

Full Length Research Paper

Clinical and radiological results of posterior instrumentation without fusion for thoracolumbar fractures

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A retrospective study of clinical and radiological results of nonfusion operative treatment for thoracolumbar fractures. In this study, we aimed to demonstrate that fusion was not always required in the surgical treatment with posterior instrumentation for thoracolumbar vertebral fractures and to show the success of surgical treatment without fusion. Fusion was added considering failure of the implant and inability to maintain the corrected kyphosis angle after posterior instrumentation for thoracolumbar vertebral fractures. Fusion related problems such as the fusion-induced loss of stability in posterior elements, graft donor site problems, increased blood loss, allograft associated infections, and prolonged operation time, focus attention on surgical treatment without fusion. We intended to demonstrate the alignment and stability of the spine in the coronal and sagittal planes after treatment without fusion. Kyphosis angle and the extent of the collapse were measured in preoperative, postoperative and final examination films of 60 patients with thoracolumbar vertebral fractures. Based on the computerized tomography and magnetic resonance images of the patients, we evaluated intracanal fragments, the presence of pedicle and laminar fractures, posterior ligamentous complex status and the presence of medullary edema. With an aim to evaluate pain and quality of life of the patients, the Oswestry disability index (ODI) and Roland morris disability questionnaire were tested. The obtained results were evaluated and the final postoperative conditions of the patients were investigated. For the statistical analysis of local kyphosis angle, sagittal index and percentage of anterior collapse that were measured in preoperative, postoperative and final examinations of the patients, descriptive analysis and one way analysis of variance for related samples were conducted. And Pearson's correlation test was used for the analysis of the relationship between radiological measurements and clinical functions. It can be concluded that the patients derived radiological and statistically significant benefit from the surgery in terms of restoration of anterior column height and that postoperative radiological values were maintained with minimal reduction until the final examination ($p>0.05$) and that the surgery was effective in remodeling of the vertebral body. When evaluated in terms of the clinical results, a negative relationship ($r = 0.300$) between Oswestry scores and percentage of anterior collapse was found to be statistically significant ($p<0.05$). Our findings that the patients derived statistically significant benefit radiologically, in terms of local kyphosis angle and sagittal index correction from the posterior instrumentation without fusion and that postoperative radiological values were maintained with minimal increase ($p>0.05$) until the final examination, support our conclusion that fusion is not required. Hence, we can eliminate complications of fusion surgery.

Key words: Thoracolumbar fractures, surgical treatment without fusion, posterior instrumentation, local kyphosis angle, sagittal index.

INTRODUCTION

Various treatment methods ranging from protective treatment to early surgical treatment have been described for thoracolumbar spinal fractures (Alici et al., 1992a, b). The aim of the treatment in spinal fractures

is to achieve a painless, balanced and stable spine, to restore the highest degree of spinal motion by ensuring proper neurological function and to enable the patient to move in a short period of time. Fusion was added to the

surgery considering problems such as failure of the implant and loss of kyphosis correction after posterior instrumentation for thoracolumbar vertebral fractures (Berk, 2008; Jacobs et al., 1980; Floman, 1993). However, based on our clinical experience, we considered that fusion may not be necessary in every patient since decortication and fusion lead to problems such as severe damage to the posterior structures, graft donor site problems, prolonged operation time and increased blood loss. We investigated the extent of changes in short and long term radiological results of the patients who underwent instrumentation without fusion in our clinic in comparison to their preoperative status, and the relationship between the radiological results obtained from the final examination and functional results.

MATERIALS AND METHODS

In this study, we investigated patients without posttraumatic neurologic deficit who were hospitalized with the diagnosis of thoracolumbar spinal fracture in Dicle University, School of Medicine, Orthopaedics and Traumatology Department and were treated with posterior instrumentation without fusion between October 1999 and February 2009. 60 patients who had preoperative, postoperative and a minimum of 12 months follow up films were enrolled in the present study. The mean follow up duration of 60 patients was 30.85 ± 19.42 months (min. 12, max. 105). 27 (45%) of patients were female and 33 (55%) male. The mean age of the patients was 35.3 (range 17 to 59). The mean age distribution of the patients was 35.34 ± 12.92 (range 17 to 59). In the present study, sites of fractures were L1 in 22 (37%) patients, T12 in 14 (23%), L2 in 11 (18%), L3 in 8 (13%) and T11 vertebra in 5 (8%). Preoperative, postoperative and final follow-up films were evaluated in terms of kyphosis angle and the extent of collapse in patients. Based on computerized tomography and magnetic resonance images of the patients, we evaluated intracanal fragments, the presence of pedicle and laminar fractures, posterior ligamentous complex status and the presence of medullary edema. With an aim to evaluate pain and quality of life of the patients, the Oswestry disability index (ODI) and Roland morris disability questionnaire were tested. The obtained results were evaluated and the final postoperative conditions of the patients were investigated.

For the statistical analysis of local kyphosis angle, sagittal index and percentage of anterior collapse measured in preoperative, postoperative and final follow-up of the patients, descriptive analysis and one way analysis of variance for related samples were conducted. Pearson's correlation test was used for the analysis of the relationship between radiological measurements and clinical functions.

RESULTS

Clinical analysis

The mean ODQ (Oswestry disability questionnaire) score of the patients was 13.7 ± 12.6 (min. 0, max. 48). Based

on the obtained results, the number of grade I patients was 45 (75%), that of grade II patients was 13 (21.6%) and that of grade III patients was 2 (0.03%). Pearson's correlation test was used to analyze the differences between postoperative and final follow-up examinations of the patients in terms of local kyphosis angle, sagittal index and percentage of anterior collapse and their relationship with Oswestry and Roland Morris scores. A negative relationship between Oswestry scores and the difference in percentages of anterior collapse ($r = 0.300$) was found to be statistically significant ($p < 0.05$). A linear positive relationship between Oswestry scores and the difference in local kyphosis angles ($r = 0.122$) was found to be statistically significant ($p > 0.05$). A negative relationship ($r = 0.179$) found between Oswestry scores and the difference in sagittal index was not statistically significant ($p > 0.05$). A linear positive relationship ($r = 0.94$) observed between Roland Morris scores and the difference in local kyphosis angle was not found to be statistically significant ($p > 0.05$). A linear positive relationship ($r = -0.122$) between Roland Morris scores and the difference in sagittal index was observed to be statistically insignificant ($p > 0.05$). A linear negative relationship ($r = -0.248$) between Roland Morris scores and the difference in percentages of anterior collapse was not observed to be statistically significant ($p > 0.05$).

Radiological analysis

Regarding the descriptive statistics, the mean local kyphosis angle of the patients was $15.6 \pm 7.8^\circ$ (min. 1° , max. 33°) before the surgery and $6.8 \pm 6.1^\circ$ after the surgery. The decrease between preoperative and postoperative local kyphosis angle was $8.7 \pm 7.3^\circ$ (min. -8° , max. 22°). The mean local kyphosis angle was found to be $7.4 \pm 5.7^\circ$ (min. 0.5° , max. 25.4°) in final examinations of the patients. There was an increase of $0.5 \pm 5.3^\circ$ in local kyphosis angle between postoperative and final examinations. The decrease in local kyphosis angles measured in preoperative and postoperative examinations were found to be statistically significant by one way analysis of variance for related samples ($p < 0.05$). A minimal increase was detected between postoperative and final examinations, which however did not reach statistical significance ($p > 0.05$). The decrease in local kyphosis angles measured in preoperative and final examinations were observed to be statistically significant ($p < 0.05$). Based on these findings, it can be inferred that patients derived statistically significant and radiological benefit from the surgery in terms of correction of the local kyphosis angle and that postoperative radiological values were maintained with minimal increase ($p > 0.05$) until the final examination. Regarding the results obtained from the descriptive analysis, the mean sagittal index of the patients was 21.7 ± 7.3 (min. 6, max. 40). The mean sagittal index value was 12.9 ± 5.9 postoperatively (min. 0.5, max. 32). The decrease between preoperative and

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postoperative values for sagittal index was 8.8 ± 7.4 (min. -10, max. 22). The mean sagittal index of the final examinations was 13.6 ± 5.4 (min. 0, max. 31). There was an increase of 1.9 ± 9.5 (min. -28, max. 14.7) in sagittal index when values obtained from postoperative and final examinations were compared. When the difference between sagittal index values were analyzed using one way analysis of variance for related samples, the decrease in preoperative and postoperative values for sagittal index was found to be statistically significant ($p < 0.05$). A minimal increase was detected between postoperative and final examinations, which was found to be statistically insignificant ($p > 0.05$). The decrease in sagittal index values measured in preoperative and postoperative examinations was found to be statistically significant ($p < 0.05$). Based on these findings, it can be suggested that patients derived statistically significant and radiological benefit from the surgery in terms of sagittal index correction and that postoperative radiological values were maintained with minimal increase ($p > 0.05$) until the final examination. Regarding the descriptive statistics, the mean preoperative rate of anterior collapse was $36 \pm 12.8\%$ (min. 8%, max. 71%), whereas the mean postoperative rate of anterior collapse was $17.6 \pm 10.3\%$ (min. 2%, max. 47%).

The decrease in preoperative and postoperative rates of anterior collapse was $18.4 \pm 10.8\%$ (min. 2%, max. 48%). The mean rate of anterior collapse was $14.8 \pm 8.6\%$ (min. 2%, max. 32%) in the final examination. There was a decrease of $2.8 \pm 9.8\%$ (min. -27, max. 28%) in the rate of anterior collapse between postoperative and final examinations. When the difference in rates of anterior collapse was evaluated by one way analysis of variance for related samples, the decrease in preoperative and postoperative rates of anterior collapse was found to be statistically significant ($p < 0.05$). The decrease between postoperative and final examinations was observed to have maintained, which however did not reach statistical significance ($p > 0.05$). The decrease between the rates of anterior collapse measured in preoperative and final examinations, was detected to be statistically significant ($p < 0.05$). Based on these results, it can be concluded that patients derived a statistically significant and radiological benefit from the surgery in terms of restoring anterior column height and that postoperative radiological values were maintained with minimal increase ($p > 0.05$) until the final examination and that the surgery is beneficial with regard to remodeling of the vertebral body.

DISCUSSION

In general, the treatment of thoracolumbar vertebral fractures is highly controversial. The vertebral stability after fracture constitutes an important part of the conflict. From the literature review, it can be established that various treatment methods ranging from protective

treatment to early surgical treatment have been used. The most important factor determining the treatment strategy is whether the patient has a neurological injury, and if yes, whether it is progressive or not. Since the concepts and definitions have not yet been agreed upon, different treatment approaches have evolved and continue to evolve (Alici et al., 1992a, b). The aim of the treatment of spinal fractures is to achieve a painless, balanced and stable spine that has healthy neurological function and the highest degree of spinal motion and to enable the patient to move in a short period of time (Berk, 2008). Surgical treatment is superior to conservative treatment in certain respects. Surgery provides spinal assignment and allows a better reduction of the fracture fragments. Canal width is more efficiently preserved regarding preventing a damage to neurological functions. It also prevents complications developing secondary to plaster cast or long-term bed rest. Due to its ability to provide a high degree of stability, patients can be mobilized earlier. Hence, rehabilitation can be initiated earlier (Jacobs et al., 1980). Posterior surgery is performed primarily in the treatment of burst fractures without neurological deficit. With the effects of lordosis and posterior distraction force applied during posterior decompression, intracanal tissues are expected to be displaced anteriorly and to be reduced by ligamentotaxis. To ensure the efficiency of ligamentotaxis, posterior longitudinal ligament (PLL) should be left intact and early reduction should be performed.

Since PLL is partially preserved with a canal compromise measuring 30 to 50%, ligamentotaxis can be effective, however, ligamentotaxis would be less useful for individuals with canal compromise of greater than 50% because PLL would be totally torn (Floman, 1993). Acaro lu et al. (1994) demonstrated that ligamentotaxis is useful in patients with a canal compromise of greater than 50%. The use of posterior fixation without fusion in the surgical treatment of thoracolumbar fractures has rarely been reported. In a retrospective study of 28 patients, Sanderson et al. (1999) performed short segment posterior instrumentation without fusion in one level above and below the fractured vertebra and followed up the patients for two years. Implant failure was screw breakage in four patients (prevalence is 14%). Functional and clinical status of the patients were determined using low back outcome score (LBOS) and a perfect or good score result was received in 62% of patients. The mean correction loss was 8° during the follow-up period. No marked correlation was observed between radiological and functional results in patients. The advantages of surgery without fusion were reported to be the absence of donor site related problems, preservation of mobile segments, decreased blood loss, and shortened duration of surgery by the authors, who concluded that posterolateral bone graft was not always necessary in thoracolumbar burst fractures (Sanderson et al., 1999). In a prospective randomized study, Alanay et

al. (2001) evaluated the efficacy of transpedicular grafting and established that similar results were obtained with and without grafting (Alanay et al., 2001a, 2001b). In a prospective clinical study, Wang et al. compared the results of surgical treatment with and without fusion in thoracolumbar burst fractures. In that study, a total of 58 patients who were neurologically intact, with a kyphosis angle greater than 20° and a canal narrowing and collapse in vertebral height of greater than 50% were enrolled. As a result of that study, no marked difference was observed in kyphosis angles between the two groups. Radiographic parameters were found to be statistically better in the non-fusion group. Implant failure was screw breakage in eight patients (prevalence 13,7%), five of whom were in the fusion group whereas 3 were in the nonfusion group.

The authors suggested that the short term outcomes of short segment pedicular fixation without fusion in the treatment of thoracolumbar fractures were satisfactory. Additionally, they suggested that the advantages of non-fusion surgery included the absence of donor site related problems, preservation of motion segments, decreased blood loss, and the shortened duration of the surgery (Wang, 2006). Li-yang et al. published the results of a 5 years prospective randomized clinical study of 73 patients who underwent posterior short segment fixation with and without fusion for thoracolumbar burst fractures. Among radiological results, local kyphosis angle and loss of kyphosis angle correction were taken as the basis. As a result, no radiological or clinical differences were detected between the two groups. The duration of the operation and blood loss were found to be statistically significantly lower in the non-fusion group ($p < 0.05$). In a prospective study by Robertson and Wray, graft donor sites were examined in 106 patients who underwent posterior spinal fusion 3.6, and 12 months after the surgery and it was demonstrated that the pain increased in the first 6 months and tended to decrease afterwards (Robertson and Wray, 2001). Also, in the study by Dai LY et al. (2009), pain was observed but not considered to be a major problem. However, they emphasized that the presence of these findings are irrefutable. Consequently, they reported that posterolateral bone grafting was not necessary when posterior short segment fixation was performed in selected patients (Dennis type B patients with a load sharing score of < 6) (Dai et al., 2009). Radiologically, patients enrolled in this study derived statistically significant benefit in terms of local kyphosis angle and sagittal index correction from posterior instrumentation without fusion. It was observed that postoperative radiological values were maintained with minimal increase ($p > 0.05$) until the final examination. Contrary to the results from the study by Üzümcügil et al. (2009), we found in the present study that only the restoration of anterior column height and functions and conditions of the patients were significantly negatively correlated ($p < 0.05$).

We also found that clinical scores were positively correlated with kyphosis angle and showed a negative linear relationship between clinical scores and sagittal index values, which however did not reach statistical significance ($p > 0.05$).

Conclusion

In this study, we established that non-fusion posterior instrumentation with pedicle screws yielded statistically significant radiological and clinical results in the short and middle-term. Thus, we can eliminate other fusion-related complications that may occur.

Radiologically, statistically significant benefits can be achieved in restoration of the anterior column height by non-fusion surgery. Nonfusion method seems to be effective in terms of achieving stability and sagittal alignment. Several improvements were observed in clinical evaluations after non-fusion surgery. Certain undesirable situations associated with fusion surgery such as increased amount of bleeding and longer disease duration, and donor graft site problems are also eliminated.

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