcıoğlu[1], Bekir Mahmut Kılınç[2]

[1]Ankara Training and Research Hospital, Clinic of Neurosurgery, Ankara, Turkey
[2]University of Health Sciences Turkey, Haseki Training and Research Hospital, Clinic of Neurosurgery, İstanbul, Turkey

ABSTRACT

Objective: The aim of this study was to assess whether a sheep cadaver cervical spine model could be useful in modeling all steps and stages of the posterior cervical foraminotomy and discectomy surgery, which was frequently used in daily practice, and to assess its suitability for laboratory training.

Materials and Methods: A whole sheep neck which had not undergone muscle stripping was obtained from a butcher and was used to model the posterior cervical foraminotomy and discectomy surgery by assessing the following steps performed under microscopy: 1- Stripping of the paravertebral muscles, 2- Determination of the borders of cervical laminae, 3- Recognition of cervical facets, 4- Performing laminectomy, 5- Determination and removal of the ligamentum flavum, 6- Defining the cervical duramater, 7- Performing cervical foraminotomy and exposure of the cervical nerve root, and 8- Determination of disc distance.

Results: The posterior cervical foraminotomy and discectomy model in sheep cadaver cervical spine was able to simulate the osseous, ligamentous, and neural stages of the surgical approach at a similar level to the human spine.

Conclusion: We believe that the proposed posterior cervical foraminotomy and discectomy model can effectively simulate all steps of this surgery, thus contributing to the anatomical orientation during surgical intervention, and such studies will most likely have a positive effect on surgical interventions in general due to their contribution to the ability to recognize and use relevant instruments.

Keywords: Training modeling, posterior cervical approach, sheep cadaver, cervical spine

INTRODUCTION

Surgical education generally has a process that can be described as "see one, do one and teach one". However, the recent increases in malpractice cases and greater involvement of patients' relatives in treatment necessitates changes in this classical surgical training process, and therefore, increases the importance of experimental studies before encountering the same procedures in patients. Cadavers, living animals, placentas and synthetic products (plastic, latex and silicone) have been used in laboratory studies so far[1]. Among these, animal cadaver models differ from other models in that they do not pose any ethical problems, are more accessible, have lower costs, and have anatomical and tissue similarities.

Animal cadaver studies have been evaluated in different studies to model both cranial and spinal interventions[2,3]. In the study by Kandziora et al.[4], comparing sheep and human cervical spines, it was stated that sheep cervical spine can be used for human spine studies even though there are significant differences between the two structures. To our knowledge, studies concerning the intraspinal region of the cervical spine of sheep are very limited[2,5].

In this study, we aimed to perform the posterior cervical foraminotomy and discectomy surgery, which is a frequently used surgery in daily practice, in sheep cadaver spines to evaluate the similarities of the application steps to procedures applied on the human spine.

MATERIALS AND METHODS

The neck of a sheep over 2 years old with non-stripped muscles was obtained from a local butcher as a whole (Figure 1). A Carl-Zeiss Opmi 1 operating microscope was used throughout all surgical steps. The surgical steps to be evaluated in the cadaver model were determined as follows: 1- Stripping of the paravertebral muscles, 2- Determination of the borders of cervical laminae, 3- Recognition of cervical facets, 4- Performing keyhole laminectomy, 5- Determination, and removal of the ligamentum flavum, 6- Defining the cervical dura, 7- Performing cervical foraminotomy and exposure of the cervical nerve root, 8- Determination of disc distance.

Address for Correspondence: Tuncer Taşcıoğlu, Ankara Training and Research Hospital, Clinic of Neurosurgery, Ankara, Turkey
Phone: +90 505 831 18 36 **E-mail:** tuncertascioglu@gmail.com **Received:** 07.12.2021 **Accepted:** 13.01.2022
ORCID ID: orcid.org/0000-0002-0359-7274

Ankara Training and Research Hospital has decided that the ethics committee approval of Animal Cadaver Study number 845 is not required according to "Regulation on Working Procedures and Principles of Animal Experiments Ethics Committees Article 8 19-k" (date 22/12/2021).

RESULTS

The sheep was placed on the table with the posterior surface of the neck on the upside. Spinous processes were palpated, and paravertebral muscles were stripped over two consecutive spinous processes (Figure 2). Then, the borders of two consecutive laminae and facet joint were determined, followed by determination of the ligamentum flavum (Figure 3), and a keyhole-shaped laminectomy was performed (Figure

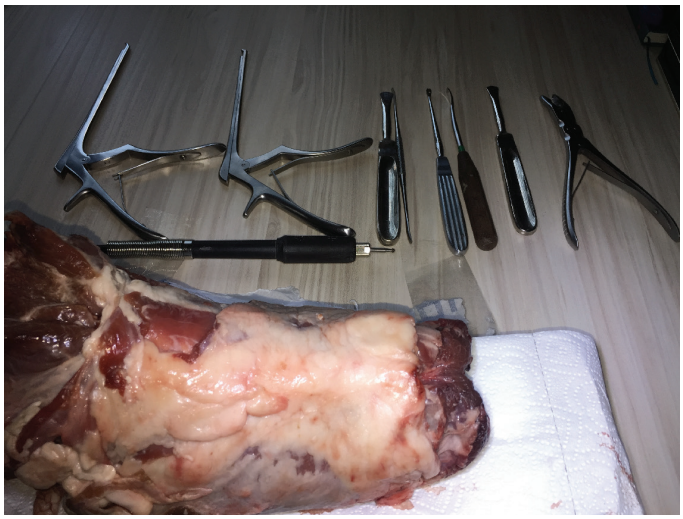


Figure 1. The neck of a sheep over 2 years old with non-stripped muscles

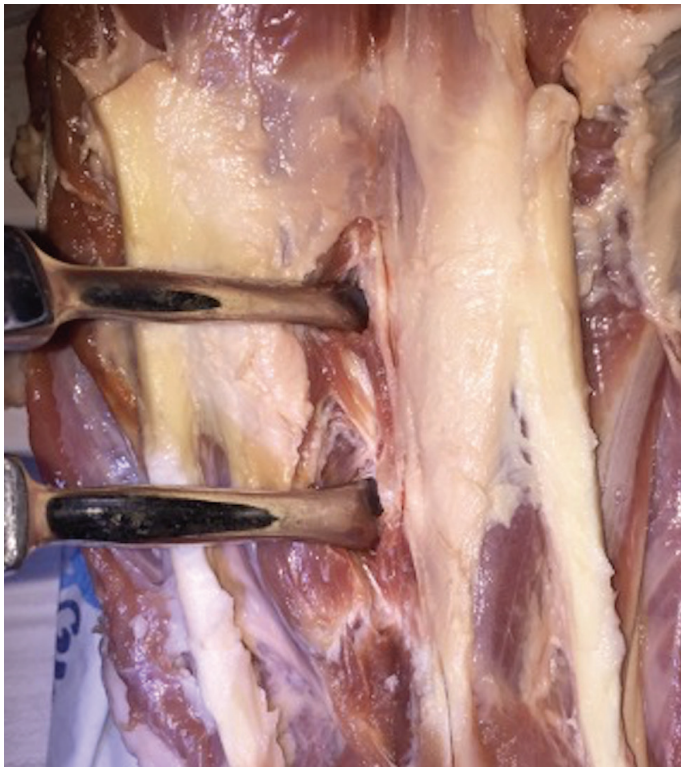
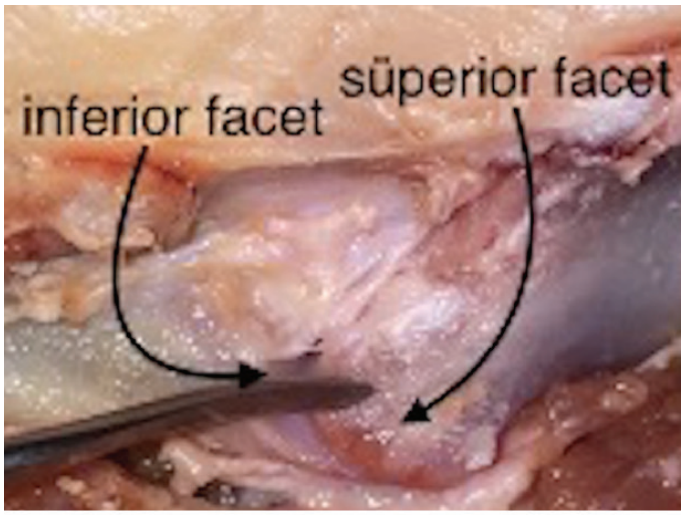


Figure 2. Stripping of the paravertebral muscles



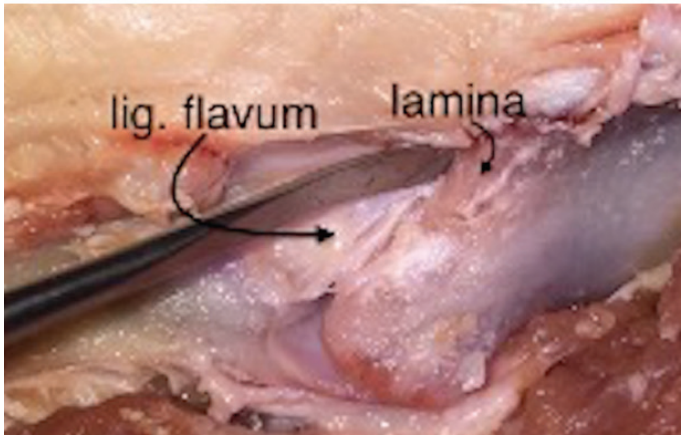


Figure 3. The borders of two consecutive laminae and facet joint were determined

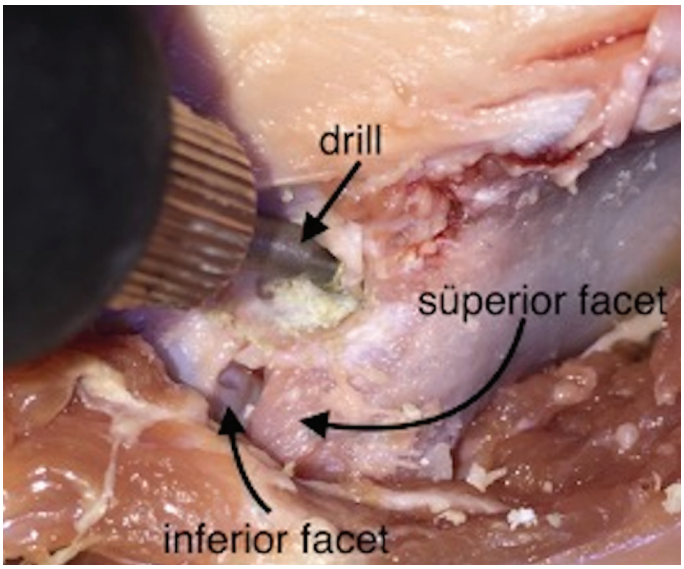


Figure 4. Keyhole-shaped laminectomy was performed

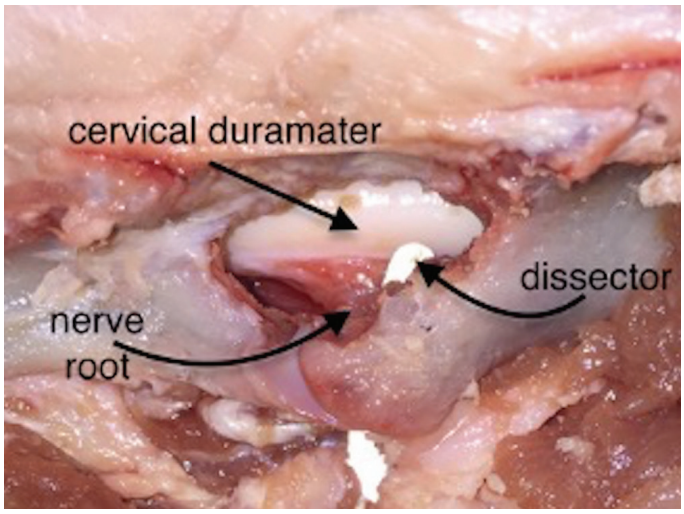


Figure 5. The cervical duramater, nerve root and cervical foramen

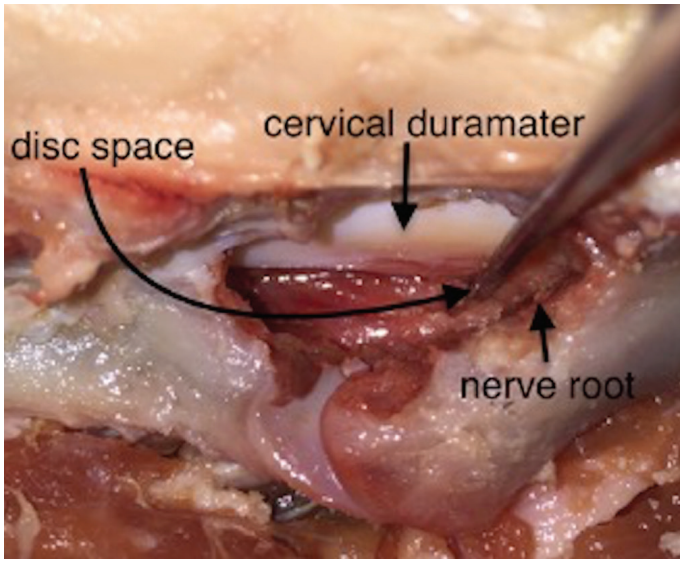


Figure 6. Determination of disc distance

4) After the cervical dura was defined, the cervical nerve root was identified by performing cervical foraminotomy (Figure 5). Lastly, discectomy was performed by determining the disc distance (Figure 6).

DISCUSSION

Traditional surgical education is based on the master-apprentice relationship, but this situation has been questioned for a long time and it is emphasized that this education model should be supported by laboratory and experimental training[6]. Therefore, important studies aiming to standardize pre-surgical laboratory training have been performed[7,8]. In these studies, mostly models were used. Although the anatomical simulation ability of these models, which can be used unlimitedly, is high, the ability to simulate tissue is almost non-existent. The cost of human cadaver studies and the need for special areas for storage limit their accessibility and they still do not have the ability to simulate *in vivo* situations, similar to model studies. Considering this situation, living animal models seem to be ideal for laboratory studies due to their anatomical similarity and viability, but recently increasing ethical concerns also limit the use of these models. Although the lack of viability of animal cadaver models is an important shortcoming, they have important advantages such as accessibility, anatomical and simulation ability, low cost, and the fact that special storage areas are not necessary[9-11].

We conducted our study using sheep cadaver spine to model posterior cervical foraminotomy and discectomy surgery used in the treatment of cervical disc herniation, which is frequently encountered in daily practice. Posterior cervical foraminotomy and discectomy is a minimally invasive surgical procedure that can be performed with a microscope or via endoscopy in selected cases of cervical disc herniation. In posterior cervical foraminotomy and discectomy, complications such as dysphagia, hematoma, and laryngeal nerve damage which may be encountered in anterior surgery, are not observed. Also, since fusion is not performed, adjacent segment degeneration is not expected, but complications such as neck pain, muscle spasm and greater blood loss may occur[12].

Of note, a simulator was developed for this specific intervention by the Congress of Neurological Surgeons Simulation Committee for use in neurosurgery training. The effectiveness of this simulator, created with a 3D printer, was evaluated by Harrop et al.[13] in terms of level detection, use of drills, removal of the laminae, decompression of neural structures and preservation of tissues, and it was stated that it could be useful for education.

Taking this information into account, the sheep cadaver cervical spine model we developed lacks the ability to simulate bleeding (similar to the spinal simulator); therefore, it is also insufficient in providing management skills concerning bleeding, which is a perioperative problem in posterior cervical foraminotomy and discectomy surgery. However, the sheep cervical spine cadaver model has some advantages. It can simulate all the targeted and tested stages in this simulator in line with bone anatomy, as well as providing the potential to practice paravertebral muscle stripping and increase experience in the recognition and removal of the ligamentum flavum and recognition of the dura mater and nerve roots.

CONCLUSION

We believe that the present posterior cervical foraminotomy and discectomy model in sheep cervical spine can effectively simulate all steps of this surgery, thus contributing to anatomical orientation during surgical intervention. In addition, the utilization of these studies will have a positive effect on

similar surgical interventions due to its contribution to the ability to recognize and use relevant surgical instruments.

Ethics

Ethics Committee Approval: Ankara Training and Research Hospital has decided that the ethics committee approval of Animal Cadaver Study number 845 is not required according to "Regulation on Working Procedures and Principles of Animal Experiments Ethics Committees Article 8 19-k" (date 22/12/2021).
Informed Consent: Animal cadaver study.
Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

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

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

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COMPARISON OF THE RESULTS OF SINGLE LEVEL CERVICAL DISC ARTHROPLASTY VERSUS ANTERIOR CERVICAL DISCECTOMY IN SHORT TO MID-TERM FOLLOW-UP

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ABSTRACT

Objective: The aim of this retrospective study is to compare results of single-level cervical disc arthroplasty (CDA) versus anterior cervical discectomy and fusion (ACDF) in two different centers with short to mid-term follow-up.

Materials and Methods: Both surgical techniques were applied by 2 different surgeons and in 2 different centers. While ACDF was performed by the surgeon in one clinic, CDA was performed by another surgeon in another clinic, in order to avoid surgical bias, and another surgeon from a different clinic performed a statistical evaluation. Modified Japanese Orthopedic Association score (mJOA), Modic changes (MC), neck disability index (NDI) and visual analogue scale (VAS), perioperative dysphagia, and the time to return work scores of the patients were evaluated in the study.

Results: Seventy-one patients were included in the study. Thirty-two of them underwent ACDF with a median follow-up period of 15 months, and 39 underwent CDA with a median follow-up period of 16 months. The median preoperative lost workdays were statistically significantly higher in the ACDF group compared to the CDA group (p=0.009). Patients in the CDA group had statistically significantly more pain intensity (p<0.001) and lower mJOA score before the surgery (p<0.001). Neck disability was significantly more severe in the ACDF group compared to the CDA group according to the preoperative NDI score (p=0.014). Improvements in VAS and mJOA scores were significantly better in the CDA group compared to the ACDF group (p=0.004 and p<0.001, respectively). The type 1 and type 2 MC were more frequent in the ACDF group than the CDA group, preoperatively. There was a statistically significant difference in preoperative MC among the groups (p=0.010).

Conclusion: In our study, both surgical techniques achieved satisfactory results. However, due to the short-term nature of the study, MC could not be evaluated and a definite opinion on this matter could not be reached.

Keywords: Modic changes, cervical disc, outcome, arthroplasty, discectomy

INTRODUCTION

Surgery has an important place in the treatment of degenerative cervical conditions that do not respond to medical therapy and cause progressive neurological dysfunction. Cervical disc arthroplasty (CDA) has been developed as a safe and segmental motion-preserving method against anterior cervical discectomy and fusion (ACDF) method in the surgical treatment of cervical radiculopathy and myelopathy caused by spondylosis and acute disc herniation[1]. Although ACDF is accepted as the standard treatment for cervical radiculopathy and myelopathy, there are reservations regarding ACDF since increased motion and intradiscal pressure in the fusion of adjacent levels causes symptomatic adjacent-segment disc degeneration[2,3]. This problem of the ACDF system has led to the development of different CDA systems.

ACDF, which was first defined by Smith-Robinson and Cloward in the 1950s, is an important method in the treatment of cervical degenerative disease[4]. However, in the long term, this method can cause adjacent segment degeneration or instability. CDA has been developed as an alternative to ACDF because it can provide intervertebral disc height and segment activity, and has become a non-fusion method. The increase in adjacent segment degeneration caused by ACDF is reduced by CDA, which has been evaluated as "good" in clinical studies[5,6].

There is limited information in the literature regarding the comparison of "short to mid-term" outcomes of these two methods, which are frequently used in cervical pathologies. The

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aim of this study is to compare clinically important outcomes of single-level CDA versus ACDF at two different clinics in short to mid-term follow-up.

MATERIALS AND METHODS

Ethical approval was obtained from Akdeniz University Faculty of Medicine Clinical Research Ethic Committee (approval no: KAEK-718, date: 13.10.2021).

In this retrospective study, the surgeries performed in two different neurosurgery centers between December 2015 and December 2019 were compared. Patients had C3-7 single-level disc disorder. Before surgery, all patients had no response to medical and physical therapy and rehabilitation treatments. The surgical indications were evaluated according to soft disc herniation, spondylotic disc, the occurence of cervical spinal cord myelopathy or hyperintense signal and "the anterior cervical surgical approach" was used in all patients. Polyetheretherketone cage or disc prosthesis was applied for fusion. Inclusion criteria were as follows: (1) subjects were 18 years old or greater and underwent surgical treatment for symptomatic cervical disc disease; (2) the intervention was ACDF and "mobile" CDA; (3) the study reported at least one valid outcome which included NDI, neck and arm pain assessments, neurological success, overall success, radiographic evaluation, complications, and reoperation; (4) patients were excluded if they had a multi-level disc disease, acute spinal fracture, infection, tumor, osteoporosis, rheumatoid arthritis, severe spondylosis, or more than one vertebral level requiring treatment.

Modified Japanese Orthopedic Association score (mJOA), Modic changes (MC), neck disability index (NDI) and visual analogue scale (VAS), perioperative dysphagia, the time to return work scores of the patients were evaluated in the study. Postoperative surgical results were analyzed according to Odom et al.[7] criteria.

Radiological evaluations were made with plain and functional radiographs before and after the operations. These evaluations were used for the surgical choice and the follow-ups. Measurements were taken from various perspectives: cervical lordosis in the neutral position and in flexion and extension cervical lordosis was measured between C2 and C7 according to Cobb[8]. In the follow-up, new formation in anterior and posterior of vertebral corpus and collapse in operation spacing (>2 mm)[9] were evaluated. In flexion-extension position, >2° movement in lateral radiography was accepted as pseudoarthrosis[10,11].

For preoperative and postoperative clinical evaluations NDI and VAS, mJOA, preoperative MC, and MC at the 8th month were used.

Both surgical techniques were applied by two different surgeons and different centers. While ACDF was performed by surgeon A in one center, CDA was performed by surgeon B in another center, in order to avoid surgical bias, another surgeon C from a different center performed a statistical evaluation.

Statistical Analysis

Statistical analyses were performed using SPSS version 20 statistical package program (IBM Corp. in Armonk, NY). Shapiro-Wilk and Kolmogorov-Smirnov tests were used to evaluate the distribution of the numeric variables. Descriptive data were presented as mean ± standard deviation and median with interquartile range for numerical variables, whereas frequency and percentage were used for categorical variables. Pearson chi-square test and Fisher's exact test were used to compare categorical variables, and the Mann-Whitney U test was used to compare the non-normally distributed numeric data, between two study groups. P<0.05 was considered statistically significant.

RESULTS

This retrospective comparative study was carried out with patients who underwent ACDF and CDA between December 2015 and December 2019. Demographics and preoperative findings of the patients were shown in Table 1. Throughout this period, 71 patients were included in the study. Thirty-two of them underwent ACDF with a median follow-up period of 15 months, and 39 underwent CDA with a median follow-up period of 16 months. The female to male ratio, age, and prevalence of preoperative dysphagia were similar among the groups. There was a statistically significant difference in the distribution of the level-of-disc disorder between groups (p=0.007), and C4-C5 level-of-disc disorder was more prevalent in the ACDF group compared to the CDA group; however, the most prevalent disc disorder was at the C5-C6 level in both two groups. Radiculopathy and myelopathy were significantly more prevalent in the CDA group, and radiculomyelopathy and neck pain were more prevalent in the ACDF group (p=0006).

The median preoperative lost workdays were statistically significantly higher in the ACDF group compared to the CDA group (p=0.009). Patients in the CDA group had statistically significantly more pain intensity (p<0.001) and lower mJOA score before the surgery (p<0.001). Neck disability was significantly more severe in the ACDF group compared to the CDA group according to the preoperative NDI score (p=0.014) (Table 1).

Improvements in VAS and mJOA scores were significantly better in the CDA group compared to the ACDF group (p=0.004 and p<0.001, respectively), notwithstanding the differences in preoperative and postoperative NDI scores of the groups were statistically similar (Table 2 and Figure 1).

The type 1 and type 2 MC were more frequent in the ACDF group than the CDA group, preoperatively. There was a statistically significant difference in preoperative MC among the groups (p=0.010); however, this difference was diminished in favor of the ACDF group at the postoperative 8th month (Table 3).

Postoperative dysphonia as a complication of the surgery occurred only in one patient who underwent ACDF. Besides, there was no dysphonic patient in the CDA group, postoperatively,

and this difference was not statistically significant. We found that the CDA method was more successful in clinical outcomes according to the postoperative 3rd month Odom criteria (p=0.002) (Table 4).

The time to return to work, which is the social indicator of surgical success, was significantly longer in the CDA group with a median of 20 days than the ACDF group with a median of 15 days (p=0.004) (Table 5 and Figure 2).

DISCUSSION

Dysphonia and dysphagia rates, which could be a clue to the evaluation of our surgical technique, were compatible with the literature[12,13]. However, in some studies, dysphagia was found to be more common in ACDF groups due to excessive retraction[14]. In our study, there was no statistically significant difference between the two groups.

There are two surgical methods in the treatment of cervical disc disease: ACDF and CDA. CDA emerged after ACDF claiming to preserve movement and prevent adjacent segment disease. The superiority of either method over the other has not been demonstrated clearly. The most important disadvantage of ACFD is that the motion segment is lost and fused. Therefore, some authors emphasized that adjacent segment disease is more common in patients treated with ACFD[14]. It has been suggested that CDA provides a physiological mechanism since it maintains the disc level, provides better spinal dynamism and reflects less stress on the disc distance[15].

Table 1. Demographics and preoperative findings of the patients

Characteristics (n=65)	ACDF (n=32)	CDA (n=39)	p-value
Sex, (F/M)	13/19	19/20	0.495*
Age (year), median (IQR)	46.0 (42.0-49.5)	46.0 (40.0-52.0)	0.871**
Disc level, n (%)			**0.007*** **
C3-C4	3 (9.4)	0 (0.0)	
C4-C5	19 (25.0)	2 (5.1)	
C5-C6	19 (40.6)	28 (71.8)	
C6-C7	19 (21.9)	9 (23.1)	
C7-T1	19 (3.1)	0 (0.0)	
Indication for surgery, n (%)			**0.006*** **
Radiculopathy	17 (53.1)	30 (76.9)	
Myelopathy	5 (15.6)	8 (20.5)	
Radiculomyelopathy	6 (18.8)	0 (0.0)	
Neck pain	4 (12.5)	1 (2.6)	
Preoperative lost work days, median (IQR)	9.0 (7.0-30.0)	6.0 (4.0-15.0)	**0.009****
Preoperative VAS score, median (IQR)	7.0 (6.0-7.8)	8.0 (7.0-8.0)	**<0.001****
Preoperative mJOA score, median (IQR)	13.0 (11.3-14.0)	16.0 (16.0-117.0)	**<0.001****
Preoperative NDI score, median (IQR)	32.5 (20.0-40.0)	22.0 (19.0-31.0)	**0.014****
Follow-up period (month), median (IQR)	15.0 (13.0-18.0)	16.0 (12.0-19.0)	0.535**

*Pearson chi-square test was used, **Mann-Whitney U test was used, ***Fisher's exact test was used.
F: Female, M: Male, IQR: Interquartile range, VAS: Visual analogue score, mJOA: Modified Japanese Orthopedic Association score, NDI: Neck disability index, ACDF: Anterior cervical discectomy and fusion, CDA: Cervical disc arthroplasty

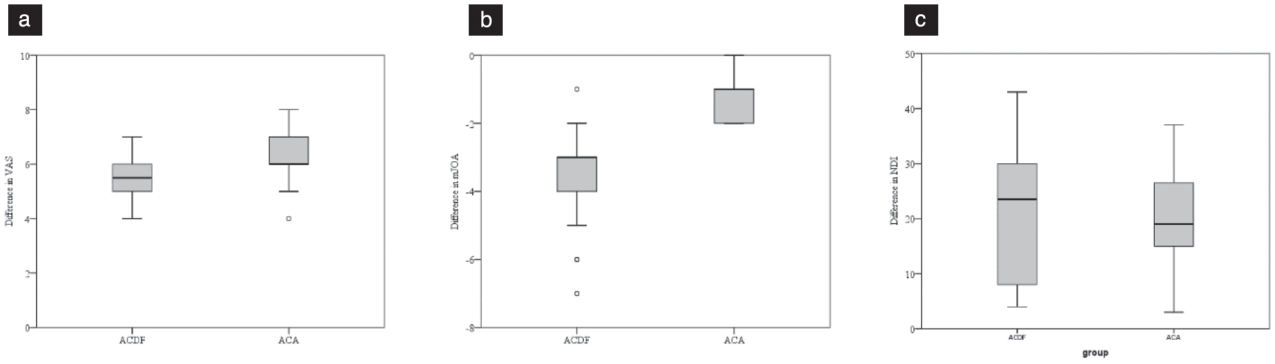

Figure 1. Boxplots of the difference in preoperative and postoperative (a) VAS, (b) mJOA and (c) NDI scores
VAS: Visual analogue score, mJOA: Modified Japanese Orthopedic Association score, NDI: Neck disability index

In a meta-analysis, no difference was found between the two surgical methods in NDI and pain scores[16]. The results of our study were parallel to studies comparing the short-term results of CDA with ACDF[14]. However, VAS and mJOA scores were relatively better than the CDA group, while NDI scores were the same.

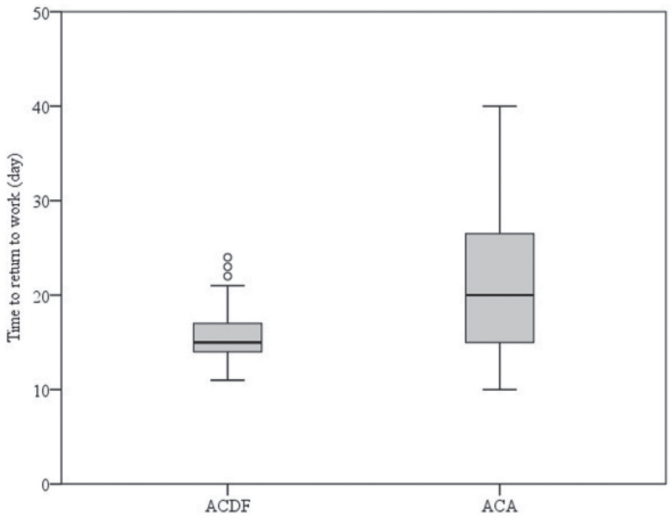

Figure 2. Boxplots of the time to return to work in days among the study groups

ACDF: Anterior cervical discectomy and fusion

Cervical degenerative disease is a chronic active process that can manifest itself with radiculopathy and myelopathy[17]. Since it is the most active cervical region, cervical degeneration is most commonly seen at C5/6[18]. Repeated loads or neck activities cause mechanical strain on the endplate and disc regions of the cervical spine. MC, degenerative changes to vertebral endplate and subchondral bone marrow that can be detected by magnetic resonance imaging (MRI), are strongly associated with degenerative disc disease[19]. Therefore, MC are also seen most frequently at C5/6[20].

In this study, we also evaluated MC between the two surgical methods. In this study, the MC in our preoperative ACDF patient group (10/32, 31.25%) were greater than the CDA group (3/39, 7%). However, MC in the CDA group increased in postoperative follow-up (9/39, 23%), and the difference with the ACDF group (16/32, 50%) lost its significance.

Cervical MC was first described by Peterson et al.[21] as the signal change in the vertebral endplate and subchondral bone marrow in MRI. In subsequent studies, the incidence of MC in the cervical region was reported to be between 3-40%[22,23]. Peterson et al.[21] found that the most common change was type 1; however, in many studies, type 2 MC was found to be the most frequent change[23].

MC are considered to be chronic inflammatory changes[22]. Inflammatory factors such as interleukin, prostaglandin E2, PGP 9.5, and tumour necrosis factor have been found in MC[24]. The

Table 2. Difference in preoperative and postoperative VAS, mJOA and NDI scores

Scale		ACDF (n=32)	CDA (n=39)	p*
Difference in VAS	Mean ± SD	5.5±0.9	6.3±2.93	**0.004**
	Median (IQR)	5.5 (5.0-6.0)	6.0 (6.0-7.0)	
Difference in mJOA	Mean ± SD	-3.8±-1.4	-1.3±-0.7	**<0.001**
	Median (IQR)	-3.0 (-4.0/-3.0)	-1.0 (-2.0/-1.0)	
Difference in NDI	Mean ± SD	21.3±12.3	20.4±7.4	0.619
	Median (IQR)	23.5 (7.0-30.0)	19.0 (15.0-27.0)	

* Mann-Whitney U test was used.
SD: Standard deviation, IQR: Interquartile range, VAS: Visual analogue score, mJOA: Modified Japanese Orthopedic Association score, NDI: Neck disability index, ACDF: Anterior cervical discectomy and fusion, CDA: Cervical disc arthroplasty

Table 3. Comparison of preoperative and postoperative Modic changes among study groups

		ACDF (n=32)		CDA (n=39)		
		n	%	n	%	p*
Preoperative Modic changes	Absent	22	68.8	36	92.3	**0.010**
	Type 1	6	18.8	0	0.0	
	Type 2	4	12.5	3	7.7	
	Type 3	0	0.0	0	0.0	
Postoperative Modic changes at 8th month	Absent	16	50.0	30	76.9	0.065
	Type 1	9	28.1	4	10.3	
	Type 2	6	18.8	5	12.8	
	Type 3	1	3.1	0	0.0	

*Fisher's exact test was used
ACDF: Anterior cervical discectomy and fusion, CDA: Cervical disc arthroplasty

Table 4. Comparison of the presence of postoperative dysphonia and postoperative Odom Criteria among study groups

		ACDF (n=32)		CDA (n=39)		
		n	%	n	%	p*
Postoperative dysphonia	Absent	31	96.9	39	100.0	0.451
	Present	1	3.1	0	0.0	
Postoperative Odom Criteria	Poor	1	3.1	0	0.0	**0.002**
	Fair	7	21.9	0	0.0	
	Good	15	46.9	18	46.2	
	Excellent	9	28.1	21	53.8	

*Fisher's exact test was used.
ACDF: Anterior cervical discectomy and fusion, CDA: Cervical disc arthroplasty

Table 5. Comparison of the time to return work among the study groups

		ACDF (n=32)	CDA (n=39)	p*
Time to return work (day)	Mean ± SD	15.7±3.5	21.0±7.7	**0.004**
	Median (IQR)	15.0 (14.0-17.5)	20.0 (15.0-27.0)	

*Mann-Whitney U test was used.
ACDF: Anterior cervical discectomy and fusion, CDA: Cervical disc arthroplasty, SD: Standard deviation, IQR: Interquartile range

natural course of MC starts as type 1 and progresses towards type 3. In this respect, although it resembles a chronic active inflammation, its cause is not fully explained. Although some studies have suggested that inflammation may be caused by anaerobic infection[25], this hypothesis has been rejected in other studies[26]. This has led to the view that CDA, used as a segmental motion-preserving method, cannot prevent MC only by preserving segmental motion, and MC must have their own internal dynamics.

Our study has several limitations. First, we had a small number of patients. Second, the follow-up time was short to evaluate the long-term effects of the two methods. To address these limitations, randomized controlled studies with higher patient numbers and long-term follow-up are needed. Both surgical techniques were applied by two different surgeons and different centers, so which might have an effect of surgeon binded bias. This bias resolved by the third blinded surgeon who evaluated statistical results.

CONCLUSION

We found that standard ACDF and CDA treatments of cervical disc disease causing radiculopathy and myelopathy reached postoperative pain goals. However, we believe that MC have unique internal dynamics rather than an effect of the surgical technique. the comparison of clinically important secondary outcomes of CDA versus ACDF at two different centers in short to mid-term follow-up also showed beneficial results.

Ethics

Ethics Committee Approval: Ethical approval was obtained from Akdeniz University Faculty of Medicine Clinical Research Ethic Committee (approval no: KAEK-718, date: 13.10.2021).
Informed Consent: Retrospective study.
Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: N.Ü., Design: A.G, Data Collection or Processing: E.G., Analysis or Interpretation: N.Ü., Literature Search: NU., E.G., A.G., Writing: N.Ü., A.G., H.Ç.

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

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BIOMECHANICAL CHANGES IN THE CERVICAL SPINE ALIGNMENT AFTER LUMBAR DYNAMIC STABILIZATION

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ABSTRACT

Objective: The aim of this study is to determine the biomechanical changes in cervical spine parameters following the surgical correction of lumbar deformity with dynamic stabilization, and to evaluate how the preoperative parameters are related to these changes.

Materials and Methods: Anteroposterior and lateral scoliosis radiographs of 20 patients were obtained, who underwent a dynamic stabilization (DynesysR, Zimmer, USA) and Safinaz screw peek rod placement procedures for lumbar deformity. The cervical spine parameters in the radiographs were measured in Surgimap program by an independent researcher, and they were classified into 5 categories and compared by using the Wilcoxon test in preoperative and early postoperative periods. The data were collected and analyzed using IBM SPSS Statistics 25th Edition.

Results: Between all the parameters examined, the changes in the patients' T1 Slop Angle were found to be statistically significant (p value<0.05). Depending on this, it was concluded that dynamic stabilization of lomber deformity could change the biomechanical loads in the postoperative cervical spine alignment.

Conclusion: Dynamic stabilization surgery for spinal deformity, which is conducted to restore sagittal balance, can also lead to biomechanical improvement in the cervical spine alignment.

Keywords: Dynamic stabilization, sagittal balance, cervical spine, surgimap

INTRODUCTION

"S" shaped arrangement of the spine is the unique factor in the formation of sagittal and coronal balance. This form allows most complicated movements to be done with minimum energy consumption. It also maintains spinopelvic alignment by establishing a balance between the compensatory mechanisms of the pelvis and the head. Nowadays, these complex interactions have become more and more revealed with computer-aided measurements[1,2].

Sagital imbalance, as seen in lumbar degenerative disease, is associated with progressive pain and disability[3]. Previous studies show that surgeries for the degenerative spine, performed to correct the sagittal balance, cause significant corrective changes even outside the stabilized areas of the thoracolumbar spine[4]. These changes cause the SVA to approach to the gravity line by rearranging the axial load distribution on the cervical spine as a result of the restoration of the sagittal balance[5].

The aim of this study is firstly to show the effect of dynamic stabilization on cervical spine alignment changes, to evaluate whether these changes influenced by a particular preoperative spine alignment, and then to determine preoperative parameters that trigger these changes on spine alignment following the corrective lumbar degenarative disease.

MATERIALS AND METHODS

Patient Population

The adult patients with consecutive lumbar degenarative diseases, who were treated with Dynesys dynamic stabilization procedure and Safinaz screw peek rod placement between 2019 and April 2021 in our hospital, were included in this study according to the surgical records. Informed consent was obtained from our patients for our study. Institutional review board approval was obtained from İstanbul Medipol University Non-Interventional Clinical Research Ethics Committee (approval number: E-10840098-772.02-5821, date: 11/11/2021). The inclusion criteria for the study were: age >50 years, lumbar degenerative disease status in at least 1 segment, and bilateral scoliosis on plain radiographs taken in pre- and postoperative on standart upright position. Patients diagnosed with ankylosing spondylitis, any tumor or infection,

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or with lumbar degenerative disease caused by neuromuscular conditions were excluded from the study. Clinical, surgical and radiographic records of the included cases were also examined.

Radiological Measurements

Full-length, standing, AP, and lateral scoliosis radiographs were obtained in a standard upright position, with arms horizontally forward and folded over the shoulder. Radiographic measurements were obtained by calibrating the Surgimap measurement program for each patient in accordance with standard techniques in scoliosis radiographs.

The angle C1-C2 (C1-2) was measured from the line between the anterior arch of C1 and the posterior arc of C2 to the line at the lower margin of body C2. The C2-C7 angle (C2-7) was measured along the line extending from the rear body of C2 to the rear body of C7. The slop angle T1 was measured between the upper endplate of T1 and the line along the horizontal reference line. T1-CL measurement, this was judged based on the C2-T1 Cobb angle. cSVA measurement, the distance between the plumb line through the C2 center and the plumb line of the posterior C7 upper ende plate. (Figure 1, 2, 3, 4). It has been concluded that this situation might result in biomechanical improvement in the cervical spine alignment. Scoliosis radiographs were taken just before the operation (1-2 days on average) and immediately after the surgery when the patients were mobilized (average 2-3 days).

Study Design and Statistical Analysis

Data analysis was collected and analyzed using IBM SPSS Statistics 25th Edition. Data were irrigated after descriptive analysis. Normality analysis of the data was performed using Kolmogorov-Smirnov test, Shapiro-Wilk test, Histogram and Variance coefficient. The dependent groups were compared using the Wilcoxon test. P<0.05 was considered significant.

RESULTS

The population demographics and diagnoses of 20 patients have been summarized as in Table 1. The mean age of the patients was 65.6, and 9 male patients and 11 female patients were included in the study. Four of the patients had degenerative disc disease, 7 had spinal stenosis, 4 had previously operated spinal instability, 3 had spondylolisthesis and 2 had spondylolysis. The highest instrumental spinal cord level was L1 and the lowest instrumentation level was L5. It has been found that there is no significant difference in the demographic parameters listed in Table 1. On the other hand, there are significant changes (p<0.05) found in the measurements of T1 slop angle in the parameters examined (Table 2 and 3). Then, the relationship between the T1 slop angle in single segment and long segment dynamic stabilization has statistically been analyzed and a significant difference has been found in favor of the long segment (p<0.05) (Table 4) (Figure 5).

DISCUSSION

Symptomatic pain resulting from the change of normal cervical lordosis and subsequent disc herniation are known to be related to each other[6]. Therefore, understanding the compensatory behavior of the cervical spine in thoracolumbar deformity patients is of importance to prevent secondary cervical spine disorders.

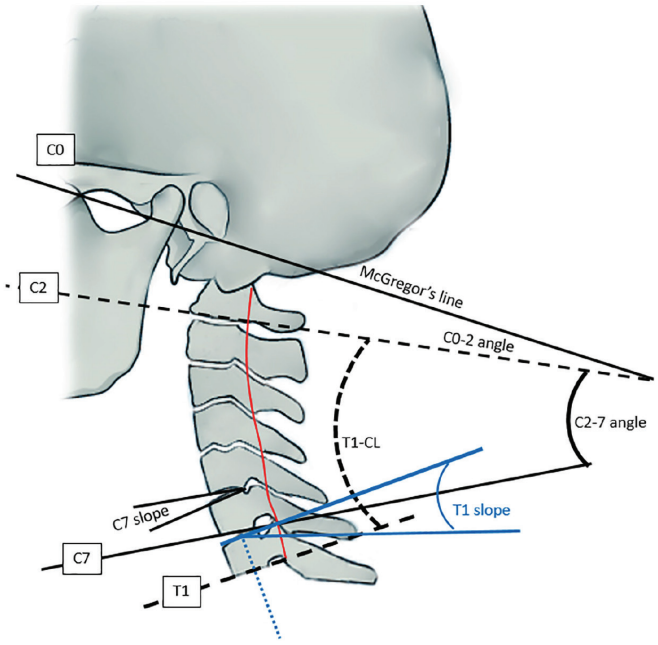

Figure 1. C0-C2 angle and C7 slop angle are shown

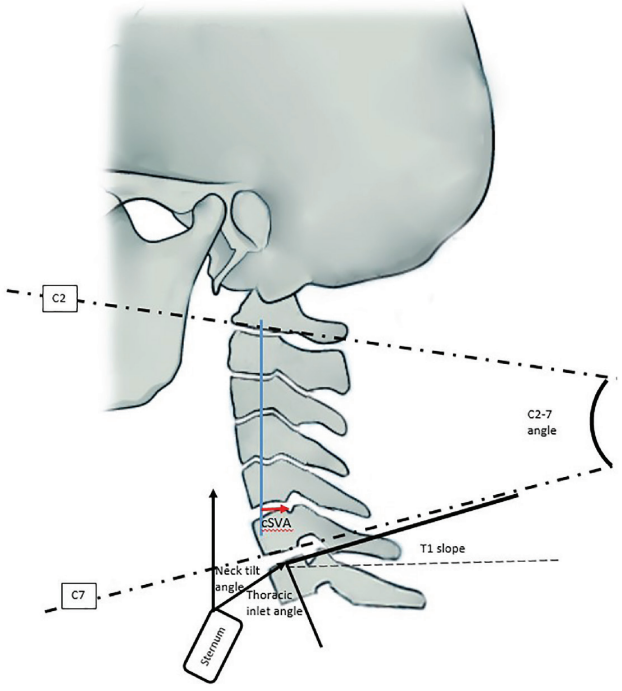

Figure 2. Thoracic inlet angle, cervical tilt angle, cSVA and C2-7 angle measurements are shown

It is a well-known fact that a disruption in the spine alignment will affect other parts of the spine. In time, the spine has gained lordotic and kyphotic inclinations in order to economically use the distribution of the load in bipedal people, and it has gained comfortable use of both arms and hands[7]. Sagittal orientation in the spine is the position which people have in daily life

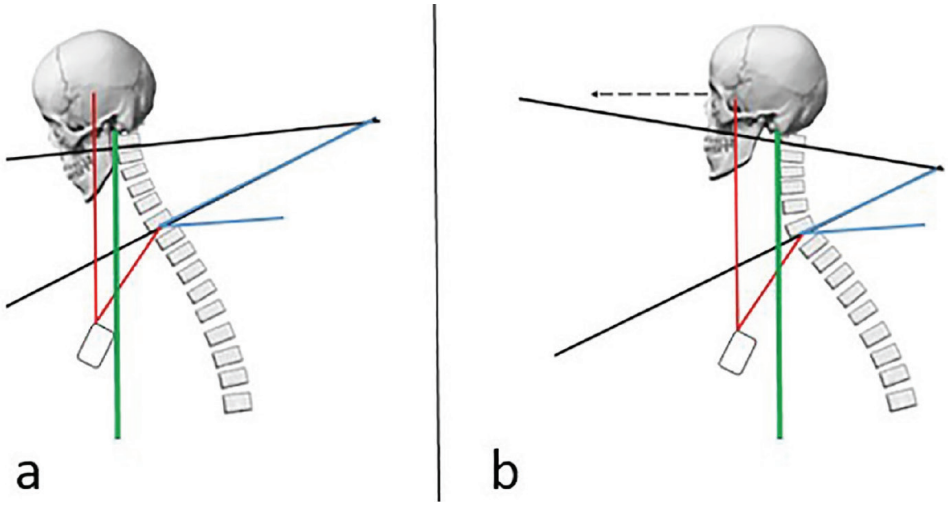

Figure 3. a) Relation between normal thoracic parameters and cervical region b) As thoracic kyphosis (blue) develops, T1 slop angle decreases and neck tilt increases (red)

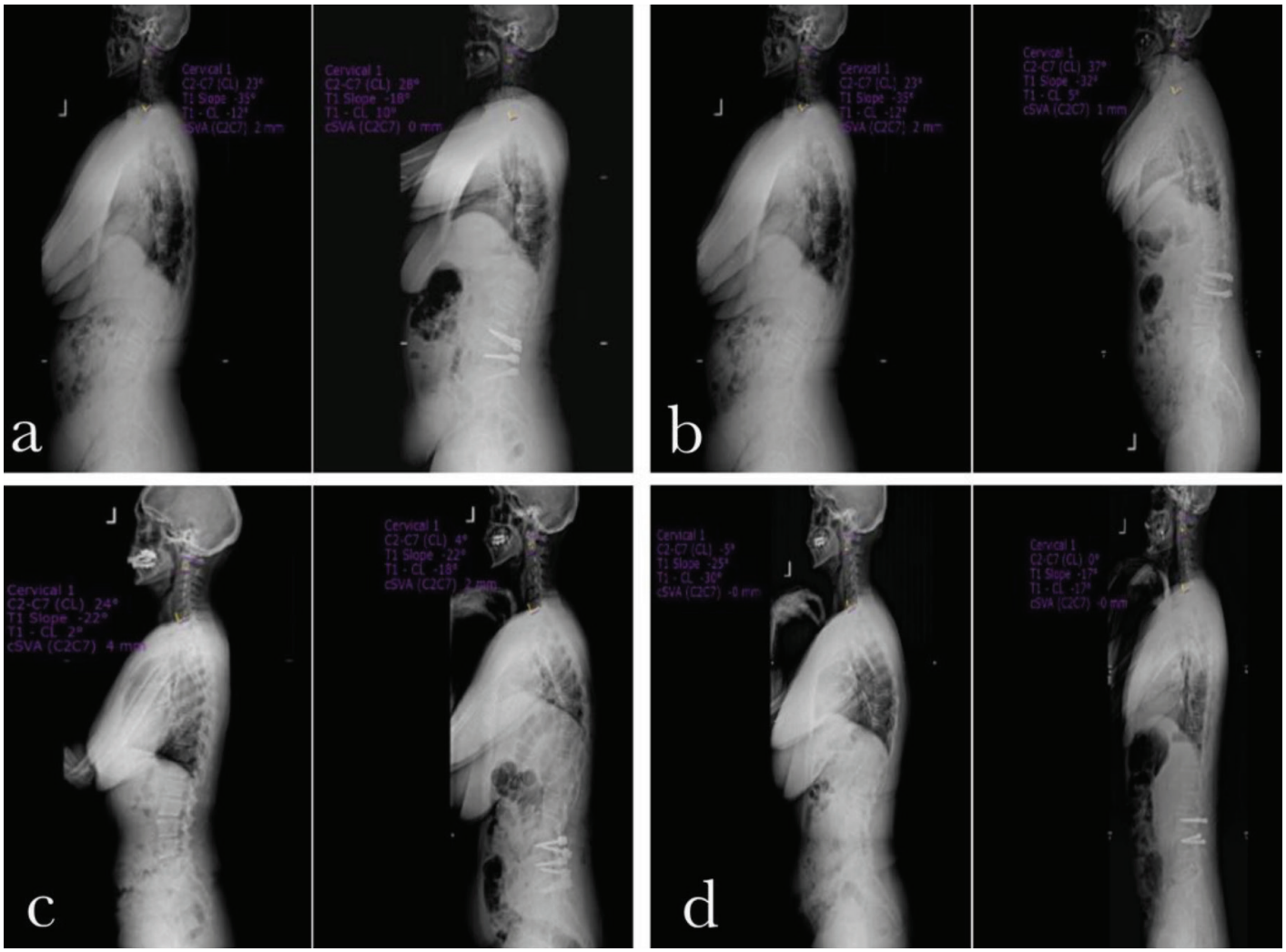

Figure 4. a. b. c. d) Preoperative and postoperative cervical biomechanic measurements

Table 1. Demographic information and diagnosis of patients

Patient no	Age	Sex	Level	Diagnosis
1	61	M	L4	Degenerative Disc Disease
2	74	M	L2 and L4	Spinal Stenosis
3	58	M	L3	Spinal instability (Operated)
4	67	F	L3 and L4	Spinal Stenosis
5	60	F	L4	Degenerative Disc Disease
6	62	M	L4	Spondylolisthesis
7	66	F	L2	Spondylolysis
8	72	M	L3 and L4	Spinal Stenosis
9	75	F	L4	Spondylolisthesis
10	69	M	L5	Spinal instability (Operated)
11	56	F	L2	Spondylolysis
12	65	F	L3	Degenerative Disc Disease
13	64	F	L4 and L5	Spinal Stenosis
14	62	F	L4	Spinal instability (Operated)
15	60	M	L4	Degenerative Disc Disease
16	69	F	L4 and L5	Spinal Stenosis
17	63	M	L2 and L3	Spinal Stenosis
18	62	F	L4	Spinal instability (Operated)
19	76	F	L3 and L4	Spinal Stenosis
20	72	M	L4	Spondylolisthesis

Table 2. Examined cervical biomechanical parameters of the patients

Patient no	Preop C1-2	Postop C1-2	Preop C2-7	Postop C2-7	Preop T1 Slope	Postop T1 Slope	Preop T1-CL	Postop T1-CL	Preop cSVA mm	Postop cSVA mm
1	35	30	17	13	-26	-21	-9	-1	4	4
2	25	29	12	-8	-24	-8	-12	-21	-3	-2
3	31	23	9	9	-34	-28	-25	-7	-7	-7
4	39	42	3	-10	-26	-15	-23	-4	-4	-4
5	31	41	2	44	-18	-61	-16	-25	-3	-3
6	25	35	-21	-2	0	-4	-21	-6	1	4
7	59	61	-2	0	-35	-36	-37	-25	-7	-5
8	18	41	37	6	-32	-23	5	-17	-2	-1
9	64	53	-6	-4	-39	-21	-45	-15	-13	-8
10	27	31	19	13	-33	-16	-14	-3	3	1
11	33	15	23	28	-35	-18	-12	14	2	0
12	42	42	11	20	-38	-37	-27	-6	-5	-2
13	31	31	24	37	-24	-32	0	5	5	1
14	35	47	30	10	-25	-27	5	-15	5	1
15	14	26	24	20	-22	-31	2	-11	4	1
16	28	39	-1	8	-13	-22	-14	-5	2	1
17	19	8	7	37	-5	-35	2	4	1	-3
18	38	28	-5	4	-25	-22	-30	-2	0	2
19	34	21	16	8	-33	-20	-17	-3	-3	-3
20	24	31	3	0	-27	-17	-24	-8	-4	0

outside of the sleeping time. Therefore, a distortion in the lower part of the spine will naturally affect the overlapping spine posture. This situation may not necessarily be in the spine. Pathologies in the pelvis, hip joints or lower extremities also play an important role in the balance of the spine. If this unwanted interaction can be balanced by posture protection mechanisms, it may not be noticed at all, but if the compensation does not work, the balance of the spine may be disturbed[8,9]. As a result, unless there are very special conditions, a deterioration in the lumbar region affects the thoracic and cervical region and the position of the head, while thoracic region pathologies mainly affect the cervical region and the head. The position of the head is affected by a deterioration in the cervical region[10]. When the current studies have been examined, it is observed that the normal and pathological parameters of the lumbar and thoracic region are predominantly revealed and a common language is created. The parameters of the cervical region affected by indirect or direct pathologies have been studied in recent years[11]. It is understood that these parameters are similar to the projection of the lumbopelvic region. The sacral slop angle is replaced by the thoracic slop angle and the pelvic tilt by the thoracic tilt angle. The thoracic inlet angle corresponds to the pelvic incidence. The thoracic inlet angle is equal to the sum of the thoracic slop and neck tilt angle.

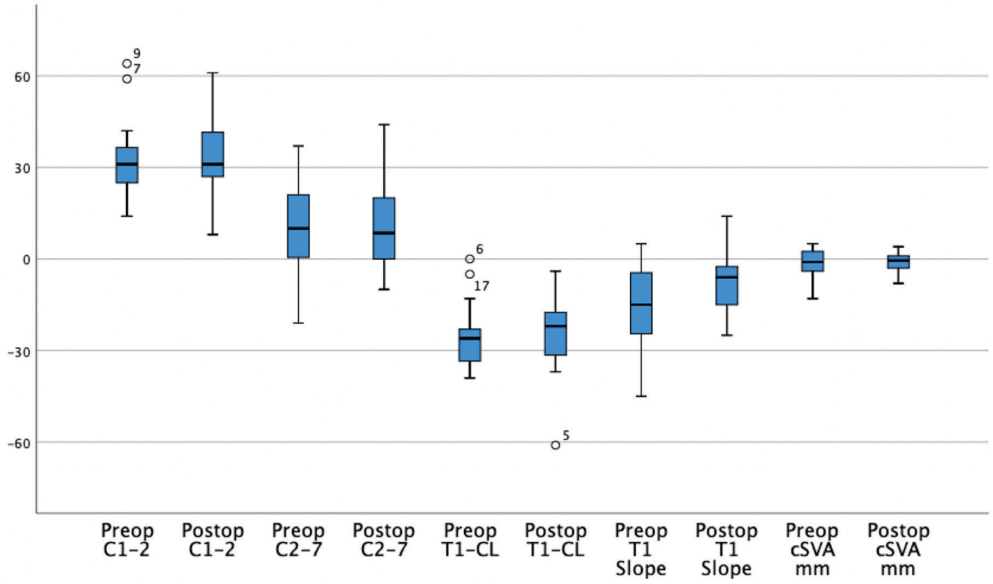

Figure 5. Statistical result cervical biomechanical parameters of patients

Table 3. Significant difference in T1 slop angle

Test statistics[a]					
	Postop C1-2 -Preop C1-2	Postop C2-7 - Preop C2-7	Postop T1 Slope - Preop T1 Slope	Postop T1-CL - Preop T1-CL	Postop cSVA mm - Preop cSVA mm
Z	-0.327[b]	-0.262[b]	-1,065[b]	-2,017[b]	-0.029[b]
Asymp. Sig. (2-tailed)	0.744	0.793	0.287	0.044	0.977

[a]: Wilcoxon-signed ranks test
[b]: Based on negative ranks

Table 4. Significant difference in T1 slop angle between the single segment and multi segment lumbac dynamic stabilization patients

Pairwise Comparisons						
Measure: Preop Postop T1-CL						
					95% confidence interval for difference[b]	
(I) Grup	(J) Grup	Mean difference (I-J)	Standard error	Signature[b]	Lower bound	Upper bound
1 segment	>1 segment	-9,250*	3,808	0,026	-17,251	-1,249
>1 segment	1 segment	9,250*	3,808	0,026	1,249	17,251

Based on estimated marginal means
*: The mean difference is significant at the
[b]: Adjustment for multiple comparisons: Bonferroni

Especially these parameters are very important in evaluating lumbar and thoracic pathologies together with those in the cervical regions[12,13].

It is known that thoracic and cervical regions are very affected by the lumbar fixed sagittal balance deformity. This situation suggests that postoperative cervical spine alignment may depend on changes in regional lumbar anatomic curvature and sagittal alignment, and the observed cervical changes differ depending on the preoperative sagittal alignment. There is a similar case in the state of imbalance that occurs after instrumentation surgery in which lumbar lordosis is not preserved. In cases where the movement at the bottom is destroyed, the upward effect becomes clear. However, it has not yet been investigated whether or how much the cervical region is affected in dynamic systems in which the functional segment is stabilized mobile in the spine. When the posture is deteriorated, the response in the upper cervical region is the increasing response of the C0-C2 angle, but there is no significant difference in the cases in this study. Here, it can be concluded that the deterioration in posture is not enough to affect this area.

In this study, the reciprocal changes of cervical spine alignment following the dynamic lumbar stabilization surgery have been identified and it has been induced by preoperative parameters. It has been found that there is no change in lumbar dynamic stabilization, cervical slop angle in cervical parameters, thoracic inlet and cervical tilt angles, except for mutual interaction in individuals without sagittal balance problems, in other subaxial parameters. While the cervical tilt and thoracic inlet angle increase naturally, the cervical slop angle also decreases. As the dynamic stabilization level increases, these values vary in parallel. It is possible to say that this is an effort of the head to look in the horizontal plane in order to increase the cervical tilt.

CONCLUSION

In this study, it has been concluded that it is very important to preserve lumbar lordosis in the dynamically stabilized spine, even if it is segmental. Although it starts to slightly and it does not affect the daily life in the early periods, it may be the first step of serious problems in the following years. In addition, it is remarkable that the cervicothoracic region is the region that responds the earliest in maintaining the neck posture.

Ethics

Ethics Committee Approval: Institutional review board approval was obtained from İstanbul Medipol University Non-Interventional Clinical Research Ethics Committee (approval number: E-10840098-772.02-5821, date: 11/11/2021).

Informed Consent: Informed consent was obtained from patients.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.T.B., A.F.Ö., Concept: A.T.B., A.F.Ö., Design: A.T.B., M.A.Ö., Data Collection or Processing: A.T.B., A.F.Ö., Analysis or Interpretation: M.A.Ö., Literature Search: A.F.Ö., Writing: A.T.B.

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

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EVALUATION OF MIDTERM CLINICAL RESULTS IN PATIENTS UNDERGOING FULL ENDOSCOPIC TRANSFORAMINAL AND INTERLAMINAR DISCECTOMY

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ABSTRACT

Objective: This study aims to evaluate the midterm results and complications in patients undergoing discectomy via a lumbar interlaminar discectomy (ID) and transforaminal endoscopic discectomy (TFED) approaches.

Materials and Methods: Clinical and radiological data from 22 patients who underwent lumbar discectomy via transforaminal and interlaminar techniques between 2016 and 2020 were evaluated. In all the patients, the diagnosis was made by history, physical examination, plain radiography, and magnetic resonance imaging. Discectomy was performed using a minimally invasive method in patients that did not respond to medical treatment and were symptomatic.

Results: Thirteen male (59.1%) and nine female (40.9%) patients participated in the study. The average age of the patients was 49.4 (37.0-66.0). There was no significant difference between the groups in terms of gender and age ($p>0.05$). All patients had radicular leg pain that was unresponsive to medical treatment. There was no loss of mobility and muscle strength in the legs of 4 patients in the postoperative period. The preoperative visual analog scale score was 8.36, whereas the scores in the 3rd and 10th months decreased significantly to 2.14 and 2.59, respectively ($p<0.001$). According to MacNab classification, only 1 patient in each group was classified as "fair"; 91.7% of the patients in ID group were classified as "excellent", whereas 90.0% of the patients in TFED group were classified as "good" ($p<0.001$).

Conclusion: It was concluded that endoscopic discectomy techniques were found to be successful and reliable in selected patients. Moreover, the surgeon's experience directly affected the success of the surgery of discectomy.

Keywords: Lumbar disc herniation, transforaminal endoscopic discectomy, interlaminar discectomy

INTRODUCTION

In cases with symptomatic lumbar disc hernias, the goal is successful conservative treatment, but surgery is required when conservative possibilities are exhausted. As with most surgical approaches, endoscopic techniques are becoming more common in spinal surgery. After microdiscectomy has been used widely and became the gold standard in disc surgery since the 90s', endoscopic discectomy techniques have been used in certain centers[1,2]. Although traditional microdiscectomy methods are the gold standard, its damage to soft tissues should be considered[3]. Conventional surgical approaches have good results[4-6]. However, in cases operated by conventional techniques, scarring occurs in the epidural space in 10% of cases, which could not be seen even by MR, and this becomes symptomatic[7]. These lesions generally tend to recur. Even if this is a pain syndrome, an endoscopic procedure is required to avoid these complications[7,8]. Minimally invasive techniques can eliminate tissue damage and related pain syndrome that may occur[9]. With the development of surgical techniques, transforaminal and interlaminar full endoscopic techniques are the most commonly used methods in percutaneous surgery. Techniques for these procedures were first described by Kambin and Gellman and developed by Yeung and Tsou[10]. First studies have achieved 88.2% of success[2,10,11]. In lumbar disc surgery, it must be reached the canal completely. Most authors accept limited restrictions in the lateral approach[3]. For example, in some cases with L5-S1 lumbar disc herniation, approaching transforaminal due to iliac crests restricts the surgeon[12].

This study aims to evaluate the mid-phase results and complications of patients undergoing discectomy with a lumbar interlaminar discectomy (ID) and transforaminal endoscopic discectomy (TFED) approach in selected patients.

MATERIALS AND METHODS

In this study, clinical and radiological data of 22 cases who underwent a lumbar discectomy with transforaminal and interlaminar techniques between 2016 and 2020 were evaluated retrospectively. The study was conducted according

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to the principles outlined in the Declaration of Helsinki. In all cases, the diagnosis was made by anamnesis, physical examination, direct radiography, and magnetic resonance imaging after receiving ethics approval (given by Necmettin Erbakan University, Meram Faculty of Medicine, Non-Pharmaceutical and Non-Medical Device Research Ethics Committee with 17/04/2020 date and 2020/2425 number). Discectomy was performed with the minimally invasive method in cases that did not respond to medical treatment and was symptomatic. Besides, it is stated that all cases were informed in detail on the treatments and an informed consent was obtained from each patient.

Our indications were defined by today's standards-based on radicular pain symptoms and existing neurological deficits[13,14]. Pain severity of the patients was evaluated with a visual analog scale (VAS) at pre-op, post-op 3 months, and 10 months periods. Ten-month satisfaction status was evaluated according to the MacNab classification given below:

Perfect: No pain, no working restrictions.

Good: Rarely back or leg pain, no hindrance to work.

Moderate: Intermittent pain, but cannot continue with the old job.

Bad: There is pain, need a second surgical procedure.

In addition to the demographic characteristics of all cases, changes in pain, operative time, and satisfaction level were evaluated.

Surgical Techniques

a. TFED:

The TFED approach is performed when the patient is in the prone position, on the translucent surgical table by biplane radiological imaging[15]. Then the midline and crista iliaca are marked with a marker pen (Figure 1).

By means of imaging, the dilator is placed in the target area after a tiny skin incision by means of a 1.5 mm atraumatic spinal guide. The atraumatic dilator with a diameter of 6.9 mm is transmitted through this guide. A guide wire is pulled and imaging is performed at this stage with scopy. Then, a 7.9 mm diameter surgical sheath is placed over the dilator (Figure 2).

Image control is required at every stage of these processes. If the gap of the foramen does not allow the removal of the disc hernias or if stenosis exits, it can be needed to perform foraminoplasty with the help of a bone burr[16].

b. ID:

In an ID, the patient is performed in a prone position with biplane radiological imaging[3,16,17]. The skin incision is made by approaching the medial side as much as possible from the craniocaudal center of the interlaminar window[18].

The dilator with a diameter of 6.9 mm is sent from the medial side of the interlaminar window to the ligamentum filavum after incision. A curved surgical cannula with a diameter of 7.9 mm is sent afterward and controlled by imaging method (Figure 3).

Then, an incision with 3-6 mm diameter is made over the ligamentum flavum, the region where the incision is made is expanded and penetrated the canal by means of the imaging device (Figure 4).

The adipose tissue is dissected in a controlled manner and partially resected. With the help of the control probe, the lesion is checked (Figure 5).

The root is eliminated with the help of a surgical cannula with a curved tip of 7.9 mm in diameter. If the interlaminar gap does not allow to penetrate the canal at these stages, or if there exists stenosis, bone resection may be required (Figure 6)[18].

Surgery Follow-up

Patients are mobilized after 3 hours for general anesthesia and 6 hours for spinal anesthesia in the postoperative period. In the

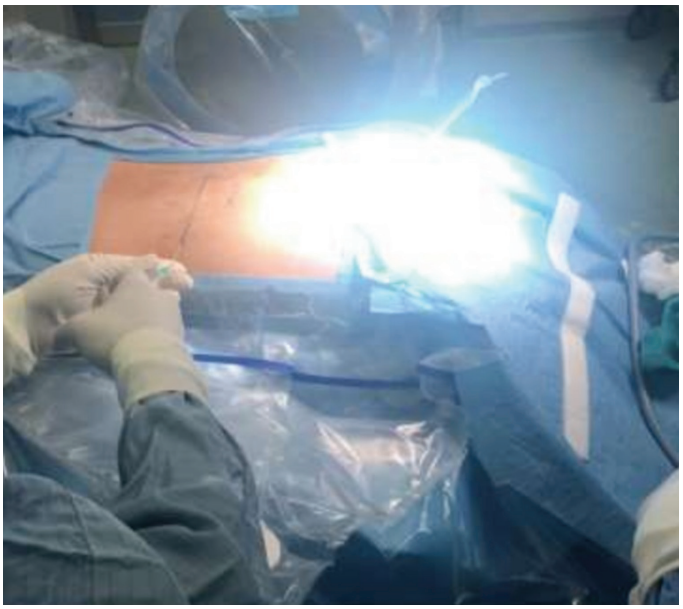

Figure 1. Penetrating by means of marking and imaging

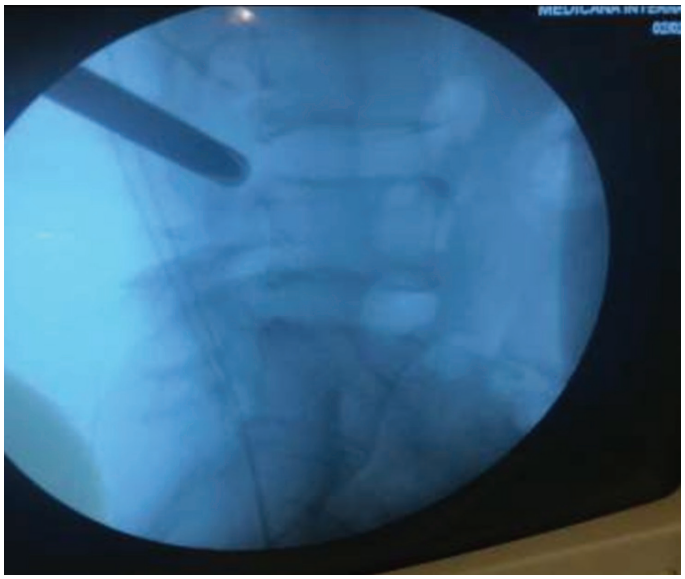

Figure 2. Image control with dilator and surgical sheath

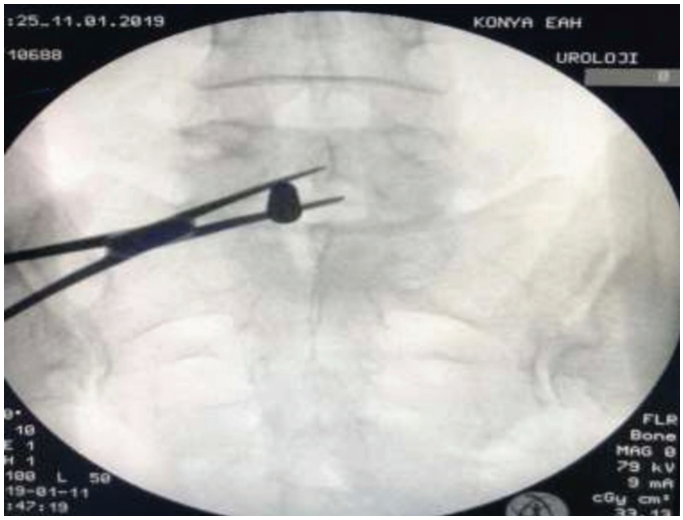

Figure 3. ID access control
ID: Interlaminar discectomy

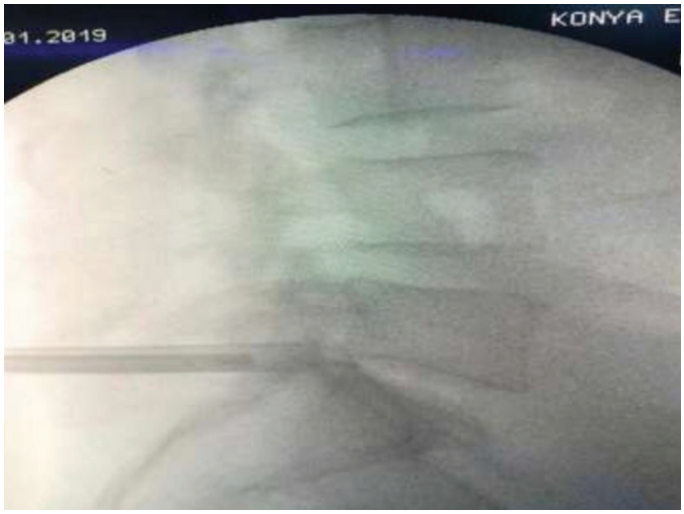

Figure 4. ID lateral control
ID: Interlaminar discectomy

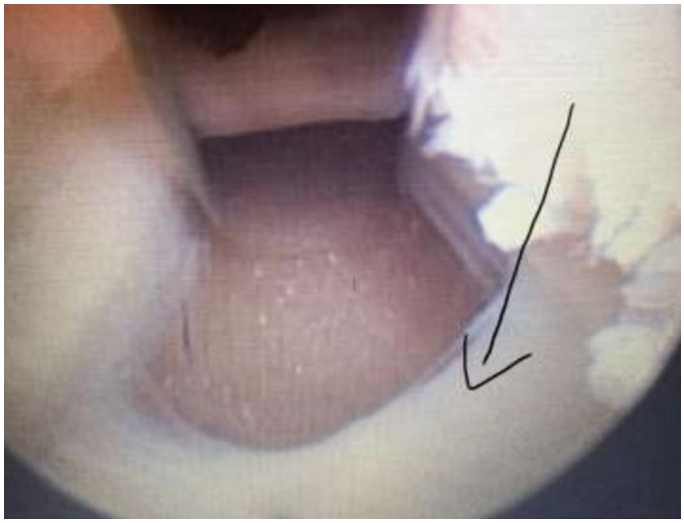

Figure 5. Ligamentum flavum

first 3 days, short walks can be suggested in the house allowing one to sit at short intervals. All patients are allowed to go to their occupation after one week.

RESULTS

This study was conducted with 13 male (59.1%) and 9 female (40.9%) patients. Of the 22 cases included in the study, 18.18% (n=4) of the cases was median, 36.36% (n=8) paramedian, 27.27% (n=6) foraminal and 18.18% (n=4) distal lumbar disc hernias (LDHs). The median and paramedian cases (n=12) were administered ID, and the patients with LDH (n=10) located in the foraminal and distant lateral position (n=10) were administered TFED. There were 10 cases (45.5%) L5-S1, 7 cases (31.8%) L4-L5, and 5 cases (22.7%) L3-L4 lumbar disc herniation. Fourteen cases (63.6%) were performed by anesthesiologists with spinal anesthesia and the rest of the cases (36.4%) were operated under general anesthesia.

The average age of the cases was 49.4[13,19]. There was no significant difference between the surgical methods as gender and age ($p>0.05$). All patients had radicular leg pain that was unresponsive to medical treatment. There was a force in four cases. The preoperative VAS score was 8.36 whereas the scores at 3rd and 10th months decreased significantly to 2.14 and 2.59 respectively ($p<0.001$).

The LDH levels did not differ significantly between the techniques ($p=0.702$). Only the L4-L5 level was lower in the TFED group. The LDH location of the cases was significantly different between the groups ($p<0.001$), such that all patients in the ID technique were median (33.3%) and paramedian (66.7%), and the others were foraminal (60.0%) and distal lateral (40.0%). No intra-op complications improved in any case, and all of them were discharged on post-op 1st day. It was observed no neurological deficits in the post-op period. The operation times were similar between the techniques ($p=0.821$), and the average time was 34.95 mins[15,17].

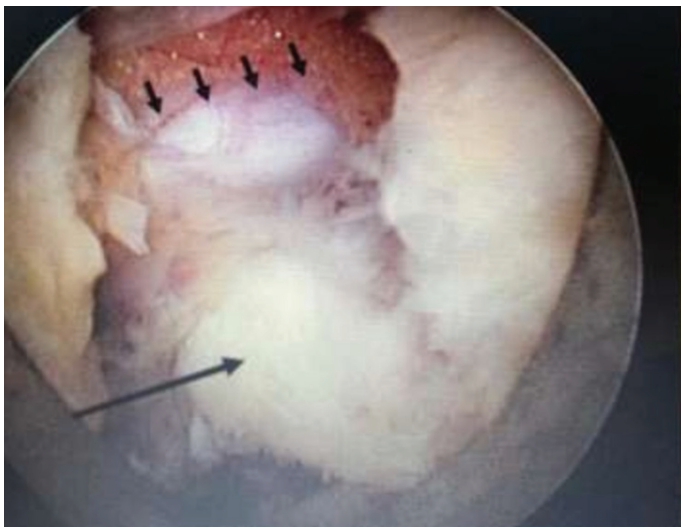

Figure 6. Disc herniation and root compression

The early satisfaction rate in the cases was determined as 81%. At the 3rd month follow-up, pregabalin 50 mg/day and paracetamol 1000 mg/day were medicated in four patients with pain reflected on the hip. Patients' complaints decreased significantly, and the satisfaction rate has reached 100% (n=22) after the follow-up of the 3rd month. According to MacNab classification, only one patient in each group was in fair class, and 91.7% of the patients in the ID group was in "excellent" whereas 90.0% of the patients in the TFED group was in "good" class (p<0.001) (Table 1).

DISCUSSION

The goal of the treatment of LDH surgery is to provide an adequate decompression with minimized surgical trauma. In this study, we showed that an adequate decompression was achieved with complete endoscopic transforaminal and ID, as an alternative way to microdiscectomy, and compatible with the literature.

Endoscopic transforaminal and ID yields similar results to other microscopy-supported conventional surgical techniques[4-6,20]. The success of an adequate decompression technique similar to the endoscopic discectomy method and other conventional procedures has also been demonstrated in a prospective randomized study using specific inclusion criteria[6].

It has been stated that when resection of spinal canal structures is prevented, minimally traumatic disc resection can decrease the operative segmental instability[7,13,14,21]. Operation time, tissue trauma, and complications decrease compared to the conventional procedures[15,22,23]. It was reported that the patient retrieves his peri-operative activity level and increases the life comfort by minimally invasive methods[24]. It has been observed that the rehabilitation precautions related to the operation are not necessary. It was reported that the pain accompanied with ID or TFED does not have surgical origination[21,25,26] and comorbid diseases do not affect to increase in morbidity[15]. Adhesions found intraoperatively can also be seen in cases that have not been previously operated on and often undiagnosed by imaging methods. Adhesions may occur as a result of degenerative and inflammatory processes[8,27]. Although general and spinal anesthesia was used in this study, it is also possible to use local anesthesia[22,28-30].

In this study, it was observed that ID and TFED were effective in the short and medium-term in selected patients. As in all discectomy methods, post-operative success in endoscopic methods depends on the well-selected patient group and the surgeon's experience. In discectomy surgery performed with conventional surgical techniques, stripping of the paraspinal muscles, lamina, facet joint, and partial resection of ligamentum

Table 1. Characteristics of the patients with lumbar disc hernia

LD Surgery type		Interlaminar (n=12)	Transforaminal (n=10)	Total	
		Mean ± SD			p
Age	Year	48.75±7.66	50.30±10.56	49.45±8.90	0.722
Operation time	Minute	36.08±11.01	33.60±8.87	34.95±9.94	0.821
VAS Pre-op†	Score	8.33±0.88	8.40±0.51	8.36±0.72	0.872
VAS 3rd month†	Score	2.17±0.57	2.10±0.73	2.14±0.64	0.875
VAS 10th month	Score	2.50±0.67	2.70±0.48	2.59±0.59	0.381
		n (%)	n (%)	n (%)	
Gender	Male	8 (66.7)	5 (50.0)	13 (59.1)	0.439
	Female	4 (33.3)	5 (50.0)	9 (40.9)	
LDH location	Median	4 (33.3)	0	4 (18.2)	<0.001*
	Paramedian	8 (66.7)	0	8 (36.4)	
	Foraminal	0	6 (60.0)	6 (27.3)	
	Distant lateral	0	4 (40.0)	4 (18.2)	
LDH level	L5-s1	4 (33.3)	6 (60.0)	10 (45.5)	0.702
	L4-l5	6 (50.0)	1 (10.0)	7 (31.8)	
	L3-l4	2 (16.7)	3 (30.0)	5 (22.7)	
Anesthesia type	General	4 (33.3)	4 (40.0)	8 (36.4)	0.752
	Spinal	8 (66.7)	6 (60.0)	14 (63.6)	
MacNab	Fair	1 (8.3)	1 (10.0)	2 (9.1)	0.001*
Classification	Good	0	9 (90.0)	9 (40.9)	
	Excellent	11 (91.7)	0	11 (50.0)	

*: Significant at p<0.05 level according to exact chi-square test
†: Significant at p<0.001 level according to Friedman's Two-Way ANOVA post-hoc test for VAS scores
LDH: Lumbar disc hernia, VAS: Visual analogue scale, SD: Standard deviation

flavum can be applied[11]. Although the conventional surgical techniques have good results, scar tissue occurring in the spinal canal in the post-operative period can be developed at 10% of the patients, and therefore a revision is needed[31]. On the other hand, revision surgery is complicated, and it is also difficult in terms of surgical procedures. In some studies, it has been stated that resection of spinal canal structures leads to spinal instability, and the incidence of spondylolisthesis was reported as 2-10%. Besides, the incidence of post-op progressive progression increases in the patients with preoperative spondylolisthesis. After microdiscectomy operation, nerve injuries, cerebrospinal fluid fistula, meningitis, and wound problems may occur. Studies report 4% of dura injuries and this rate is reported as 17% in subsequent surgeries[11,31].

Endoscopic discectomy methods are less invasive than conventional methods. The risk of scar development is lower in intra-canal structures[32,33]. Yeung and Tsou[10] reported the risk of dura injury to endoscopic methods as 0.3% in their studies[11]. In our study, none of our patients had dura injuries, and no neurological deficits developed in the post-op term. With endoscopic methods, patients can be discharged on the first day of post-op and can be rehabilitated quickly with a short operation time, since the anatomical structures are traumatized during the procedures, the post-op pain is low and the risk of instability is reduced. Early mobilization, early work start, low pain, and early discharge are the main advantages of endoscopic methods[2,11,29,32,33]. Endoscopic discectomy revision operations are much easier compared to classical surgery. The recurrence rate after endoscopic discectomy has been reported as 5% in the studies of Yeung and Tsou[10] and Hoogland et al.[32,33]. The standard indication in endoscopic discectomies is disc pathologies that cause discogenic lower-extremity pain[11]. The presence of advanced paresis, cauda syndrome, some neurological symptoms, and segmental instability are contraindications for endoscopic surgery[11,19,31].

Infection, dysesthesia, dura, and vascular injuries are among the post-op complications of endoscopic discectomy, and the complication rate is between 2.7-3.5%. In conventional surgery, this rate is given as 6%[1]. No complication was observed in any of our patients. It is emphasized that the endoscopic discectomy gives similar results to microdiscectomy. In an article published by Tzaan[11], 134 patients who underwent TFED were evaluated according to the modified MacNab criteria. 89% of patients were reported "excellent" or "good" results after surgery (28% excellent (n=38), 61% good (n=82). Only 7% of the patients were in "fair" and 4% of them in the "poor" class. Those 6 patients (4%) with poor results were re-operated. Temporary dysesthesia occurred below the leg in 8 patients (5.9%) after the operation, which improved within 3 months[1].

In our study, 90.9% of the cases had good or excellent results and 9.1% of them had fair results according to the modified MacNab classification. Two patients had leg pain in the early period, and their complaints were relieved with paracetamol 1000 mg/day and pregabalin 50 mg/day.

In a study by Hoogland et al.[32], 142 patients underwent TFED[1]. Patients were evaluated 1 year later according to the VAS and MacNab criteria. The pre-op VAS value of leg pain was 8.2 while the post-op VAS value was 2.6 at the end of one year. According to the MacNab classification, 50.8% of excellent and 33.8% of good results were obtained at the end of two years. While 14.4% of the patients had moderate satisfaction, 0.9% (1 patient) was reported having a poor result.

CONCLUSION

It can be concluded that the endoscopic discectomy methods were found to be significant and reliable in selected cases. However, the surgeon's experience directly affects the success of the technical change of the disc location.

Ethics

Ethics Committee Approval: Ethic committee approval was obtained from Necmettin Erbakan University, Meram Faculty of Medicine, Non-Pharmaceutical and Non-Medical Device Research Ethics Committee with 17/04/2020 date and 2020/2425 number.

Informed Consent: Informed consent was obtained from each patient.

Peer-review: Externally peer-reviewed.

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MINIMALLY INVASIVE TRANSFORAMINAL LUMBAR INTERBODY FUSION IN GERIATRIC PATIENTS

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ABSTRACT

Objective: Several studies report that spine surgery in elderly patients (>65 years old) is associated with higher reoperation and complication rates. Although transforaminal lumbar interbody fusion (TLIF) in elderly patients can result in lower clinical improvement and higher complication rates, minimally invasive surgery (MIS) TLIF has potential advantages. We compared clinical outcomes and complication rates after MIS TLIF with pedicle screw fixation in younger and older geriatric patients (those aged 65 to 74 years compared to those aged 75 to 85 years).

Materials and Methods: This was a retrospective cohort study of patients with lumbar degenerative spondylolisthesis. Patients were divided into those between 65 and 74 years old (n=45) and those between 75 and 84 (n=23). Patients had two-year follow-up.

Results: Older geriatric patients (between 75 and 84 years old) had 1.3 times as many comorbidities as the younger patients, but the difference was not statistically significant. Surgery was significantly longer in the older cohort, but there were no significant differences in intraoperative complications. There were no differences in complication rates during postoperative hospitalization or within 30 days after discharge. No significant differences in complication rates were noted at 6 or 24 months after discharge. There were no differences in patient reported outcomes. Minimum clinically important differences in patient reported outcomes were the same between cohorts at last reported outcome.

Conclusion: The MIS TLIF with pedicle screw fixation for degenerative spondylolisthesis is as safe and effective in older geriatric patients as in younger ones.

Keywords: Degenerative spondylolisthesis, transforaminal lumbar interbody fusion, minimally invasive surgery, geriatric, patient reported outcomes

INTRODUCTION

Advanced age is associated with the development of degenerative spondylolisthesis[1]. As life expectancy increases, and older adults desire to remain active and enjoy high quality of life, it is likely that the number of surgeries performed will increase. Several studies have reported that spine surgery in elderly patients is associated with a higher likelihood of reoperations and complications[2,3]. When non-operative treatments fail to treat symptomatic degenerative spondylolisthesis, decompression and fusion surgeries are frequently performed in the presence of unstable segments, even in elderly patients[4]. The transforaminal lumbar interbody fusion (TLIF) technique is one fusion option and can be used for various pathologies of the spine including degenerative spondylolisthesis[5].

Although TLIF in elderly patients can result in lower clinical improvement and higher complication rates[6], minimally invasive surgery (MIS) TLIF has many potential advantages: less blood loss, shorter hospital stays, and earlier rehabilitation compared to open surgery[7,8]. MIS surgery is particularly well suited for the lumbar region for decompression and interbody fusion. By reducing the surgical trauma, MIS surgery can reduce perioperative morbidities and improve functional outcomes.

The goal of this study was to determine whether advanced age affects complication rates and clinical outcomes of patients who underwent MIS TLIF for degenerative spondylolisthesis. Our hypothesis was that advanced age would not affect complication rates and clinical outcomes.

MATERIALS AND METHODS

We conducted a retrospective cohort study of subjects treated over a four-year period at a spine specialty center by a single investigator. Quorum Review Institutional Review Board (#30779/1) approved the investigation and we obtained written informed consent for participation from all participants. In this study, eligible subjects were 65 years old or older on the date of surgery. All subjects were diagnosed with lumbar

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degenerative spondylolisthesis and treated by MIS TLIF with pedicle screw fixation. Other pathologies (traumatic, dysplastic, isthmic, and pathologic spondylolisthesis) and other treatments (e.g., open posterolateral fusion) were excluded. Prior lumbar spine fracture and a history of malignancy were also reasons for exclusion. We only studied patients who were cleared by anesthesia and received surgery. Information about others who did not receive surgery because of health concerns was not available to us.

At 65 years, patients are considered old[9] and at 75 years, old-old[10]. Accordingly, we stratified subjects into two cohorts, according their ages at the time of their index surgery: sixty-five to 74 years old and 75 to 84 years old[11]. Patient demographics were collected, including age, body mass index (BMI), sex, smoking status, worker compensation status, and prior lumbar spine surgery history. Eight comorbidities (diabetes mellitus, chronic kidney disease, coronary artery disease, chronic obstructive pulmonary disease, endocrinopathy, neurologic disorder, metabolic bone disease, and rheumatologic disorder) were noted. Patients were followed for 24 months.

Our minimally invasive technique has been previously described[12]. A 2.5 cm, paramedian skin incision is made 4.5 cm from midline on the symptomatic side. A fascial incision is made medial to the skin incision. The 22 mm retractor tube is obliquely directed in the Wiltse plane toward the facet joint. When the tube meets the facet joint at the operative level, radiographic confirmation is obtained. A unilateral facectectomy is performed with high-speed burr or osteotome for direct decompression of the disc space. Resected bone tissue is saved for bone grafting. The discectomy is performed with scalpel and box chisel; rasps are used for endplate preparation. The disc space is sized with trials and the appropriately-sized interbody device (packed with bone graft) is implanted by gentle impaction. For two-level procedures, the retractor tube is "wanded" to access both disc spaces and all pedicle screw locations through a single skin incision. The contralateral side is similarly exposed to place pedicle screws and perform facet joint fusion.

Intraoperative data included the length of surgery, estimated blood loss (EBL), number of levels fused, and use of bone morphogenetic protein (BMP). Complications were collected intraoperatively, during postoperative hospitalization, and 30 days, 6 months, and 24 months postoperatively. Major complication classifications included durotomy, genitourinary injury, wound-related, neurologic, pulmonary, cardiac, vascular (including deep vein thrombosis and pulmonary embolism), and gastrointestinal. Complications requiring surgical management within 24 months were adjacent segment disease, recurrence of symptoms, painful instrumentation and pseudoarthrosis. Painful instrumentation was defined as local pain over the site of the instrumentation which was relieved by trigger point injection. In all patients diagnosed with this complication, the instrumentation was removed, and symptoms resolved.

Functional outcomes [oswestry disability index (ODI) and the visual analog scale (VAS) for back and leg pain] were collected preoperatively and at each postoperative clinic visit (6 weeks and 3, 6, 12, and 24 months). Because some data points were missing for some patients at one or more time point, we calculated the difference between the preoperative value and the last reported value. The minimum clinically important difference (MCID) for ODI was 12.8, for VAS back pain was 1.2, and VAS leg pain was 1.6[13].

Statistical Analysis

The two age cohorts were compared using independent sample t-tests for numeric variables. Chi-square analysis was used for categorical variables. Fisher's exact test was used instead of the chi-square t-test when expected cells sizes were less than 5. A significance level of 0.05 was used throughout. The data analyses for this paper were generated using the Real Statistics Resource Pack software (Release 6.8). Copyright (2013-2020) Charles Zaiontz. www.real-statistics.com.

RESULTS

Patient Characteristics

Eighty-five subjects were identified but seventeen declined to be involved in research (Figure 1). The average age at the time of the index surgery was 71 (range, 65-84) (Table 1). There were 45 subjects in the 65-74 cohort and 23 in the 75-84 cohort. There were 40 females and 28 males. The average BMI was 30±6 (Table 1). Thirty subjects (30/68, 44%) were current and former smokers. Eighteen patients (26%) had prior lumbar spine surgery. Two subjects (3%) were receiving worker's compensation. All patients had 2-year follow-up for complications.

Cohort Specific Comorbidities

The older cohort had, on average, 1.3 times more comorbidities than the younger cohort, but difference was not statistically significant (p=0.20, Table 2). In the 65-74 cohort, 24 subjects (53%) had one or more major comorbidity and in the 75-84 cohort, 16 subjects (70%) had. Coronary artery disease was

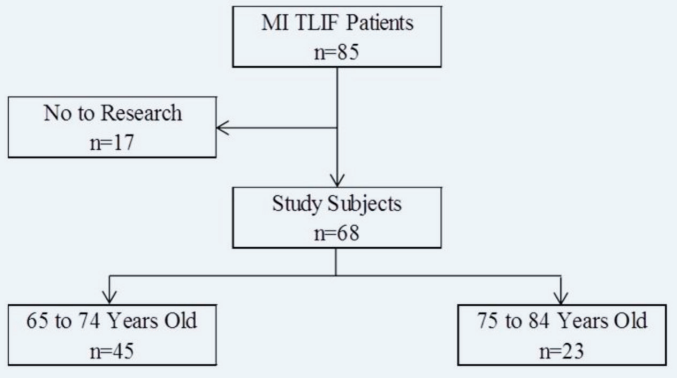

Figure 1. Disposition of study population
TLIF: Transforaminal lumbar interbody fusion

significantly more prevalent in the older group compared to the younger group (p<0.01).

Perioperative Factors

The younger and older cohorts were statistically similar with respect to the length of surgery, the EBL, the number of levels fused, use of biologics, and length of hospital stay (Table 3).

Intraoperative Complications

An incidental durotomy was noted in one patient in the 65-74 cohort (Table 4). Statistically, there was no difference between cohorts with respect to intraoperative complications (p=1.00). The length of surgery was statistically longer for the older group compared to the younger group (p=0.4), but EBL, number of levels fused, and use of BMP were not different.

Hospitalization Complications

It is the general practice at our institution to monitor patients in the in-patient setting for MIS spine fusion surgery. Accordingly, most patients were discharged a few days postoperatively [median length of stay (LOS), 3 days, range 2 to 12 days] (Table 2). Genitourinary complications were the most common during postoperative hospitalization, but the rate was not different between groups (Table 4, p=0.22). Wound-related, neurologic, pulmonary, and cardiac complications occurred less frequently. Overall, the complication rate during postoperative hospitalization the same between groups.

30-day Postoperative Complications

Six subjects (9%) experienced a complication from the day of discharge to 30 days postoperatively. Three subjects were in the younger cohort and 3 were in the older cohort (p=0.40). There were two superficial wound complications among the older subjects (Table 4).

6-Month Postoperative Complications

Two subjects (4%) experienced complications in the period between 30 days after discharge and six months postoperatively (Table 4). Both were in the 64-74 years old cohort (Fisher's exact test, p=0.55).

Table 1. Demographics of study population

		Age category		
Demographic	**All patients (n=68)**	**65-74 (n=45)**	**75-84 (n=23)**	**p-value***
Age at surgery, median (range)	71 (65-84)	69 (65-74)	77 (75-84)	<0.01
BMI, mean (SD)	31±7	31±7	30±7	0.61
Female sex, n	40	27	13	0.78
Smoking status, n				
Current	2	1	1	0.69
Former	28	20	8	
Never	38	24	14	
Prior lumbar surgery, n	18	13	5	0.53
WC/litigation, n	2	1	1	0.62

*Comparing age categories
BMI: Body mass index, SD: Standard deviation

Table 2. Comorbidities of study population

		Age category		
Major comorbidity	**All patients (n=68)**	**65-74 (n=45)**	**75-84 (n=23)**	**p-value***
Diabetes mellitus	14	9	5	1.00
Chronic kidney disease	7	4	3	0.68
Coronary artery disease	13	4	9	<0.01
Chronic obstructive pulmonary disease	5	3	2	1.00
Endocrinopathy	11	6	5	0.49
Neurologic disorder	5	2	3	0.33
Metabolic bone disease	7	4	3	0.68
Rheumatologic disorder	3	3	0	0.55
Patients having 1 or more major comorbidity	40	24	16	0.20

*Comparing age categories

Table 3. Perioperative factors

Factor	All patients (n=68)	Age category 65 74 (n=45)	75-84 (n=23)	p-value*
Length of surgery, minimum Median (range)	131 (75-248)	123 (73-203)	144 (85-248)	0.04
Estimated blood loss, mL Median (range)	113 (10-600)	100 (10-600)	150 (50-500)	0.21
Number of levels fused Median (range)	1 (1-2)	1 (1-2)	1 (1-2)	0.20
BMP used, n	34	21	13	0.44
Length of stay, days Median (range)	3 (2-12)	4 (2-12)	3 (2-10)	0.44

*Comparing age categories
BMP: Bone morphogenetic protein

Table 4. Summary of complications

Complication	All patients (n=68)	Age category 65-74 (n=45)	75-84 (n=23)	p-value*
Intraoperative period				
Durotomy	1	1	0	1.00
Hospitalization period				
Genitourinary	7	3	4	0.22
Wound-related	2	1	1	1.00
Neurologic	2	2	0	0.54
Pulmonary	4	3	1	1.00
Cardiac	2	0	2	0.11
30-day postoperative follow-up				
Genitourinary	1	1	0	1.00
Wound-related	2	0	2	0.11
Neurologic	1	1	0	1.00
Pulmonary	1	1	0	1.00
Vascular/DVT/PE	1	0	1	0.34
Gastrointestinal	1	1	0	1.00
6-month postoperative follow-up				
Neurologic	1	1	0	1.00
Pulmonary	1	1	0	1.00
Vascular/DVT/PE	1	1	0	1.00
Two-year postoperative follow-up				
Adjacent segment disease	3	2	1	1.00
Recurrence of symptoms	3	1	2	0.26
Painful instrumentation	4	3	1	1.00
Pseudoarthrosis	1	1	0	1.00
Patients having 1 or more complication				
Intraoperative period	1	1	0	1.00
Hospitalization period	12	6	6	0.32
30-day postoperative follow-up	8	5	3	1.00
6-month postoperative follow-up	2	2	0	0.55
Two-year postoperative follow-up	11	7	4	1.00

*Comparing age categories
DVT: Deep vein thrombosis, PE: Pulmonary embolism

24 month Postoperative Complications

Painful instrumentation was the most common complication between six and 24 months postoperatively (Table 4). Overall, 10 of the 68 subjects (15%) experienced a complication in this period.

Functional Outcomes

ODI, VAS back pain, and VAS leg pain were comparable between older and younger subjects (Table 5). Considering the proportions of subjects achieving MCID, there were no statistically significant differences between cohorts ODI, VAS back pain, or VAS leg pain (Table 6).

DISCUSSION

Low back and leg pain from degenerative spondylolisthesis complaints are common in the elderly population, impacting the activities of daily living and decreasing quality of life. Additionally, chronic pain can cause depression, sleep disorders and loss of independence[14]. As the population ages, spine surgeons can expect to have more surgical discussions with this population in the future. Knowledge of the expected outcomes and complication rates in this population is critical for surgical decision making. The literature has demonstrated both good outcomes, as well as increased complication rates. Studies have shown that MIS techniques are safe for the elderly population[15]. However, elderly patients who had longer operative times and more extensive surgeries have been found to have more complications[16]. A meta-analysis showed that MIS TLIF has shorter operative times and LOS compared to open surgery, while providing similar clinical outcomes[17]. Rouben et al.[18] showed excellent five-year clinical outcomes in older patients who underwent MIS TLIF, comparable to the younger population. Our study corroborates these findings by showing that younger and older geriatric patients improved in ODI, VAS back and VAS leg after surgery and at last follow-up[18]. MIS surgery, when compared to open surgery, has similar complication rates and clinical success, but is technically challenging with a steep learning curve[19,20]. This is a consideration in elderly patients, who may be more affected by the increased blood loss and operative time associated with MIS procedures performed by surgeons learning MIS techniques. In the present study, a senior surgeon who with 20 years of MIS experience performed all the surgeries. The overall intraoperative complication rate for older patients was like that of the younger population. Buck and Yoon[21] reported a 5% rate of incidental durotomies for short segment lumbar

Table 5. Patients reported outcomes

		Age category		
Outcome (n)	All patients	65-74	75-84	p-value†
Oswestry disability index				
Preoperative (62)	46±15	46±15	45±14	0.73
12 m postoperative (51)	22±19	22±19	23±20	0.81
24 m postoperative (26)	27±17	25±18	29±16	0.53
VAS-back				
Preoperative (39)	7±3	6±3	8±2	0.07
12 m postoperative (37)	2±3	2±3	2±3	0.99
24 m postoperative (26)	2±3	2±2	3±4	0.27
VAS-leg				
Preoperative (40)	7±3	6±3	7±2	0.29
12 m postoperative (26)	2±3	1±2	2±4	0.75
24 m postoperative (22)	2±2	1±2	2±3	0.11

*Number of subjects at the time point of interest
†Comparing age categories
VAS: Visual analog scale

Table 6. Patients achieving MCID* at last patient reported outcome†

		Age category		
Outcome	All patients	65-74	75-84	p-value‡
Oswestry disability index	39 (63%)	26 (62%)	13 (65%)	0.81
VAS-back	33 (85%)	20 (77%)	13 (100%)	0.08
VAS-leg	27 (71%)	17 (71%)	10 (71%)	0.97

†MCID Thresholds: 12.8 for ODI; 1.2 for VAS-back; 1.6 for VAS-leg
‡Comparting age categories
*MCID: Minimum Clinically Important Difference, VAS: Visual analog scale

fusions, with age being a risk factor. Klingler et al.[22] reported a rate of 6% incidental duratomies for MIS-TLIF, with age greater than 65 being a positive predictor factor. In the present study, durotomy was seen in 1.5% of patients. Other studies found advanced age to be a risk factor for incidental durotomy in lumbar surgery, but we did not find age to be a risk factor for durotomy in MIS-TLIF[21,23,24].

Complications after surgery may or may not have direct connection to the procedure. Wang reported a 37% overall complication rate after MIS TLIF, 14% related to the surgery and 23% not. Similarly, in our study 18% of patients experienced one or more complication during hospitalization (12/68), but only 7% of patients (5/68) experienced one or more complication directly related to the surgery. Wang found genitourinary problems were the most common complication not directly related to the surgery[25]. Likewise, the most common complication we observed was genitourinary (10% of all patients). Pneumonia, delirium, confusion, arrhythmia, pulmonary edema, and hypoxia were other problems encountered during hospitalization in the elderly group.

In a meta-analysis comparing the incidence of adjacent segment disease after open versus MIS TLIF and posterior lumbar interbody fusion, authors reported MIS can reduce the incidence of adjacent segment degeneration[26]. Ong et al.[3] reported a 17% reoperation rate and a 25% readmission rate after posterolateral fusion in older patients at 2 years. Sears et al.[27] reported 13% of patients who had a lumbar interbody procedure needed further surgery at an adjacent level at a mean of 43 months. Age greater than 60 years was a risk factor for adjacent level surgery in Sears et al.[27] study. Lee et al.[28] also reported that age greater than 60 years was an independent risk factor for adjacent segment disease. In our study, there was an overall 4% incidence of adjacent segment disease. The incidence did not increase with aging, as the rates were the same between cohorts. Preserving supportive midline tissues via MIS in this particular group may decrease adjacent segment disease. A future study comparing open vs MIS TLIF in elderly patients could guide optimal treatment for this demographic.

Patient reported outcomes were similar between cohorts. At the end of the study period, there were no differences between older patients (>75 years old) and younger patients (>65 years old). Moreover, even though geriatric patients often have significant comorbidities, our sub-analyses of patients with one or major comorbidity did not elucidate any differences between cohorts with respect to complications or functional outcomes. The older patients need not expect more complications or inferior clinical outcomes compared to younger patients.

Study Limitations

This study was limited to the diagnosis of degenerative spondylolisthesis. This limitation strengthens our study with respect to others as some investigators report that clinical outcome depends upon pathology. By limiting ourselves to one pathology, we avoided a possible confounder. Another limitation of this study is that it is retrospective. Retrospective designs may have unrecognized bias and/or confounders. We had 2-year follow up for complications, but we had some loss-to-follow-up with regard to patient-reported outcomes. Fortunately, the proportions of patients in the cohorts was similar at the beginning and end of the study. Thus, this bias may possibly be mitigated. Another limitation is that we did not include a radiographic evaluation of the MIS TLIF technique. This was outside the scope of the present study.

CONCLUSION

This study asked the question whether advanced age affects complication rates and clinical outcomes of MIS TLIF for degenerative spondylolisthesis. We found that MIS TLIF for degenerative spondylolisthesis is as safe and effective for older geriatric patients (75-84 years old) as it is for younger geriatric patients (65-74 years old). Older patients need not expect more complications or inferior clinical outcomes compared to younger patients. These results can help guide surgeons and patients when considering an MIS TLIF with pedicle screw fixation for degenerative spondylolisthesis.

Ethics

Ethics Committee Approval: Quorum Review Institutional Review Board (approval number: #30779/1, date: 30.07.2015) approved the investigation.

Informed Consent: Written informed consent was obtained for participation from all participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Concept: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Design: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Data Collection or Processing: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Data analysis or Interpretation: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Literature Search: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Writing: A.F.B., E.S., J.M.D., C.J.G., J.D.S.

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

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ORIGINAL ARTICLE
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THE RELATIONSHIP OF THE CLINICAL RESULTS OF THE PATIENTS UNDERGOING TRANSFORAMINAL EPIDURAL INJECTION WITH PREOPERATIVE MAGNETIC RESONANCE IMAGING FINDINGS

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ABSTRACT

Objective: Lumbar disc herniation (LDH) is a common cause of low back pain and lumbar radiculopathy. In this study, the relationship between clinical results and pre-procedural magnetic resonance imaging (MRI) findings of patients with LDH-related radiculopathy symptoms who underwent lumbar transforaminal epidural steroid injection (TFESI) was evaluated.

Materials and Methods: Between 2017 and 2021, 65 patients who were diagnosed as having LDH clinically and radiologically and underwent new MRI examination at the latest 3 months before the procedure were included in the study. In the operating room, under the scopy imaging, 1 cc opaque substance (iohexol) was diluted with 5 cc isotonic solution and 1.5-2 cc of this was injected into the area for confirmation in the scopy vision. Then 1 cc betamethasone and 4 cc 2% prilocaine hydrochloride were mixed, and 5 cc of this was injected. Pain scoring was evaluated with visual analog scale (VAS) and disability was evaluated with oswestry disability index (ODI). Pre-procedural MRIs were examined and grouped according to Michigan State University classification.

Results: The patients' median VAS and ODI scores were 8 [interquartile range (IQR): 7-8] and 74 (IQR: 67-77) before treatment; 2 (IQR: 1-3) and 14 (IQR: 10-29) in the 2nd week; and 2 (IQR: 1-4) and 16 (IQR: 4-40) in the 3rd month, respectively. It was determined that there was a statistically significant change in the pain and disability levels of the patients over time (ANOVA type test statistics=338,743, degree of freedom=1,542, p-value<0.001). It was determined that the change observed in VAS and ODI scores over time did not show a statistically significant difference according to disc type and location.

Conclusion: The TFESI is a treatment method that can be used safely, independent of the disc type and localization in the MRI performed before the procedure.

Keywords: Transforaminal injection, disc hernia, radiculopathy

INTRODUCTION

Although lumbar disc herniation (LDH) is a common cause of low back pain and lumbar radiculopathy, it also causes socio-economic losses in society. The incidence of symptomatic LDH has been reported as 1-3%[1,2]. LDH welded in selected cases for radicular pain, lumbar transforaminal epidural steroid injections (TFESI) has been shown to be an effective treatment method[3]. The complaints of radiculopathy and related leg pain occur together with low back pain associated with the compression of the nerve roots[1].

There are studies indicating that TFESI is significantly effective and safe for discogenic low back pain and moderately effective in spinal stenosis[4]. Radiculopathy pain caused by lumbar disc hernia of patients can be controlled with TFESI technique, which is one of the current treatment options in patients with LDH. Prior to the TFESI procedure, patients should have undergone medical treatment and/or physical therapy protocols. Since it is an interventional procedure; it is applied to groups of patients who cannot obtain results from non-invasive treatments[5].

The size, localization and nerve compression of the disc herniation can be seen on magnetic resonance imaging (MRI), and it also guides the clinic and treatment[6,7]. Abnormal findings on imaging can be measured more objectively. Although a standard classification for LDH cannot be fully established in MRI[1], the Michigan State University (MSU) classification is frequently used in surgical selection as an objective measure of LDH in MRI with 98% inter-inspector reliability[8].

The aim of this study is to examine the relationship between the clinical results of patients with radiculopathy symptoms due to LDH and who underwent TFESI with pre-procedural MRI findings.

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MATERIALS AND METHODS

Study Group

Ethics committee approval was obtained for this study from Uludağ University Faculty of Medicine Clinical Research Ethics Committee (dated 16.06.2021 and numbered 2011-KAEK-26). All of the patients were selected from the patient groups who had previously received medical treatment and/or physical therapy protocol treatment, but did not have a clinical response. Patients with a history of previous surgery, stenosis of degenerative background, surgical indication, bleeding diathesis, morbidly obese (body mass index over 40), local skin lesion and patients under 18 years of age were excluded from the study. Sixty-five patients with radiculopathy symptoms due to LDH, without acute neurological symptoms and motor loss, who were confirmed by clinical and radiological diagnosis between 2017 and 2021, and who underwent new MRI examination at the latest 3 months before the procedure, were included in the study (Figure 1).

Process Preparation and Technique

Informed consent forms were obtained from all patients before the TFESI procedure. To the patients; level detection was performed in the operating room, on the surgical table, with monitoring, in the prone position, under fluoroscopy control. After the application of 2% prilocaine hydrochloride as 5 cc local anesthetic, the area to be injected is reached with a 22 gauge spinal needle, again under fluoroscopy control, with the posterolateral transforaminal area accompanied by antero-posterior and lateral fluoroscopy images (Figure 2), 1 cc opaque substance (iohexol), 5 cc isotonic solution was diluted and injected into the area in a volume of 1.5-2 cc for confirmation in scopy vision (Figure 3). After the foramen and root level were determined, 1 cc betamethasone and 4 cc 2% prilocaine hydrochloride were mixed and 5 cc was applied. Patients were monitored during the procedure, while staying in contact with the patient during the procedure, whether there was severe leg pain and motor deficit with active foot movement. After the procedure, the patients were followed for at least 3 hours, and after the motor-sensory block was completely over, they were

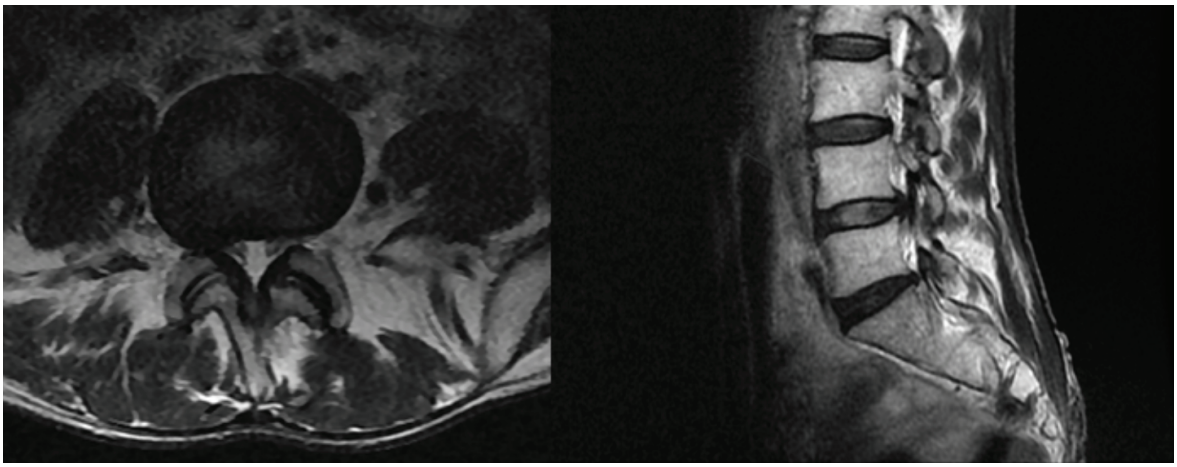

Figure 1. MRI of lumbar spine before transforaminal injection
MRI: Magnetic resonance imaging

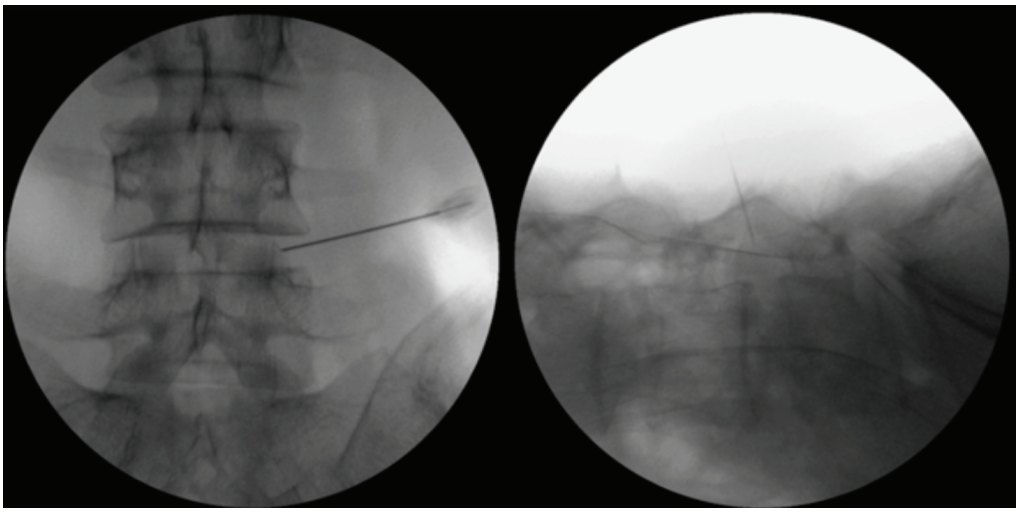

Figure 2. The antero-posterior and lateral fluoroscopic image of lumbar spine

mobilized and externated. Pain scores [visual analog scale (VAS)] and functional oswestry disability index (ODI) scores were analyzed from the files of the patients who underwent TFESI procedure, before the procedure, at the 2nd week and 3rd month after the procedure. By examining their MRIs retrospectively; based on the MSU classification, protusion and bulging were grouped according to the herniation type, and central, posterolateral and foraminal according to their localization.

Statistical Analysis

The distributions of age, VAS and ODI were examined by using Shapiro-Wilk's tests, normality plots and skewness/kurtosis statistics. Since only age was distributed normally, it was summarized by mean ± standard deviation while numeric rating scale and ODI were provided by median (IQR: 1st quartile-3rd quartile). Frequencies (%) were given for gender, disc type and disc localization.

The changes in VAS and ODI measurements across time was examined by LD-F1 design in overall and were compared by F1-LD-F1 design with respect to the disc type and disc localization. ANOVA type test statistics (ATS), degree of freedom (df) and p-values were reported for the overall time effect and group*time interaction (GTI) effects. Relative treatment effects (RTEs) were provided with 95% confidence interval by graphs. A p-value<0.05 was considered as statistically significant. Descriptive statistics were calculated by IBM SPSS Statistics 22.0 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). The LD-F1 and F1-LD-F1 designs were performed using the RStudio Software program (v.1.4.1106)[9] and the nparLD package[10] in the R v.4.1 programming language[11].

RESULTS

The mean age of the patients included in the study was 49.72±15.35 years (minimum-maximum: 21-80). Disc type was protruded in 50.8% (n=33) of the patients and bulging in 49.2% (n=32). Disc localization was determined as posterolateral in 56.9% (n=37), central in 24.6% (n=16), and foramen/PL in 18.5% (n=12).

The patients' median VAS and ODI were 8 (IQR: 7-8) and 74 (IQR: 67-77) before treatment, respectively; 2 (IQR: 1-3) and 14 (IQR: 10-29) at 2nd week; They were 2 (IQR: 1-4) and 16 (IQR: 4-40) at 3rd months (Table 1). It was determined that there was a statistically significant change in the pain and disability levels of the patients over time (ATS=338,743, df=1,542, p-value<0,001). When RTEs were examined, it was observed that there was a significant decrease in the 2nd week and the pain and disability level in the 2nd week was maintained at the 3rd month (Figure 4).

When the pain and disability levels of the patients were analyzed by disc type, the median VAS was 8 (IQR: 7-8) before treatment and 2 (IQR: 1-3) at week 2 for both disc types. The median VAS at 3 months was 2 (IQR: 1-4) for patients with protrusion disc and 2 (IQR: 0-4) for patients with bulging disc (Table 1). It was determined that the change observed in pain level over time did not show a statistically significant difference

Table 1. Patients' pain and disability levels through time with respect to the disc type

		Disc Type	
	Overall [n=65]	Protrusion [n=33]	Bulging [n=32]
NRS [median (IQR)]			
Baseline	8 (7-8)	8 (7-8)	8 (7-8)
2nd week	2 (1-3)	2 (1-3)	2 (1-3)
3rd month	2 (1-4)	2 (1-4)	2 (0-4)
ODI [median (IQR)]			
Baseline	74 (67-77)	77 (67-79)	70 (67-77)
2nd week	14 (10-29)	14 (11-28)	12 (9-30)
3rd month	16 (4-40)	18 (4-40)	12 (3-38)

NRS: Numeric rating scale for pain, ODI: Oswestry disability index
IQR (interquartile range): 1st quantile-3rd quantile

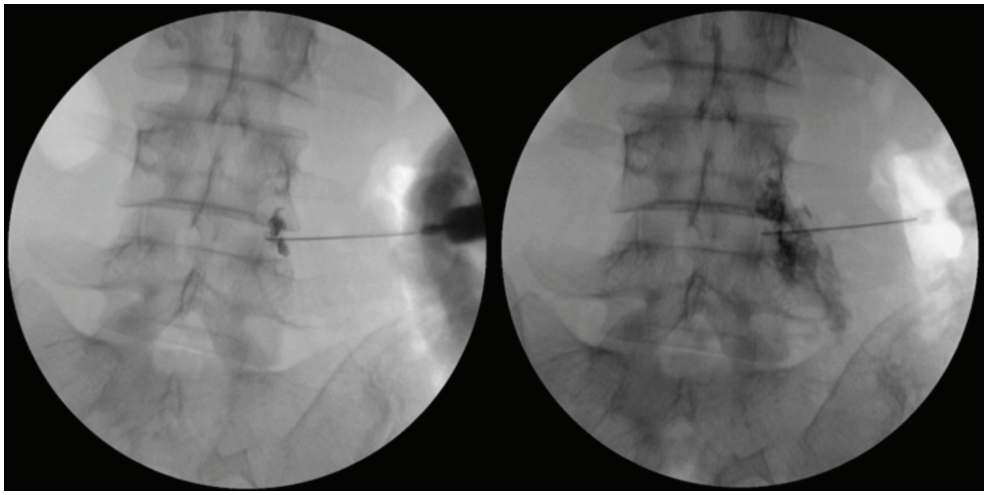

Figure 3. The fluoroscopic image of lumbar spine at the time of injection

according to disc type ATS=0.234, df=1,536, p-value=0.731 for GTI (Figure 5). The median ODI was 77 (IQR: 67-79) for patients with protrusion discs before treatment and 70 (IQR: 67-77) for patients with bulging discs; 14 (IQR: 11-28) for patients with protrusion discs at 2nd week, 12 (IQR: 9-30) for patients with bulging discs, 18 (IQR: 4-40) for patients with protrusion discs at 3rd month, 12 for patients with bulging discs (IQR:3-38) (Table 1). The change observed in ODI measurements over time did not differ according to disc type (ATS=0.279, df=1,439, p-value=0.682 for GTI, Figure 5).

The distribution of VAS and ODI measurements according to the disc location in the patients is given in Table 2. In these measurements, it was determined that the change observed over time did not show a statistically significant difference according to the disc location (ATS=1,312, df=2,722, p-value=0.269 for GTI effect in VAS; ATS=1.332, df=2,555, p-value=0.264 for GTI effect in ODI; Figure 6).

DISCUSSION

Although a standard classification for LDH in MRI cannot be fully established[1], Mysliwiec et al.[8] they used the MSU classification to follow the surgical route with 98% reliability between examiners, and we grouped the disc size and localization MRIs retrospectively on the basis of the MSU classification in our study. According to this; it was classified as bulging and protrusion based on size and shape, and as central, posterolateral and posterolateral/foraminal in terms of localization. Since there is no criterion showing disc degeneration in the current classification, soft or hard disc types were not differentiated and these criteria were not included in the study.

Manchikanti et al.[12] in his review; between 1966 and 2011, 70 publications were reviewed and the level of evidence for radiculitis secondary to disc herniation was good when

Table 2. Patients' pain and disability levels through time with respect to the disc localization

	Disc Localization		
	Foramen/PL [n=12]	Posterolateral [n=37]	Central [n=16]
NRS [median (IQR)]			
Baseline	8 (8-8)	8 (7-8)	8 (7-8)
2nd week	3 (2-4)	2 (1-3)	2 (1-4)
3rd month	3 (1-5)	1 (0-4)	3 (1-5)
ODI [median (IQR)]			
Baseline	77 (69-77)	74 (67-78)	70 (66-78)
2nd week	17 (12-32)	14 (7-29)	14 (10-30)
3rd month	20 (9-48)	10 (2-31)	21 (6-43)

PL: Posterolateral, NRS: Numeric rating scale for pain, ODI: Oswestry disability index
IQR (interquartile range): 1st quantile-3rd quantile

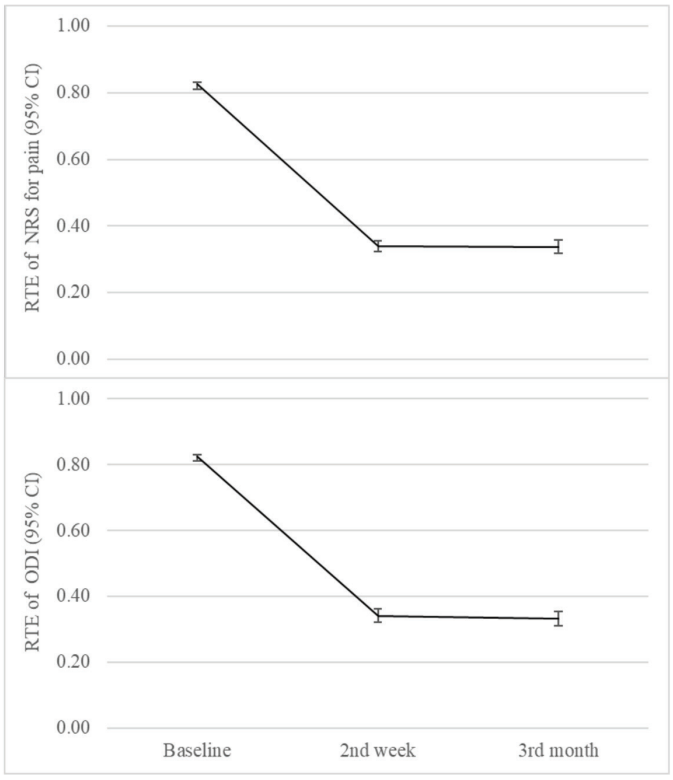

Figure 4. Overall relative treatment effect for pain and disability level

NRS: Numeric rating scale for pain, ODI: Oswestry disability index, RTE: Relative treatment effects, CI: Confidence interval

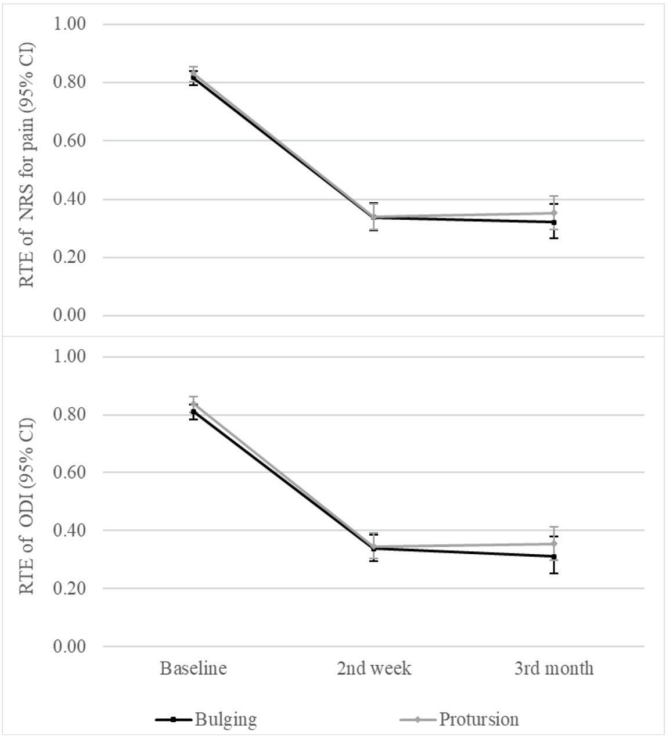

Figure 5. Relative treatment effect of pain and disability levels based on disc type

NRS: Numeric rating scale for pain, ODI: Oswestry disability index, RTE: Relative treatment effects, CI: Confidence interval

applied with local anesthetic and steroid in TFESI, moderate when only local anesthetic was applied; they found moderate evidence for radiculitis secondary to spinal stenosis with local anesthetics and steroids, and limited evidence for axial pain and postoperative syndrome using local anesthetics with or without steroids. We applied local anesthetics and steroids only to patients with LDH in our study, and we achieved significant improvement in patient groups regardless of disc types in MRI.

Although transforaminal epidural steroid injection (TFESI) is a useful diagnostic, prognostic and short-term therapeutic tool for lumbar radiculopathy, Leung et al.[13] reported that it has been reported that although TFESI cannot change the need for surgery in the long term, it is a very safe procedure to provide short-term pain relief and as a preoperative evaluation tool. In our study, significant improvement was achieved both in the early and late periods compared to the pre-procedure. This improvement also confirms that it is due to the disc localization seen on MRI in a diagnostic sense.

To in epidural steroid administration methods; In terms of recovery and pain control in patients with unilateral lumbar radiculopathy; Makkar et al.[14] reported that the transforaminal approach is equivalent to the parasagittal interlaminar application and superior to the midline interlaminar approach. Buenaventura et al.[15] reported that epidural corticosteroid injection is one of the most commonly used interventions in the treatment of chronic spinal pain, the transforaminal pathway to

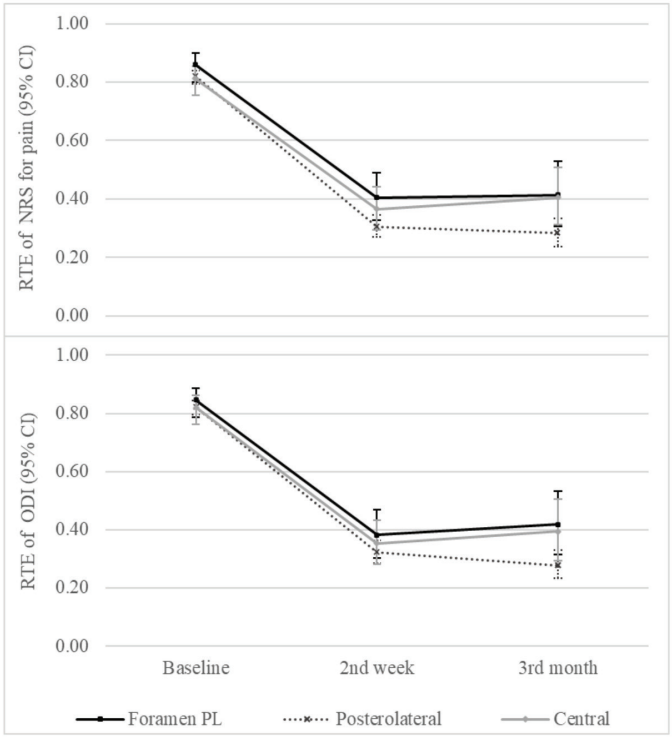

Figure 6. Relative treatment effect of pain and disability levels based on disc localization

NRS: Numeric rating scale for pain, ODI: Oswestry disability index, RTE: Relative treatment effects, CI: Confidence interval

the lumbar epidural space for steroid injection is a fast-acting and widely accepted method for the treatment of lumbar and leg pain. TFESI was applied to all patients in our study and successful results were obtained.

Tecer et al.[16] have stated that TFESI is an effective treatment method in patients with radicular pain regardless of the type or location of disc herniation. Kwak et al.[17] in his study, there was no significant difference in TFESI results in patients with radiculopathy due to LDH according to the location, type and size of disc herniation determined on MRI. Parallel to this, in our study, no statistical correlation was observed between disc type and localization and VAS and ODI scores in the pre-procedural MRI.

Roberts et al.[18] found compelling evidence to support that TFESIs are superior to placebo in the treatment of radicular symptoms. They reported good evidence that TFESIs should be used as a prophylactic intervention and that TFESIs are superior to interlaminar and caudal epidural steroid injections for radicular pain[18]. Only TFESI method was applied to all of our patient group.

Kozlov et al.[19] showed that epidural steroid and non-steroid injections are more effective than non-epidural injections in cases with radicular pain symptoms. In addition, studies have shown the effectiveness of non-particulate steroids to approximate the efficacy of particulate steroids. It supports the better efficacy of transforaminal injection due to the higher incidence of ventral epidural spread compared to interlaminar injection. Thus, they proposed a transforaminal approach when unilateral radicular pain is limited to a nerve root. However, the transforaminal approach is associated with a higher incidence of central nervous system injury, including paraplegia, which is attributed to particulate steroid embolization. Recent studies have shown that non-particulate steroids potentially last as long as particulate steroids. Therefore, they recommended the use of non-particle steroids in the first transforaminal epidural injection[19]. Makkar et al.[20] stated that the recovery scores of particulate steroids were slightly better than non-particle steroids, and stated that the clinician should weigh the risk of complications, however. We administered 5 cc by mixing 1 cc betamethasone and 4 cc 2% prilocaine hydrochloride to all our patients, and although a significant improvement was achieved in the patient groups, we did not encounter any complications.

Although Roy et al.[21] designed to inject the drug once, the long-term pain relief effect was found to be better in patients with pain duration less than 6 months, most of the patients needed a second injection and reported that better results could be obtained with multiple injections in a predetermined time interval. All of our patient group was a patient group that did not respond to conservative treatment for a minimal period of 1 month. In addition, the need for recurrent injections and cases leading to surgery, only single injection results were included in this study.

In this study, no correlation was found between the disc type and localization in MRI findings and the patients' response to

treatment. There is a need for new studies with standardized MRI criteria and different injection practices, as well as larger study groups in different centers.

CONCLUSION

In patients with radiculopathy due to LDH and who do not benefit from conservative treatment; although it is not an alternative procedure to surgery, TFESI is a treatment method that can be used safely, regardless of the disc type and localization in the MRI taken before the procedure, considering its rapid effect in the early period and significant recovery results in the future.

Ethics

Ethics Committee Approval: Ethics committee approval was obtained for this study from Uludağ University Faculty of Medicine Clinical Research Ethics Committee (dated 16.06.2021 and numbered 2011-KAEK-26).
Informed Consent: Informed consent forms were obtained from all patients before the TFESI procedure.

Authorship Contributions

Surgical and Medical Practices: B.A., Concept: B.A., A.K., Design: B.A., A.K., Data Collection or Processing: B.A., A.K., Analysis or Interpretation: B.A., Literature Search: B.A., A.K., Writing: B.A., A.K.
Peer-review: Externally and internally peer-reviewed.
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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ORIGINAL ARTICLE
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THE EFFECT OF COVID-19 PANDEMIC ON THE FREQUENCY OF SPINAL TRAUMA: AN EPIDEMIOLOGICAL STUDY

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ABSTRACT

Objective: This study aims at comparing the patients with spinal trauma in the Coronavirus disease-2019 pandemic era and pre-pandemic era.

Materials and Methods: Patient records for a 9-month period of pandemic (April 1, 2020 - December 31, 2020) and the same period of the previous year (April 1, 2019 - December 31, 2019) were retrospectively collected. These 2 periods were compared in terms of the total number of patients with spinal trauma, the type of injuries, the level of injuries in the spine, the treatment methods applied, and whether there was a neurological deficit . The first group was called as pandemic group (PG) and the latter as control group (CG). The differences between them were statistically examined.

Results: The study sampled 278 patients (CG: 203 patients, PG: 75 patients). It was detected that the number of patients with spinal trauma in the PG dropped by 60% compared to the CG. The most frequent cause of spinal trauma for both groups was traffic accidents. No statistically significant difference was detected in terms of the type, level and severity of injuries, neurological examination findings and method of treatment (p>0.05). However, the rate of indoor or outdoor falls were significantly different between the two groups (p=0.002).

Conclusion: It has been determined that the pandemic-induced social isolation and lockdown process is an important factor in the primordial prevention of spinal trauma. With the result obtained, we think that if adequate and correct measures are taken, the number of spinal traumas will continue to remain low in the post-pandemic period as well.

Keywords: COVID-19 pandemic, spinal trauma, epidemiological study

INTRODUCTION

Spinal trauma-related spinal fractures and spinal cord injuries may lead to significant loss in the quality of life, and they are among the most common causes of mortality and morbidity[1,2]. Spinal injuries are seen in 10% of trauma patients and have a higher mortality rate compared to other injuries[3]. Studies have reported that the number of spinal fracture incidences varies between 16-117/100.00[4-6]. Compared with the other organ injuries, spinal fractures and spinal injuries cause more severe functional losses and impairment in activities[7]. The most effective way to prevent spinal traumas is to describe the problem in various populations and try to identify possible risk factors. Most of the traumas are caused by traffic accidents and high and short-distance falls. While the most common causes of trauma in the young population are traffic accidents and high falls, severe spinal traumas are observed even in short-distance falls in the elderly population due to osteoporosis[4,8]. This study seeks examine the impact of social isolation and lockdowns induced by the coronavirus disease-2019 (COVID-19) pandemic which has affected the whole world over the past year, with a view to determine the risk factors that cause spinal traumas. The purpose of this study is to investigate the frequency of the hospital visits by spinal trauma patients within the same periods of the pandemic and the year before pandemic and to reveal the general characteristics, similarities and differences of the patients. Our hypothesis is that the number of spinal trauma patients visiting the emergency department decreased over the past year which was affected by the COVID-19 pandemic.

MATERIALS AND METHODS

The present research conducts a retrospective single-center analysis. The data of each patient who visited the emergency department of our hospital between April 1 and December 31, 2020 and diagnosed with vertebral fracture or spinal cord injury were retrospectively collected. Only the patients visiting the emergency department were included in the sample. The demographic information, diagnosis, type of treatment and duration of hospitalization of these patients were obtained from the medical records. The patients visiting the emergency department in a period of the pandemic year were compared with those making such visits with the same complaints in the same period of the previous year (1 April-31 December 2019).

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The patients who visited in the pandemic period was called as the pandemic group (PG), and those from the previous year as the control group (CG). Surgical indications of the patients and the level of injuries were recorded. Thoracolumbar injury classification and severity score was used to evaluate spinal cord injuries related to thoracic and lumbar fracture and Subaxial Cervical Injury Classification and Severity score was used to evaluate spinal cord injuries related to cervical fracture. The same procedure was applied to the patients in both PG and CG. The data of the patients were obtained by searching for specific diagnostic codes in the institutional database. Then the clinical information was taken from each patient's medical records.

All procedures were carried out in accordance with the 1964 Helsinki declaration. Written informed consent for scientific purposes and clinical data collection were obtained from patients according to institutional protocol. Ethical approval was obtained from both the local ethics committee University of Health Sciences Turkey, Gaziosmanpaşa Training and Research Hospital (approval date: 28.04.2021, approval number: 259) and the Ministry of Health.

Statistical Analysis

Statistical Package for the Social Sciences version 25.0 software (SPSS Inc., Chicago, IL, USA) was used for data analysis. Mean, median, standard deviation, minimum, maximum, frequency and percentage were used as descriptive methods. Shapiro-Wilk test was performed to assess the normality of the distribution. According to the results of normality analyses, the data was not normally distributed. For the comparison of categorical data, the chi-square test was applied. The Mann-Whitney U test was used for comparison of means. The statistical significance level was set at $p<0.05$.

RESULTS

A total of 278 patients, 203 patients in CG and 75 patients in PG, were included in the study. It was observed that the number of patients decreased by 63% in the pandemic year compared to the pre-pandemic era. The distribution of spinal trauma patients who visited emergency department each month is given in Figure 1. No statistically significant difference was found between the PG and the CG in terms of gender, age and length of hospital stay (Table 1). 39% of the CG consisted of female patients and 61% of male while 42% of the PG consisted of female patients and 58% of male. The mean ages of the CG and the PG were 38±17.53 and 41±19.18 respectively. While the length of hospital stay was 5±4.48 in the CG, it was 2±4.12 in the PG (Table 1).

There was no statistical difference between the PG and the CG in terms of the type of injury, the severity of injury, the level of injury in the spine, the presence of neurological deficits, and the treatment methods (Table 2).

The most common causes of trauma in both control and PGs were traffic accidents (CG: 40%, PG: 39%). Lumbar injury was the most common in both groups (CG: 67%, PG: 55%). Likewise, there was no difference between the two groups in terms of development of neurological deficits (CG: 10%, PG: 13%). While 53% of the patients in the CG received surgical treatment, 44% of the patients in the PG received this treatment (Table 2). Among the patients with fall-related trauma, a significant difference was found in terms of indoor falls (CG: 45%, PG: 85%) and outdoor falls (CG: 55%, PG: 15%) (p=0.002) (Table 3).

DISCUSSION

In December 2019, a series of new infectious respiratory diseases of unknown origin were observed in Wuhan, China.

Table 1. Demographic characteristics of the groups

	Control	Pandemic group	p-value
Sex (n F/M) (% F/M)	80/123 (39/61)	32/43 (42/58)	0.623[1]
Mean age (min-max)	38±17.53 18-78	41±19.18 14-81	0.876[2]
Mean hospital stay (day) (min-max)	5±4.48 1-45	2±4.12 1-24	0.246[2]

[1]Chi-square test
[2]Mann-Whitney U test
F: Female, M: Male, min: Minimum, max: Maximum

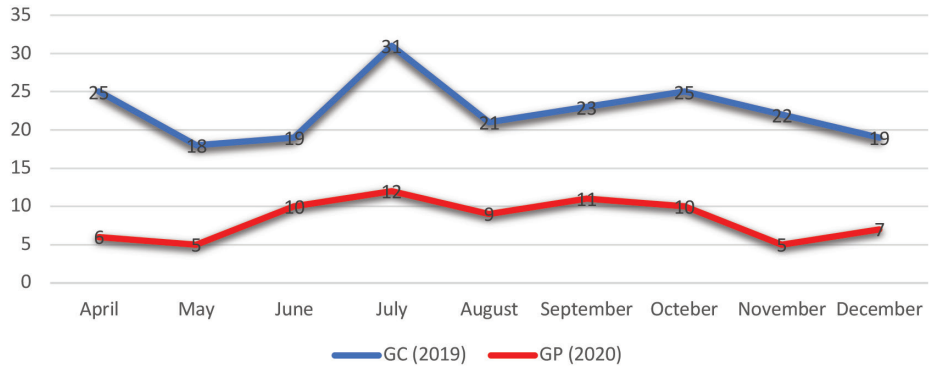

Figure 1. Number of patients with spinal trauma in GC and GP by months
GC: Group of control, GP: Group of pandemic

With the first case detected 2019, COVID-19 has gradually become a global pandemic. Some extraordinary measures and practices have been put in place in order to fight effectively against the pandemic. As part of this process, many hospitals have been transformed into pandemic hospitals. Since our hospital is consisted of two blocs, while one of these blocs has been turned into a pandemic hospital to admit exclusively the COVID-19 patients throughout the pandemic, the other bloc continued to admit trauma patients as usual, and the quality of the emergency department services remained same as the previous year. For this reason, throughout the pandemic, the emergency department continued to admit the trauma outpatients as well as the trauma patients transferred by ambulance. Contrary to expectations, even as many hospitals in our city closed their emergency departments to serve as pandemic hospital, the number of spinal trauma patients who visited our hospital decreased dramatically.

COVID-19 bans have been found to have a serious impact on trauma-related emergency department visits. There was a significant difference between the PG and the CG in terms of hospital visits with complaint of spinal trauma. Local and global public health measures such as the travel bans within and between the cities, traffic restrictions, lockdowns, curfews, quarantines have not only slowed down the spread of COVID-19 but also significantly reduced exposure to trauma.

Many studies in the literature focused on how to perform elective surgeries during the pandemic or the decreasing number of them. Few articles have written about performing emergency surgery in spinal trauma cases, and even few of them compare spinal trauma patients in the pre-pandemic and the pandemic period. The results of previous studies also confirm our study's results. For example, according to a research conducted on the pediatric population in Canada, comparison of two months of pandemic with the same period of the previous year demonstrated a reduction of 35 to 83% for different age groups[9]. Likewise, having compared a period of one month of the pandemic and the pre-pandemic, another study carried out in Italy reached similar results, showing

Table 2. Clinical features of spinal traumas according to groups

Spinal trauma		Control n (%)	Pandemic group n (%)	P[1]
Type of injury	Total	203 (100%)	75 (100%)	0.919
	Traffic accident	81 (40%)	29 (39%)	
	Falling (inside or outside)	55 (27%)	20 (27%)	
	Occupational accident	41 (20%)	14 (18%)	
	Others	26 (13%)	12 (16%)	
Severity of injury	Total	203 (100%)	75 (100%)	0.121
	Multiple trauma	32 (16%)	16 (21%)	
	Isolated spinal trauma	171(84%)	59 (79%)	
Trauma level	Total	203 (100%)	75 (100%)	0.315
	Lumbar	136 (67%)	41 (55%)	
	Thoracic	40 (20%)	17 (23%)	
	Cervical	11 (5%)	7 (11%)	
	Multiple level	16 (8%)	8 (11%)	
Neurologic deficit	Total	203 (100%)	75 (100%)	0.482
	Negative	182 (90%)	65 (87%)	
	Positive	21 (10%)	10 (13%)	
Treatment	Total	203 (100%)	75 (100%)	0.173
	Conservative	95 (47%)	42 (56%)	
	Surgery	108 (53%)	33 (44%)	

[1]Chi-square test

Table 3. Comparison of groups according to the place of the fall

Falling place	Control n (%)	Pandemic group n (%)	p-value
Inside of house	25 (45%)	17 (85%)	**0.002**[1]
Outside of house	30 (55%)	3 (15%)	
Total	55 (100%)	20 (100%)	

[1]Chi-square test

that the number of patients decreased dramatically (77-83%)[10]. Another study which covered all age groups found a 49% reduction in the number of patients[11]. We think that the main reason for this is the decrease in traffic accidents resulting from the reduced use of private cars and public transportation due to the pandemic-induced lockdowns and work from home. According to a study, the figures from some states of the USA showed that throughout the pandemic the number of traffic accidents dropped by 50%[12,13].

In our research, we found a 63% reduction in the number of emergency department visits during the pandemic. There was no difference between the CG and the PG in terms of the cause of injury, the place of injury in the spine and spinal cord, exhibition of multiple trauma or isolated spinal trauma depending on severity of the injury, presence of neurological deficits and treatment options. In addition, no significant difference was found in terms of patient age, gender and length of hospital stay. There was only a significant difference in the total number of patients between the two groups. It can be seen that the measures put in place to prevent spread of COVID-19 and bring down the number of cases have also protected people against trauma. Thus, exposure to trauma and spinal trauma patient visits have decreased.

During the pandemic, where lockdowns and work from home have become prevalent due to quarantines and curfews, the number of indoor falls, falls down stairs or falls into the gaps within the buildings increased significantly. At the same time, the number of outdoor falls (falls at workplace, school, sports centers, etc.) decreased. Although there is a significant decrease in the total number of traumas, indoor protective measures should be put in place. Areas that may cause indoor falls such as wet floors, stairs and steps should be carefully checked to make them safer.

Consistent with our hypothesis, as a result of quarantines, lockdowns, curfews, work from home and travel bans, a significant decrease was observed in the number of patients visiting emergency departments[12,13]. Primordial prevention is an important public health matter. Pandemic measures such as quarantines, lockdowns, curfews and travel bans put in place to reduce the transmission and spread of the disease also protected people from trauma.

If we consider this lockdown as a primordial prevention such as wearing seat belts to prevent injuries in traffic accidents, wearing helmets to prevent injuries in motorcycle accidents, wearing protective equipment to prevent injuries in sports and workplace accidents, we think that lockdowns have been particularly effective in preventing trauma. We also think that compliance with traffic rules, using the right protective equipment, ensuring workplace security, creating remote jobs or hybrid work models (part-time office jobs/part-time remote jobs) for some desk workers, and strictly following the precautions in the post-pandemic normalization period will significantly reduce exposure to trauma and emergency department visits.

The main strength of our study is that it examines a relatively longer period (nine months) and compares it to the pre-pandemic period. Studies in the literature have focused on one to three months. In our study, however, a period of nine-month was examined.

Study Limitations

The main limitation of this study is that it is based on data from only one hospital. In addition, we evaluated only the outpatients visiting the emergency department, thus the patients transferred by ambulance was not included in the sample. It is also possible that as patients know that most of the state hospitals have been turned into pandemic hospitals, they may have visited private hospitals and medical centers with no or fewer COVID-19 patients to avoid infection.

CONCLUSION

The pandemic restrictions put in place to prevent the spread of the infection also led to a decrease in the number of spinal traumas. The lessons learned during the pandemic will guide us in our fight against spinal trauma and all other types of trauma when we return to normalcy in the post-pandemic era.

Ethics

Ethics Committee Approval: Ethical approval was obtained from both the local ethics committee University of Health Sciences Turkey, Gaziosmanpaşa Training and Research Hospital (approval date: 28.04.2021, approval number: 259) and the Ministry of Health.

Informed Consent: Written informed consent for scientific purposes and clinical data collection were obtained from patients according to institutional protocol.

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Authorship Contributions

Surgical and Medical Practices: Ö.Ö., Concept: Ö.Ö., F.D., Design: Ö.Ö., O.B., E.C., Data Collection or Processing: Ö.Ö., M.K., Analysis or Interpretation: Ö.Ö., S.K., E.C., Literature Search: Ö.Ö., Writing: Ö.Ö., E.C.

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NEW ERA IN POSTOPERATIVE ANALGESIA IN SPINAL SURGERY: THORACOLUMBAR INTERFASCIAL PLANE (TLIP) BLOCK

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Keywords: Analgesia, spinal surgery, tlip block

Dear Editor;

Spinal surgeries are painful procedures, and effective postoperative analgesia improves patient outcomes and reduces complications, thus reducing hospital stay and preventing the development of chronic pain[1]. For this purpose, neuraxial methods such as subarachnoid and epidural block, paravertebral block, systemic opioid infusion with a patient-controlled analgesia device and wound infiltration techniques are applied in these surgeries.

Recently, with the widespread use of ultrasound in anesthesia practice, regional anesthesia has been performed very frequently both for anesthetic purposes and to provide postoperative analgesia. Thoracolumbar interfascial plane (TLIP) block, one of these applications, is a technique that was first defined in 2015 in single-level lumbar spinal surgery by injecting local anesthetic bilaterally into the fascial area between the multifidus and longissimus muscles at the L3 level. At this point, the target is the dorsal ramus of the thoracolumbar nerves. Patients described the loss of sensation starting from the midline at the injection level and spreading cephalolaterally at the 20th minute[2]. Later, a modified technique, lateral TLIP, was defined, which is more comfortable for viewing, ease of application, and reduces the possibility of neuraxial puncture. In this technique, the block is performed between the iliocostal and longissimus muscles and has been shown to be as effective as classical TLIP[3]. In another study, modified lateral TLIP was performed bilaterally from the L3 vertebra level in a multilevel spinal surgery with a local anesthetic injection of 40 mL (20 mL on each side). It was reported that there was a sensory loss from the left midaxillary area to the right midaxillary area between L1-L5 segments, and the patients did not require additional analgesics[4]. In another lumbar spinal surgery study, it was mentioned that TLIP block suppresses the hemodynamic response to surgical stress and reduces intraoperative analgesic consumption[5]. In a case series in which awake endoscopic laminectomy with mild sedation was applied, it was stated that there was a loss of sensation between T12-L5 25 minutes after the block was performed, and the patients did not require analgesics during the surgery and for 24 hours postoperatively[6].

Studies on TLIP are mostly case reports or randomized controlled studies completed with a small sample size, and they have not yet been studied in an important population such as pediatric scoliosis cases. With more randomized controlled studies, this easy-to-apply minimally invasive block may be an effective component of multimodal analgesia in the near future.

Ethics

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