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A COMPARISON OF SAGITTAL PROFILE OF SPINE IN FOLLOW UP CASES OF THORACOLUMBARAND LUMBAR BURST FRACTURES MANAGED OPERATIVELY VERSUS NON-OPERATIVELY

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ABSTRACT Spinal fractures are less frequent than limb trauma but results in poorest outcomes functionally, in terms of return to work. Management of thoracolumbar spine fractures remains controversial issue. Non-operative management of spinal fractures without neurologic deficits with postural reduction, bed rest with bracing has been proposed. Surgical management involves decompression of spinal cord and nerve roots followed by short-segment posterior stabilization using pedicle screws. The availability of safe and effective surgical stabilization provides effective alternative for many patients who would otherwise require prolonged bed rest. However it is important to remember that bone heals spontaneously and many fractures can be managed non-operatively. One of the limitations of non-operative management is inability to correct the kyphosis and reconstruct the vertebral height. However, most of the studies suggest that there is no correlation between kyphosis and clinical outcome or persistent back ache. In standing position vertebral column is subjected to gravitational forces creating forward bending movements as center of gravity lies ventral to S1 vertebra. Fracture of vertebra will shift the axis of rotation posteriorly at the affected segment increasing bending movements of spine and shortens of the lever arm of muscles and ligaments adding to potential instability. Burst fracture results from compression failure of both anterior and middle columns under axial loads. Key feature of this injury is fracture of posterior vertebral body cortex with retropulsion of bony fragments into spinal canal. It is uncommon for a patient to develop neurological deficit with proper immobilization even in the setting of severe canal stenosis. Usual protocol for thoracolumbar spinal fracture management is based on Thoracolumbar Injury Classification System (TLICS). Preservation or restoration of neutral upright sagittal spinal alignment has become priority in both deformity correction and other spinal surgeries. Sagittal spinal alignment has become an important predictor of a patient's functional outcome after spinal surgery. Proper total spinal sagittal alignment is important to not only maintain balanced standing posture, but also reduce the pain component of quality of life. In this study, we have compared the sagittal spinal parameters in follow up cases of thoracolumbar and lumbar burst fractures managed non-operatively and operatively to draw conclusions regarding mode of treatment.

KEYWORDS : : Kyphosis, Retropulsion, Thoracolumbar, Decompression, Immobilisation, Burst Fracture.

AIMS AND OBJECTIVES

AIM OF THE STUDY

The aim of our study is to compare the sagittal profile of spine in follow up cases of thoracolumbar and lumbar burst fractures treated operatively and non-operatively.

OBJECTIVES

To compare the radiological outcome of patients with thoracolumbar and lumbar burst fractures managed operatively and non-operatively in terms of

1) Kyphotic deformity at fractured level, in terms of local Cobb's angle and kyphotic angle.
2) Restoration of vertebral height, in terms of change in anterior and posterior vertebral body heights.
3) Sagittal parameters of spine and pelvis, viz., lumbar lordosis, thoracic kyphosis, sagittal vertical axis, sacral slope, pelvic tilt and pelvic incidence.

MATERIALS AND METHODS

STUDY DESIGN

A retro-prospective study of patients with thoracolumbar and lumbar burst fractures with or without neurological deficits admitted and treated in Department of Orthopaedics, Kasturba Hospital, Manipal, from September 2014 to September 2016 with a minimum of 1 year follow up. During this period a total number of seventy one cases of thoracolumbar and lumbar burst fractures were treated, out of which eight cases were ASIA – B, twelve cases were ASIA- C and fifty one were ASIA – D.

INCLUSION CRITERIA

An isolated burst fracture in thoracolumbar (D11 to L2) and lumbar spine (L3 to L5) identified in anteroposterior and lateral radiographs and computed tomography (CT) revealing retropulsion of bony fragments into spinal canal.

Patients with TLICS score >4 underwent surgery; patients with TLICS < 4 were managed conservatively and patients with TLICS score 4 were explained both the treatment options. Patients who were not willing for surgery were managed conservatively.

All patients who can stand at the end of 1 year follow up (ASIA D & E) regardless of initial neurological status (ASIA B to D) were included.

EXCLUSION CRITERIA

Patients with complete neurological injury, patients with osteopenic compression fractures and patients with TLICS score >4 but having medical co-morbidities which come in way in management of spine were excluded from the study.

RESULTS AND ANALYSIS

At the end of our study we have followed sixty three patients with minimum of one year follow up.

Demography:

The age group ranged from 17 to 65 years with mean age of 40.85 years. No differences in involvement in age groups.

There are twelve females and fifty one males in our study, showing males are very commonly affected compared to females.

In our study we found, fall from height being the most common cause of thoracolumbar spine injury comprising more than half of the cases, followed by road traffic accidents, we found that L1 vertebra was the most commonly involved level in thoraco lumbar spine injuries.

At the time of presentation, (Table 9) on neurological examination, fifty-one patients were ASIA-D, twelve patients were ASIA-C and eight patients were ASIA-B out of which fifty six patients improved to ASIA-E and seven patients to ASIA-D. Four patients have not improved from ASIA-B and two patients were lost for follow-up.

All patients with TLICS score > 4, those with TLICS score 4 and willing for surgery were managed operatively (N =33), patients with TLICS < 4, those with score 4 and not willing for surgery were managed non-operatively (N=30).

All patients were followed up for minimum of 1 year and radiological parameters were analysed at the end of follow up.

The parameters in the study were randomly distributed in operative and non-operative groups. Both the groups have significant effect on the parameters under study (MANOVA was used to test the effect of groups on variables). Effect of groups on Cobb's angle, local kyphotic angle and vertebral height was significant ($p < 0.001$).

The improvement in Cobb's angle from post injury to final follow up was evaluated using Repeated measures ANOVA between the two groups. The mean Cobb's angle improved from 18± 7 to 7.5±3.8 in operative group, where as in non-operative group it is improved from 14±5.2 to 11±6.4. The rate and amount of improvement in Cobb's angle was significant in operated patients ($p < 0.001$). Operated patients have higher baseline Cobb's angle compared to non-operative patients.

The improvement in local kyphotic angle between the groups was evaluated using repeated measures ANOVA. The mean local kyphotic angle is improved from 15.4±8.5 (post –injury) to 8±5.1 (post surgery); the correction was lost slowly during follow up to reach 11±7.6 at 1year follow up in operative group. In the non-operative group mean local kyphotic angle post injury was 13.6 ±6.3, which was improved to 9.3±4.9 following reduction which was lost progressively during follow up to reach 12.2±6.3 at 1 year follow up. The rate and amount of improvement are significantly higher in operated patients ($p<0.001$) (Figure 1).

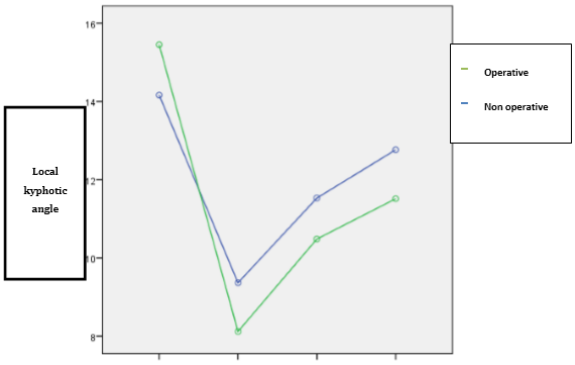

Figure 1: Assessment of local kyphotic angle

The improvement in anterior and posterior vertebral heights in both the groups were analysed and compared using repeated measures ANOVA. The mean anterior vertebral height post injury was 1.8±0.5 cm in operative group and 1.9± 0.3cm in non-operative group. There was significant improvement in anterior vertebral height in operated patients which was maintained throughout the follow up. The amount of improvement of anterior vertebral height is significantly more in operated patients compared to non-operative group ($p<0.001$), whereas there is no significant difference in improvement in posterior vertebra height between the two groups ($p = 0.53$).

We have done paired t-test of samples to analyse the means of Cobb's angle, local kyphotic angle and vertebral height to assess the maintenance of correction from pre-reduction to final follow up. Both the groups have significantly lost the achieved correction of local kyphotic deformity by 6months, which was maintained there after till final follow-up, however vertebral height is significantly better maintained in operative group compared to non-operative group.

Sagittal spinal meters, viz., lumbar lordosis and thoracic kyphosis are restored to near normal in operative group compared to non-operative group. The mean lumbar lordosis of operated group was 51^o± 9^o(normal range - 50^o±10^o) and mean thoracic kyphosis was 39^o± 7^o (nomal range- 41^o±8^o), where as in non-operative group mean lumbar lordosis was 52^o± 10^o and mean thoracic kyphosis was 36^o±5^o. However, stastically there was no significant difference in sagittal spinal parameters between the two groups ($p>0.05$). Sagittal vertical axis (SVA), a vertical plumb line from spinous process of C7 vertebra, which is a determinant of sagittal plane balance of spine, was measured in full length lateral radiograph of spine. Horizontal distance from SVA and postero-superior corner of cranial end plate of S1 vertebra was measured, ± 5mm of distance between these two lines was considered neutral.

In the non-operative group sagittal plane balance was restored to neutral in 37 % cases (N=11), it was negative in 40 % of cases (N=12) and positive in 23% cases (N=07) whereas in operative group sagittal plane balance was restored to neutral in 55% cases (N=18), it was negative in 24% cases (N= 08) and positive in 21% cases (N=07). As SVA is determinant of sagittal plane balance which is used in evaluation of results from surgical procedures and corrections for different spinal disorders, neutral balance of spine was achieved in more cases of operative group compared to non-operative group.

Complications

In our study we have encountered complications like loosening of implant in one patient at 9 months follow-up, which was identified incidentally on radiographic evaluation, he underwent implant removal. One patient had loss of reduction at 6 months follow-up, presented with mild back ache, he was managed conservatively with medication and brace (figures 2, 3); however, none of the patients had neurological deterioration or any other complications at the final follow up.

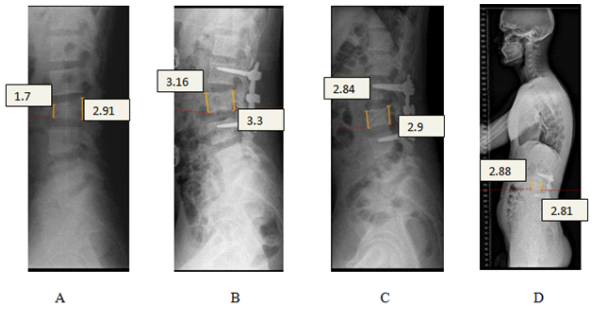

Figure 2: Patient managed operatively: (vertebral heights)

A. Post-injury
B. Post-reduction
C. At 6 months
D. At 1 year

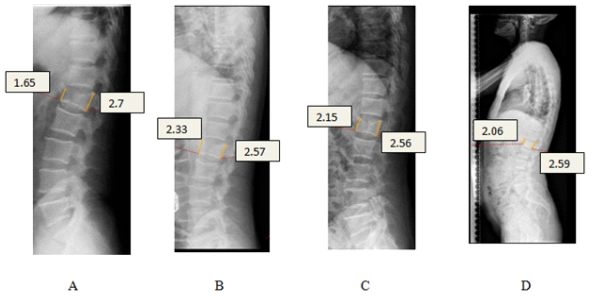

Figure 3: Patient managed non-operatively: (vertebral heights)

A. Post-Injury
B. Post-reduction
C. At 6 months
D. At 1 year

DISCUSSION

Decision making in thoracolumbar burst fractures is still a controversial issue, and evidence from various studies is inconclusive.1 As there is very limited evidence on decision making in treating these injuries, most of the patients are being treated inappropriately and being exposed to inadvertent complications.2 For selecting the treatment method, multiple parameters, like fracture type and stability, degree of canal compromise, injury to posterior ligament complex and neurological status have to be considered.3,4-5

Non-operative management of thoracolumbar spinal fractures have

been advocated even in the presence of kyphotic collapse by some authors,3,6 however few authors have reported that if the spine is left with a deformity after fracture, this will have significant effects on the spinal balance and the vertebral levels above and below.7 The older the patient, the less able the spine will be to compensate, and even in younger patients one would expect the spine to decompensate in later years with consequent disability.

Operative management with indirect reduction without fusion for thoracolumbar spinal injuries have been reported with good results.8,9 The goal of operative management is to decompress the spinal canal and nerve roots, restoration and maintenance of vertebral height and spinal alignment, rigid fixation for early mobilisation and progression of further progression of neurological injury. Increase of vertebral canal after the indirect reduction is averagely less than 20% but may sometimes increase up to 50% depending on situation.[4,10,11]

The mean age of injury was 40.85 years (range 17-65) in our study which is comparable to other studies12,13, males being affected four times more than females. Fall from height was the most common cause of injury followed by road traffic accidents as described in literature. Thoracolumbar transition zone (D11 – L2) was the most affected region with L1 being the most commonly involved level. Most of the patients were neurologically intact at the time of presentation (N =51). In a prospective randomized study by Wood et al2, they have compared the outcomes of surgical and conservative treatment in forty-seven patients with thoracolumbar burst fractures (24 treated surgically and 23 treated conservatively with orthoses). Radiographic analysis showed similar results with respect to kyphosis, mean kyphosis at admission was 12.90 and 17.20 at final follow up. In our study, mean Cobb's angle in operated patients post injury was 180±7.0^{o}and at final follow up was 7.5^{o}±3.8^{o} while in non-operative group, post injury it was 14^{o} ± 5.2^{o} and at final follow up it was 11.0^{o}±6.4^{o}which has shown significantly better improvement of local kyphotic deformity in operated patients.

The average progression of the kyphotic deformity in a study by Avanzi et al14, was 1.80 in a group of 17 patients who were followed for average of 34.7 months. In their retrospective study, Tropiano et al15 assessed 41 patients treated conservatively with hyperextension brace, reported mean initial kyphosis of 3.40 and mean final kyphosis of 4.60, showing mean increase in the deformity of 1.20. In a study by Cantor et al15, after non-operative management of 20 patients with orthoses, have reported 190 initial kyphosis, 200 final kyphosis and 10 mean progression of deformity. Chow et al6, in their case series of 24 patients treated conservatively with cast or orthoses, reported mean progression of deformity of 2.30, with initial kyphosis of 5.30 and final kyphosis of 7.60. In another study by Shen et al16, in their patients treated with orthoses, reported initial kyphosis of 200 and final kyphosis of 240, presenting mean deformity progression of[40.]

A similar result was verified by Mumford et al17, in which the mean deformity progression was 3.870, with initial kyphosis of 16.240 and final kyphosis of 20.120. Even after a long follow-up of up to 41 years, Moller et al18, found results similar to those of other authors, reporting initial kyphosis of 15.40 and final kyphosis of 18.50, evidencing mean deformity progression of 3.10. In comparison, in our study, post reduction mean Cobb's angle in operative group was 8.00 and at final follow up it was 11^{o} whereas in non-operative group, post reduction mean Cobb's angle was 9.3^{o} and at final follow up it was 12.2^{o}. However greater correction was achieved in operative group which is statistically significant compared to non-operative group. Similar results were obtained in terms of local kyphotic angle also. The vertebral body is made up of cancellous and cortical bone. Cortical bone fractures occur first under compression load as the deformity range of cortical bone is less than cancellous bone.6 As the load increases the spongy bone absorbs the pressure by decreasing distance between trabeculae and resulting in decrease in height of cancellous bone and damage to trabecular mesh work. The vertebral height will not reach its maximum size until the external force is balanced. In a study by Youjia Xu et al12, shown no significant difference between vertebral heights (intraoperative and postoperative) after both postural and instrumental reductions, suggesting postural reduction was major reduction force. Other studies by Bernucci et al19 and Roy – Camille et al20 have proven that short segment posterior fixation is useful not only in restoring vertebral height but also maintaining it. In our study, the mean anterior vertebra height post- injury was 1.8±0.5 cm in operative group and 1.9±0.3 cm in non-operative group. Post –reduction the mean height improved to 2.8±0.4 cm in operated group and 2.3±0.4 cm in non-operative group. At the end of final follow up mean anterior vertebral height is 2.7±0.4 cm in operated group and 2.2±0.4 cm in non-operative group, which has shown significant improvement in operated group which is maintained well throughout the follow up. There was no significant difference in improvement of posterior vertebral height in both the groups. Recently, there is increasing recognition of the importance of sagittal spinal alignment for normal function of spine and with reference to its various disease states.21,22-23 There are certain physiological standards for sagittal spinal and pelvic parameters21,24, allowing to plot those values against our group. There are several studies involving volunteers and patients with spinal disorders demonstrating association between sagittal spinal and pelvic parameters with pelvic incidence (PI) being the major determinant of organisation of lumbosacral spine.21,22,23 Tanguay et al25 observed a close relation between lumbar lordosis and sagittal pelvic parameters that was maintained following posterior fusion. An increased sacral slope predisposes to increased lumbar lordosis to maintain the trunk centred over the femoral heads. As in other studies on non-traumatic spinal disorders26,27, loss of lumbar lordosis led to an anterior displacement of sagittal vertical axis (SVA). The equilibrating capabilities of the spine and pelvis to compensate to for post-traumatic kyphotic deformity is sufficient in 55 % of operated cases, while only 37 % of non-operative group were able to attain neutral sagittal balance.

CONCLUSION

Vertebral height was better restored in operative group than in non-operative group. Corrected vertebral height was maintained in operative group during follow-up. Operative group had better correction of local kyphotic deformity compared to non-operative group at immediately after reduction, at 6 months and 12 months follow-up. Kyphotic deformity at 6 months follow-up was statistically increased compared to immediate post-reduction in operated patients. The correction was maintained till 12 months follow-up. Sagittal pelvic and spinal parameters were achieved to normal range at final follow-up in both the groups.

LIMITATIONS OF STUDY

As the sample size is limited and short term follow up was difficult. Another aspect is there no Correlation of radiological and functional outcome and there is a Lack of homogeneity of fracture characteristics in both the groups.

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