SEQUENTIAL - SIMULTANEOUS CORRECTION OF SHORT SEGMENT HYPERKYPHOSIS

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ABSTRACT

Sequential-simultaneous anterior and posterior correction is the authors preferred technique for short segment hyperkyphosis. It allows posterior instrumentation placement and osteotomy performance in the preferred prone position, as well as direct control and visualization of both the anterior and posterior columns during kyphosis correction and placement of anterior strut grafts. When compared to staged procedures, this technique maintains the potential advantages of improved correction and nutrition, decreased blood loss, decreased hospital stay, and decreased morbidity.

Key Words: *Hyperkyphosis, surgical treatment.*

INTRODUCTION

Short segment hyperkyphosis presents one of the greatest challenges that spine surgeons face. Kyphosis and instability may result in pain, deformity, and/or neural embarrassment. Progressive kyphotic deformity results from altered spine biomechanics. Following the basic biomechanical principles of replacing that aspect of spinal instability that is compromised, whether anterior, posterior, or both, logically should provide the best result. Hodgson in 1956 demonstrated that anterior surgery offered the distinct advantages of direct visualization of the extent of disease, anterior cord decompression, and excision of diseased vertebrae, and anterior stabilization and fusion. Surgeons agree that posterior fixation does not control progression in kyphotic deformities since the fusion mass is under tension forces. Progression can be controlled only by adding bone on the compression side of the deformity.

Although somewhat controversial, most surgeons recommend posterior fusion and instrumentation for added stability. Anterior fusions can fail and a thick cortical strut wall takes far longer than the usual nine to twelve months of immobilization to re-ossify. Furthermore, it is rarely possible to fuse the full length of the deformity by the anterior route alone. In summary, a staged combined approach allows improved correction, improved stabilization, earlier mobilization, and decreases pseudarthrosis and malunion rates. However, potential problems of staged procedures, including procedure length, blood loss, length of hospitalization, development of malnutrition, and instability between procedures have been identified.

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Farcey, et al, have popularized simultaneous anterior and posterior procedures. They note that it provides circumferential decompression and fusion, rigid fixation, and improved sagittal alignment. Their technique also offers the potential advantages of decreased operating time, decreased blood loss, decreased morbidity, and decreased hospital stay when compared to staged procedures.

MATERIALS AND METHODS

Patients

Eleven consecutive patients with short segments hyperkyphosis who underwent surgery by the senior author (MAA) between August of 1992 and February of 1994 were reviewed. The review included all hospital charts, office notes, and operative reports. There were seven males and four females with an age range from 14 to 45 with a mean age of 42 years. Kyphotic deformity etiology was post-traumatic in seven, drawfism in two, metastatic tumor in one, and idiopathic scoliosis status post multiple reconstructive procedures in one. Six of the patients had undergone previous spinal surgical procedures with a range of one to six. All patients had severe pain and/or progression of deformity.

Technique

All patients were first placed prone on a Relton-Hall frame and a standard posterior approach performed. The upper and lower instrumentation foundations were established, followed by placement of intermediate fixation points. Posterior osteotomy was placed though a previous fusion mass or if there was a pseudarthrosis this was enlarged. Posterior iliac crest cortical cancellous bone graft was then harvested through a separate longitudinal incision and that

wound subsequently closed. Proper sized for length, 1/4-inch rods were then cut and contoured to provide as near anatomic sagittal plane alignment as possible. The rods were placed and provisionally secured. The midline wound was then pulled together over packed sponges and covered with two layers of Vi-Drape.

The instruments were moved to the side, the patient undraped and repositioned into a right lateral decubitus position (unless a left anterior approach was contraindicated) and secured in this position held up at 90°. The patient was positioned at the edge of the operating table so that access to the posterior wound was possible later in the procedure.

A transthoracic and/or thoracic retroperitoneal approach to the anterior spine was then performed. Vertebrectomy or discectomy as appropriate was then carried out, followed by kyphosis correction as the anterior graft is secured under direct vision as the posterior instrumentation is simultaneously tightened. After chest tube placement, both anterior and posterior wounds were then closed in routine fashion.

Spinal cord monitoring (somatosensory evoked potentials) was utilized. Cell saver use was routine. All patients received prophylactic antibiotics for at least 48 hours and prophylactic thromboembolic care including long leg hose and sequential compression devices. Patients were allowed to ambulate as tolerated and most were braced.

RESULTS

Average blood loss was 1,950 cc (range 750 - 4,000 cc). Mean operative time was 620 minutes (range 420 - 884). The mean hospital stay was 7.8 days (range 5 - 12 days). Average follow-up was 10 months (range 3 - 18).

Patients Self Assessment

Each patient completed self assessment questionnaires regarding their function, pain, and appearance. The questionnaire included a simple five point analogue scale (with 5 being best possible) for each category, i.e. function, pain, and appearance.

Mean function score at follow-up was 4.2 (range 3-5), compared to preop mean of 3.0 (range 2-5). Pain score improved to a mean of 4.2 (range 3 - 5) versus 2.4 (range 2 - 4) preap. Mean appearance score at follow-up was 3.9 (range 2 - 5) compared to a preop mean of 2.0 (range 1 - 4).

Radiographic Evaluation

Radiographic evaluation on each patient included three foot standing (or sitting in the one paraplegic patient) AP and lateral scoliosis films. Most patients' kyphotic deformity was localized over very few levels. Eight of 11 (72.7 %) patients' deformity involved only one or two levels. Preoperative deformity (and subsequent correction) was quantified by comparing each patients existing defority to a "normal" sagittal alignment predicted from Bernhardt and Bridwell data (Spine 14: 717-721, 1989). Preoperative kyphotic deformity (over "normal") per patient averaged 40°. Mean correction immediately post-op was 84% (range 70-113 %). Correction was well maintained as ten of eleven (91 %) patients maintained greater than 55% correction. Overall, mean correction at longest follow-up was 74% (range 19 - 106 %).

Sagittal T1 balance at follow-up was improved from preop in five of ten (50 %) patients with radiographs adequate to visualize T1 well. Four of the five (80 %) of patients whose T1 sagittal balance worsened had a negative balance preoperatively. T1 was moved slightly more posteriorly in each of these patients. Only one patient with a positive T1 balance preoperatively was more anterior at follow-up. The best T1 sagittal correction was noted in a 31-year-old female with a 42° kyphotic deformity from T12 to L2, whose preop T1 offset of +78 mm improved to + 10 mm at follow-up.

COMPLICATIONS

There were no infections, instrumentation fixation losses, neurologic complications, or deaths. one patient underwend instrumentation removal 14 months postop for pain and questionable prominence. Removal did relieve much of his pain and his fusion mass was noted to be solid at that exploration.

Two patients developed some kyphosis above the instrumented constructs, but both appear to have stabilized on postop radiographs.

Although not a complication, one patient underwent a planned revision to shorten his instrumentation construct. He had sustained an L4 burst which resulted in L3 - 5 kyphosis of + 10° (normal –33°). He underwent an L3 - 5 fusion with an L2 to sacrum instrumentation. Six months postop, the construct was revised and shortened to include only the fused levels (L3-5).

RESULTS OF TRANSPEDICULAR SCREW-ROD FIXATION IN THORACOLUMBAR VERTEBRA FRACTURES

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Fiftyeight patients who had thoracolumbar vertebrae fractures and that were fixed with transpedicular screw and rod combination between 1987-1993 were evaluated after a minimum follow-up of one year. Mean age of patients were 38.08 (14-66) years. In their follow-up, patients were evaluated clinically and and radiologically considering changes in neurological findings, functional status, number of vertebrae that were fused; development of spinal deformity and implant failure. The status of the neural canal was evaluated by CT. At the and of the first year in some of the patients. In conclusion, fixation with transpedicular screw-rod combination was found to be a good stabilizing system that enabled early rehabilitation.

Key words: *Thoracolumbar vertebra, traetme transpedicular screw-rod.*

Today, orthopedic surgeon has to deal with more high energy trauma patients because of technologic improvements. For that reason spinal injuries are more frequently seen by the surgeons. There are a lot of treatment alternatives for these injuries which makes the problem difficult. In toracolumbar spinal fractures fixation with transpedicular screw-rod combination offer a good stabilizing system but which is technically difficult. ın that study results of transpedicular screw-rod fixation in thoracolumbar spinal fractures, treated at Hacettepe Univ. Faculty of Medicine, Dept. of Orthopedics and Traumatology has been presented.

MATERIAL AND METHOD

Between 1987-1993 eighty patients were hospitalized because of unstable thocolumbar spinal fractures and 58 of them were treated with transpedicular screw and rod combination. Forty patients were male and 18 female. Mean age was 38.08 (14-66) years old. At first admission to emergency department patients were evaluated by complete physical examination, direct radiogram and CT. Neurological status of the patients were noted according to Frankel scale. Sagittal index, kyphosis were obtained. Neural canal status was evaluated by CT.

Thirty-three first lumbar, twelve second lumbar, six twelfht thoracic, four thirth lumbar and three eleventh thoracic vertebral fractures were present.

The first generations cephalosporin was administered as a prophylactic antibiotic for twenty-four hours. For the purpose of lavage only saline solution was used.

All operations were done with image intensifier. Laminectomy were not done for observing the pedicle. Isola, TSRH, Alıcı, IQL, Dick fixateur Interne were used for stabilization (Figure 1). Patients were standup and walked at the third day of the operation if their neural status good enough to do it. All the patients tried to get upright position as soon as possible. External support were used after all of the operations.

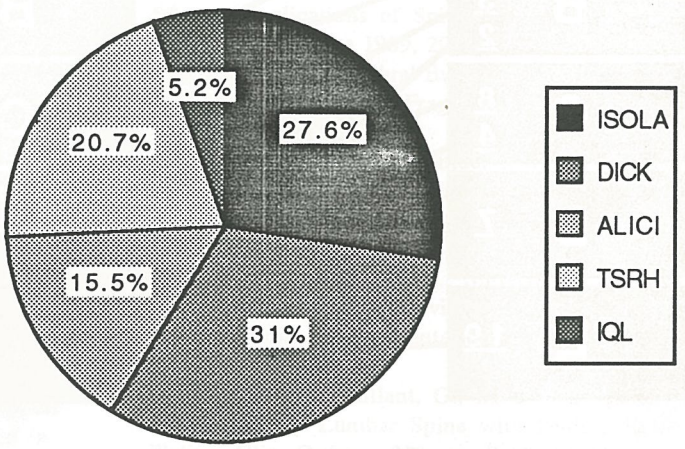

Figure 1.

At follow-up period patients were evaluated complete physical examination, direct radiogram and twelve of the patients by CT. Spinal deformity and displacementpercent of vertebral column were calculated for all the patients. Spinal deformity were calculat-

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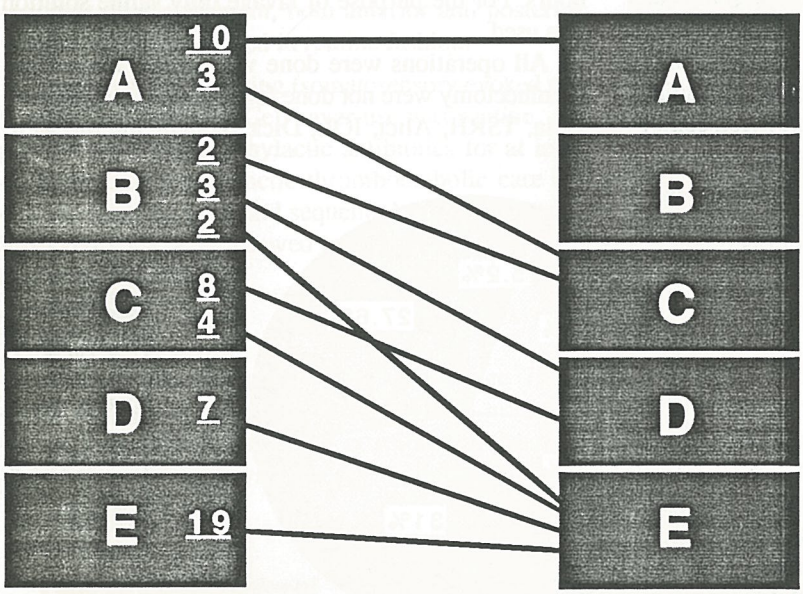
ed according to Dickson and Harrington (4). At follow-up, functional status of the patients were obtained.

RESULTS

At first admission to the hospital, by direct radiological examinations mean sagittal index were found 28 degree (6). Spinal deformity according to Dickson andHarrington were found 24 degree; vertebral displacement were found 26% for the patients (4). Postoperative spinal deformity was 4 degrees, vertebral displacement was 7%. At the and of the follow-up, 11 degrees spinal deformity, 10% vertebral displacement was observed.

In the study group, 3.28 spinal segment fusion were obtained. At the and of the follow-up period any pseudoartrosis were seen which had been demonstrated by clinic or radiological examination.

Table 1.



Functional neurologic status of the patients were evaluated by Frankel scale at first admission and in the follow-up period (8) (Table 1).

Twelve of the patients were evaluated by CT at the end of the one year follow-up. In this examinations any spinal stenosis were obtained (9).

Four implant failure occurred in the follow-up period. Two Alici, 1 IQL and 1 Dick system had been applied to these patients. First of all was thirth lumbar spinal fractures which was stabilized by IQL system. In this patients upper pedicle screw was found to be broken at the third other patients was operated because of L-1 unstable burst fractures. Dick "fixateur interne" had been used to that patient (3). Upper pedicle screw was found to be broken at the follow-up period. The other two patients were operated because of unstable twelfth thoracic and first lumbar spinal fractures. Alici spinal instrumentation system had been used to these patients. Upper vertebral pedicle screw was found to be broken in these patients too. These patients had any subjective symptoms. They also rejected to implant removal.

Two post-operative superficial wound infection were obtained which were controlled by antimicrobial chemotheraphy. Any deep wound infection were found. No cases of pulmonary embolism or death were observed.

DISCUSSION

Clinical instability is defined as the loss of the ability of the spine under physiologic loads to maintain relationship between vertabrae in such a way that there is neither initial nor subsequent damage to the spinal cord or nerve roots, and in addition there is no development of incapacitating deformity or severe pain (14). As a result of this define, spinal instability is the major factor that effects the surgical decision. The goals of the surgical management of spine injuries are to provide stability to the axial skeleton, regain sagittal and frontal alignment and create a stable environment to enhancing neurologic recovery and function. Decompression necessary in conjunction with with stabilization may enhance neurologic recovery (2, 10). But it is well known that laminectomy does not decompress the neural elements, since often the offending structures are anterior to the cord or cauda equina (1, 5, 7, 13). For that reason we didn't do any laminectomy to our patients to provide decompression.

There are numerous advantages to surgical manage-

ment of thoracolumbar fractures. Operative fixation of spine fractures enables reduction of the fracture and deformity, allows decompression, either direct or indirect of the neural canal and stabilization. With transpedicular screw four point fixation can be obtained. Fixation with transpedicular screw offered by Boucher at first and after that popularized by Roy-Camille at 1960-70 (12).

According to some authors; PLL. is the key factor for the posterior instrumentation. If neural canal narrowing is between 30-50% reduction can be obtained by posterior instrumentation because PLL. is partially ruptured. If canal narrowing is more than 50% PLL. is totally ruptured for that reason ligamentotaxis is not a good way for reduction (1, 7). But in this study we observed that with posterior instrumentation reduction can be achieved in patients whose canal narrowing is more than 50%.

Fixation with transpedicular screw is technically demanding and needs image intensifier. The other problem is root injuries and anterior vital blood vessels (9). For that reason surgeon must be familiar with this technique. In this study we didn't see any vascular or root injuries.

Post-operative spinal deformity were obtained 11 degrees in our patients. This kyphotik progression can be prevented by hook application to upper vertebra.

Implant failure is an another important problem. Although the patients had no subjective complaint, pseudoartrosis is an important factor that cause this complication. Microfractures which occur bone-metal interface is an important factor that cause implant failure (11). In addition to that pedicular screw and rod combination is an unconstrained construct; for that reason we can explain somehow screw breakage occurred. Wittenberg et al. had been showed that Luque plate is stiffer than Dick "Fixateur Interne" (15). But rigidity is nor the only factor that effects the outcome of the instrumentation. If the fusion does not happen fatigue failure is going to happen to every kind of instruments. In this point of wiev technique of the arthrodesis getting more important. In this study, we observed 3.24 spinal segment fusion. With this technique uninjured spinal segments can be protected.

As a result transpedicular screw and rod combination is a good stabilizing system. But it is technically demanding but in an experienced hands the complication rates can be reduced.

REFERENCES:

1. Argenson, C. Boileau, P., Floman, Y., Farcy, C.J.P., Argenson, C., eds. Thoracolumbar Spine Fractures. New York Raven Press, 1993; 131-156.
2. DeWald R.L., Burst Fractures of the Thoracic and Lumbar Spine. Clin. Orthop. 1980; 12: 882-890.
3. Dick, W.: The "Fixateur Interne" as a versatile implant for spine surgery. Spine 12: 882, 1987.
4. Dickson, J.H., Harrington, P.R., and Erwin, W.D.: Result of Reduction and Stabilization of the Severely Fractured Thoracic and Lumbar Spine. J. Bone Joint Surg., 60-A 799, 1978.
5. Esses SI, Botsford DJ, Huler RJ. Rauschning W. Surgical anatomy of the sacrum. A guide for rational screw fixation. Spine 1991; 16 (3S): S 146-150.
6. Farcy J.P.C., Weidenbaum M, Glassman S.D. Sagittal Index in Management of Thoracolumbar Fractures. Spine 1990; 15: 958-965.
7. Floman, Y., Posterior Instrumentation in the management of Thoracolumbar Injuries. Floman, Y., Farcy, C.J.P., Argenson, C., eds. Thoracolumbar Spine Fractures. New York Raven Press, 1993; 279-306.
8. Frankel, H.L., et al.: The Value of Postural Reduction in the Initial Management of Closed Injuries of the Spine with Paraplegia and Tetraplegia. Part 1. Paraplegia, 7: 179-192, 1969.
9. Georgis T., Rydevik B., Weinstein JN, Garfin SR. Coplications of Pedicle Screw Fixation. In: Garfin SR, ed. Coplications of Spine Surgery. Baltimore: Williams & Wilkins 1989, 200-210. Guerra J, Garfin S.R., Resnick D. Vertebral Burst Fractures: CT Analysis of the Retropulsed Fragment. Radiology 1984; 153: 769-773.
10. Jacops R.R., Asher M.A., Snider R.K. Thoracolumbar Spine Injuries. A Comparative Study of Recumbent and Operative Treatment in 100 Patients. Spine 1980; 5: 463-467.
11. McAfee, P.C., Farcy C.J.P., Sutterlin, C.E., Gurr K.E., Cunnigham, B.W. Device Releated Osteoporosis with Spinal Instrumentation. Spine, 14: 919-926.
12. Roy-Camille, R., Saillant, G., Mazel Ch.; Internal Fixation of the Lumbar Spine with Pedicle Screw Plating. Clin. Orthop., 203: pp. 7-17, 1986.
13. Tencer AF, Allen BL, Ferguson RL. A Biomechanical Study of Thoracolumbar Spinal Fractures with bone in the canal. I: The effect of Laminectomy. Spine 1985; 10: 586-589.
14. White, A.A., Panjabi, M.M.: Clinical Biomechanics of the Spine. Philadelphia, W.B. Saunders, 1982 pp. 219-244.
15. Wittenberg RA, Coffe MS, Swatz De, Edwards WT, White AA, Hayes WC. Fatigue Properties of Lumbar Spine Traction Devices. 7th Meeting of European Society of Biomechanics, Aarhus Denmark, 1990.