Posterior surgical treatment of traumatic and pathological upper thoracic spine lesions

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Purpose
A retrospective case series of 28 patients with upper thoracic spine lesions treated by posterior circumferential decompression fusion procedure was performed.
Patients and methods
The patients were recruited from 2008 and 2011 and divided into three groups: traumatic, pyogenic, and neoplastic. Patients were examined perioperatively and followed up clinically for pain using visual analog scale; sensory and motor deficit using American Spine Injury Association grading; functionality using Oswestry disability index; radiologically using kyphosis correction, loss of correction, and fusion time; and laboratory workup in pyogenic group. Operative time, hospital stay, blood loss, and complications were documented.
Results
Mean follow-up period was 32±5.5 months. Local manifestations were relieved significantly postoperatively. Deformity correction and neurological recovery were significantly improved ($P<0.05$). Solid interbody fusion was evident in 25 cases. Overall, three patients had superficial wound infection and three had intercostal neuralgia.
Conclusion
Posterior circumferential decompression fusion technique is a feasible and effective tool for maintained deformity correction, bony fusion, thecal decompression, and functional improvement.

Keywords:
kyphosis correction, posterior circumferential decompression fusion, upper thoracic spine lesions

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Introduction

Upper thoracic spine (T1–5) region may be affected by neoplastic, infectious, and traumatic disorders with or without kyphotic deformity [1,2]. Narrow thoracic inlets, near brachial plexus, and the supraaortic trunks and parascapular musculature are the main causes of complexity and difficulty in anterior or posterior approaching of upper thoracic segments [3,4]. We discuss our experience with posterior circumferential decompression fusion (PCDF) technique and clinical, laboratory, functional, and radiological outcomes in 28 patients.

Patients and methods

During a 4-year interval between January 2008 and December 2011, 28 patients were enrolled in our hospital who underwent PCDF surgery. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Minia University, Minia. There were 18 (64.3%) males and 10 (35.7%) females. The study was approved by the ethical committee of Al-Minia University. The inclusion criteria were patients who had a histopathologically confirmed diagnosis of pyogenic spondylitis±paravertebral or epidural abscess, neoplastic lesion, and burst fracture ±dislocation in upper thoracic segment with significant progressive destruction, persistent pain, neurological deficit, and deformity (kyphosis>40°). A confirmed diagnosis was made by histological examination of tissue removed at surgery to identify the nature of the lesion. The patients were divided into three groups: group I, traumatic (eight patients); group II, tuberculosis lesion (12 patients), and group III, neoplastic (primary or metastatic) lesion (eight cases). Overall, three cases had primary extraosseous dumbbell cavernous hemangioma, whereas the other five metastatic spinal lesions had the breast, colon, myeloma, liver, lung, and bladder as its origin.

T4 and T5 levels were the most common affected level in all groups (57.1%) [six (21.4%) in group I, six (21.4%) in group II, and four (14.3%) in group III].

The American Spine Injury Association (ASIA) motor index was used for neurological evaluation [25 (89.3%) patients had neurological deficits (A, B, C, and D)]. The kyphosis angle was calculated on lateral spinal radiograph and multidetector computed tomography (MDCT) by modified Konstam's method [5]. MRI was performed to detect epidural abscess in tuberculosis lesions, suspected nature of neoplastic lesion, neural structure state (gliosis, transection, and infiltration of the cord), and integrity of posterior ligamentous complex. Pain was evaluated by visual analog scale (VAS) and functionality using Oswestry disability index, which is valid in Arabic language.

Bone fusion was confirmed by appearance of continuing trabecular pattern of dense cortical bone across the disc space between the vertebral bodies and by Sentinel sign, when a metal cage was used [6]. If there is a difficulty in assessing the trabecular pattern, MDCT scan was performed.

Pyogenic patients were given antibiotics therapy according to culture and sensitivity. Five patients with neoplastic lesion were given radiotherapy after our procedure. All patients were followed up until 32 months.

Operative procedure

The patients laid prone under hypotensive general anesthesia and underwent one-stage spinal-cord decompression, anterior corpectomy from posterior, distraction–compression using pedicular screws, or sometimes lateral mass fixation in cervical 6/7 in T1/2 lesions to prevent proximal junctional kyphosis and correct kyphosis±coronal malalignment with grafting±cage. The anesthesiologist decreased the tidal volume during our procedure and sometimes single lung ventilation was used to decrease lung inflation/deflation to facilitate paravertebral necrotic or neoplastic tissue evacuation, anterior column corpectomy, intracorporal bone grafting, and shortening reconstruction. In the upper thoracic vertebrae, after unilateral or bilateral costotransversectomy with subperiosteal excision of 6–8 cm of more than one rib of the involved vertebral level/levels, and temporary stabilization of one side using a connecting rod, laminectomy of the destroyed vertebra was done, and the opposite-side pedicle was cut to gain access to the diseased vertebral body, and thorough circumferential decompression was completed by doing the same on the other side. Bipolar electrocoagulation is mandatory to control and prevent excessive intraoperative bleeding and minimize blood loss. In neoplastic lesions, the surgical field was bloody and highly vascular, especially in extraosseous cavernous hemangioma and secondary lesions (hepatic carcinoma). Sometimes infiltrative lesion invades the cord and thoracic nerve roots, which may be sacrificed (rhizotomy) by cutting and proline suturing (except T1 nerve root) to prevent leakage, widen working space, and facilitate the decompression reconstruction procedure with concern to the integrity of the spinal cord.

The anterior column defect was measured and reconstructed with titanium mesh cage filled with impacted morselized rib or iliac bone graft, or by resected healthy rib plus tricortical iliac crest graft applied press fit. Rod stabilization was completed after adequate anterior compression and correction. Intraoperative spinal cord monitoring with Stagnara wake-up test was used for patients with no or minimal neurological deficit.

Postoperative regimen

Postoperative plain radiograph (two views) and MDCT were done for all patients to assess alignment, deformity correction, and implant or graft placement. All the patients were given parenteral antibiotics (third-generation cephalosporin) till drain removal (3–5 days after operation). Antibiotics therapy in group II was continued for 3 months until radiological and laboratory improvement. Radiotherapy in group III started after 2–3 weeks until wound healing and followed up by us and the radiotherapist. One or 2 weeks after surgery, the patients were permitted to sit on the bed or walk supported by orthosis; this orthosis support was maintained for 3 months. Passive and active movements of the trunk and lower limb muscles were individualized for every case and supervised by a physiotherapist.

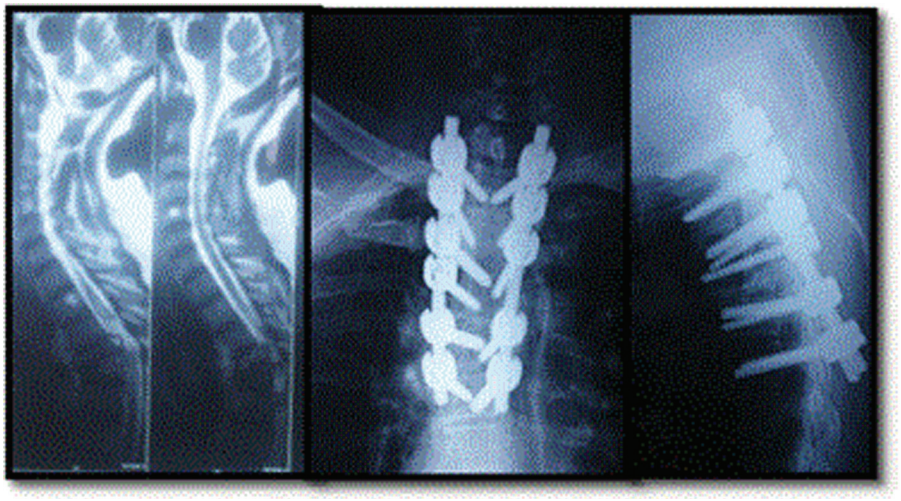
Follow-up

The patients were followed up at 1-month intervals in the first 3 months, 3-month intervals in the next 9 months, 6-month intervals in the second year, and then once a year till the end of follow-up (Figs 1–3). At each follow up, the patients were evaluated clinically, radiologically, functionally, and with laboratory investigations in pyogenic lesions.

Statistical analysis

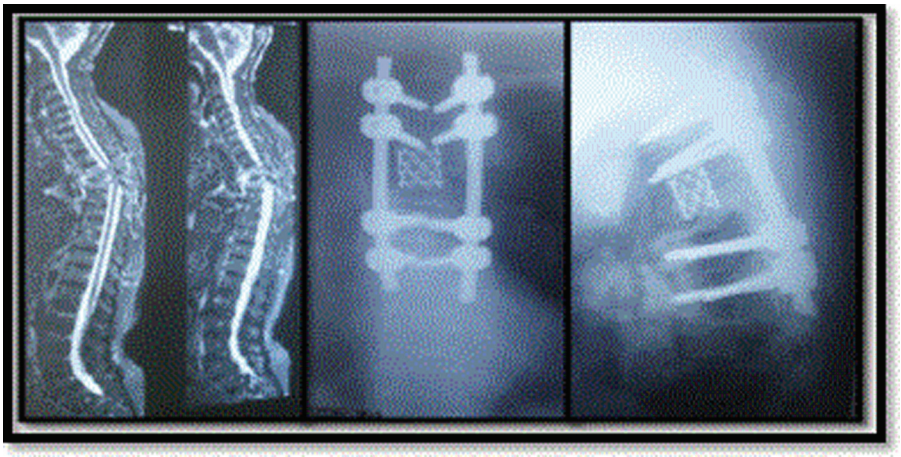
The collected data were coded, tabulated, and statistically analyzed using SPSS (version 20). Descriptive statistics were done for numerical data by mean, SD, and minimum and maximum of the range, whereas categorical data were done by number and percentage. The χ^2 test was used for noncontinuous variables, and Student t test was used to analyze the statistical significance in each group and

Figure 1



(a) MRI finding of a 55-year-old nonwalker male patient (ASIA grade B) with hyperintense signal affecting spinal cord opposite old presented fracture subluxation at T4–5 3 weeks ago. (b and c) 6-month follow-up radiograph after PCDF procedure using pedicular screws fixation with interbody bone grafting. ASIA, American Spine Injury Association; PCDF, posterior circumferential decompression fusion.

Figure 2



(a) MRI finding of a 55-year-old nonwalker female patient (ASIA grade C) with tuberculosis destructive lesion and paravertebral abscess at T3–4. (b and c) Follow-up radiograph after PCDF procedure using pedicular screw fixation with a mesh cage. ASIA, American Spine Injury Association; PCDF, posterior circumferential decompression fusion.

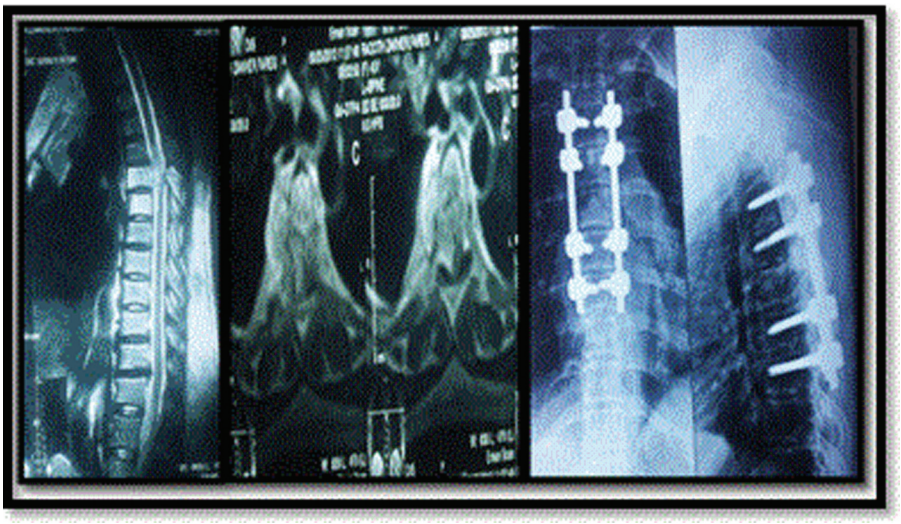
between two groups. One-way analysis of variance and Kruskal–Wallis test was used to compare among the three groups for normally and not normally distributed quantitative data, respectively. The level of significance was set as follows: *P* value less than 0.05 was considered significant, *P* value less than 0.01 was considered highly significant, and *P* value more than 0.05 was considered insignificant.

Results

The mean follow-up period was 32±5.5 (22–40) months. The mean age was 35.5±3.5 (25–55) years. T4 and T5 levels were the most common affected level in 16 (57.1%) patients, T2 and three levels in nine (32.1%) patients and T1 level in three (10.7%) patients. Pyogenic lesion (group II) was found in 12 (42.9%) cases [six (50%) in T4–5, four (33.3%) in T3, one (8.3%) in T2, and one (8.3%) in T1], neoplastic lesion (group III) in eight cases [five (62.5%) in T4–5, one (12.5%) in T3, one (12.5%) in T2, and one (12.5%) in T1] and traumatic disorders (group I) in eight cases [four (50%) in T4–5, two (25%) in T3, one (12.5%) in T2, and one (12.5%) in T1]. A total of 25 (89.3%) cases had neurological deficits owing to affection at different level/levels.

From the five complete paraplegics, 2 cases (group I) improved to grades B and C, one case (group II) improved to grade C, and two cases (group III)

Figure 3



(a, b) MRI finding of a 45-year-old nonwalker female patient (ASIA grade C) with dumbbell extraosseous cavernous hemangioma at T4–5. (c) Follow-up radiograph using pedicular screw fixation with intercorporeal bone grafting. ASIA, American Spine Injury Association.

Table 1 Preoperative, immediate postoperative, and final follow-up state American Spine Injury Association motor index

	Immediate postoperative ASIA index					Final ASIA index (48 months)				
Preoperative ASIA index	A	B	C	D	E	A	B	C	D	E
A (5 cases)	2	2	1	–	–	2	1	2	–	–
B (8 cases)	–	1	5	2	–	–	–	4	2	–
C (5 cases)	–	–	–	1	4	–		1	1	4
D (7 cases)	–	–	1	1	5	–	–	–	1	7
E (3 cases)	–	–	–	–	3	–	–	–	–	3
Total	2	3	7	4	12	2	1	7	4	14

ASIA, American Spine Injury Association.

remain complete paraplegics owing to complete invasion and infiltration. Among all the cases, only one patient in group II had transient deterioration from ASIA D to C, who improved to ASIA E by medical treatment after one and a half month (Table 1). There was a significant difference between preoperative and final ASIA motor index in each group and significant difference between groups I and III and also between II and III in the final follow-up state ($P<0.05$). The percentage of neurological state improvement was better in group II (87.8%) than group III (22.2%) and group I (68.5%). At the final follow-up, the ambulatory status of paraplegics in all cases showed a statistically significant increase from 35.7 to 64.3% ($P<0.05$).

Anterior column was reconstructed with mesh cage filled with morselized bone graft in 20 (71.4%) cases [eight cases in group I, 10 in group II, and two in III] and bone graft either resected healthy rib/laminae, both facets, and transverse process or tricortical iliac bone graft in eight (28.6%) cases [four cases in I, one in II, and three in III].

Erythrocyte sedimentation rate significantly decreased from 160±30 (130–220) preoperatively to a normal level of 20±5 (15–25), and also, C-reactive protein with its titer significantly improved to normal levels within 3–6 months ($P<0.001$) in group II.

Spinal canal compromise showed statistically significant improvement from 85.5±6.74% preoperatively to 18±7% postoperatively ($P=0.001$) in all groups.

In each group, there was a significant difference between preoperative and immediate postoperative and between pre and final kyphotic angle ($P<0.001$), with insignificant difference among all groups in the final kyphotic angle (Table 2).

Mean intraoperative estimated blood loss (EBL) was 850±200 ml (600–1450 ml). Mean operative time was 180±40 min (140–270 min). Mean hospital stay was 3.5±2 day (2–10 days). Mean EBL was more in groups II and III than that in group I, whereas hospital stay and operative time were less in group I than that in groups II and III. There was a significant difference

Table 2 Perioperative outcomes, kyphotic angle correction, visual analog scale, and Oswestry disability index score

Mean±SD	Group I	Group II	Group III	*P* value
EBL (Ml)	900±300	1000±250	1250±300	<0.001*
Hospital stay (day)	3.5±1.5	6.53±2.5	7.5±2	0.000*
Operative time (min)	170±20	180±50	220±50	<0.001*
Preoperative angle	49.5±3.17°	48.5±5.2°	43±2.5°	0.756
Immediate postoperative	11.5±2.34°	10.5±3.2 °	14±3.6°	0.657
Final angle	13±6.4°	13±2.35°	16±2.5°	0.435
% of correction	76.8	78.4	67.4	0324
Loss of correction	1.5±4.1°	3±1.12°	2±1.1°	0.867
Preoperative VAS	7.5±1.2	7.34±0.88	8.4±0.75	0.543
Final VAS	4.5±0.57	1.51±0.5	5.4±0.58	<0.05*
P (Pre versus final) VAS	<0.02*	<0.001*	<0.05*	–
Preoperative ODI	69.5 ±10.5	70±9.5	65±5.5	0.634
Final ODI	25±1.2	15±0.25	25±2.5	<0.05*
P (Pre versus final) ODI	0.05*	0.000*	0.01*	–
Fusion time (months)	13±2.5	10.5±1.5	16±4.5	0.798

EBL, estimated blood loss; ODI, Oswestry disability index; VAS, visual analog scale. *Mean *P* value is significant.

among all groups regarding EBL, operative time, and hospital stay ($P<0.001$) (Table 2).

Computed tomographic scan was done when radiographs were insufficient and needed for five (17.9%) patients for confirmation of fusion, and 25 (89.3%) patients showed fusion at the final follow-up and three (10.7%) cases failed to fuse (two in group III and one in group I).

VAS and Oswestry disability index score significantly improved between preoperative and final follow-up state in each group, with significant difference between groups I and III and also between groups II and III in the final follow-up state ($P<0.05$) (Table 2).

Regarding complications, one case had neurological worsening, which recovered after one and a half month in group II; one case had superficial wound infection, which resolved within 1 month after local debridement in group II; two cases had intercostal neuralgia (one case persistent) after rhizotomy; and one case in group III had intraoperative excessive bleeding owing to uncontrolled epidural veins injury before bipolar electrocoagulation. Two cases showed pleural injury that needed intercostal tube and one cases had cage subsidence that showed radiological loss of correction.

Discussion

Displaced bone/discal fragments and necrotic or neoplastic tissues cause direct cord compression and kyphotic deformity. This requires different surgical procedure, either from anterior or posterior approach [7]. A limited vertebral bodies approach by costotransversectomy was described by Mirnard [8], but Capener [9] modified it by resecting a longer segment of the rib to create a wider operating space on the anterolateral vertebral body surface. Direct ventral approach by a median sternotomy was operated by Cauchoix and Binet [10]. Sundaresan *et al.* [11] demonstrated a direct surgical exposure by partial resection of manubrium and clavicle with low morbidity rate. In our study, the cases were operated by PCDF technique, which involves laminectomy, pediculectomy, and unilateral or bilateral costotransversectomy with 6–8 cm extraperiosteal resection of one or more ribs at the affected level/levels.

The results of group I disagree with the results of Barcelos and Botelho [12], which report 2 cases of upper thoracic injuries, unlike our study, which reported 8 cases owing to increasing incidence of road traffic accidents in our city. EBL, operative time, and postoperative kyphotic angle were elevated in the study by Barcelos and colleagues, whereas longer follow-up period and higher correction angle were seen in group I of this study (Table 3).

The results of group II of our study were convergent with the results of Zeng *et al.* [14], concerning that operative time, blood loss, correction angle, fusion time, and loss of correction were increased in our study owing to extensive PCDF procedure, but the study by Zeng and colleagues had relatively higher postoperative kyphotic angle and longer follow-up and hospital stay than our study (Table 3).

Group III outcomes of our study were relatively compatible with those of Jandial and Chen [13], where operative time, EBL, and hospital stay were

Table 3 Results of Barcelos and Botelho [12]

	Barcelos and Botelho [12]	Zeng *et al*. [14]	Jandial and Chen [13]
Number of cases	2	34	9
Operative time (min)	360	152.1±24.4	250±30
Blood loss (ml)	986	650.7±150.2	1350±550
Hospital stay (days)	Not evaluated	12.4±4.1	7.8 (4–15)
Postoperative kyphotic (deg.)	16	16.9±3.1	Not evaluated
Follow-up (months)	20	40.6±3.6	14 (4–30)
Angle of correction (deg.)	16	25.1±6.2	Not evaluated
Final VAS	Not evaluated	1.1±0.8	Not evaluated
Fusion time (months)	Not evaluated	8.1±1.5	Not evaluated
Loss of correction (deg.)	Not evaluated	1.5±0.6	Not evaluated

VAS, visual analog scale.

slightly declined but follow-up period was longer in the current study. However, postoperative kyphotic angle, angle of correction, loss of correction, fusion time, and final VAS score were not evaluated by the study by Jandial and Chen (Table 3).

On comparing the three groups of our study, it was found that neurological, ambulatory, and functional outcomes significantly improved in group II than other groups owing to malignant infiltration of the spinal cord in group II and late presentation with deteriorated ASIA index and transection of the cord in group I. Operative time, EBL, and hospital stay were significantly increased in group III than other groups owing to high vascularity of the neoplastic lesions, especially metastatic and hemangiomatous tumors, lack of preoperative arterial embolization, and the need to specific postoperative intensive care unit which lengthen the hospital stay. Percentage of kyphotic correction was higher in groups II and I than III, whereas loss of correction was higher in group II than groups III and I. Fusion was greater in group II (100%) than I (87.5%) and group II (75%), and fusion time was late in group III owing to radio-necrosis delaying healing and faster in group II owing to tendency of healing in tuberculosis lesions.

Conclusion

Three-column correction stabilization surgery could be successfully obtained by PCDF technique. This procedure attained good results for maintained deformity correction, bony fusion, spinal cord decompression, and neurological improvement. Favorable outcomes were obtained more in pyogenic and traumatic than neoplastic disorders owing to neural infiltration.

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Conflicts of interest

There are no conflicts of interest.

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