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Research Article

Ministerntomy to attack Upper Thoracic Lesions

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Abstract
Background: Surgical intervention and access to the upper dorsal vertebrae through the anterior approach is difficult due to the anatomy of the region and the structures surrounding the upper dorsal spine, we go into precise detail about the mini-sternotomy approach in treating traumatic, infectious, and metastatic upper Dorsal vertebral body pathologies. **Aim of the work:** our experience in using the mini-sternal approach in treatment of anterior upper dorsal pathologies. **Patients and methods:** This is a retrospective study on 10 patients with dorsal myelopathies due to traumatic, infection and metastases with D1 to D4 vertebral body involvement from 2018 treated with a mini-sternal approach in Minia university hospital. **Results:** Follow up was for 12 months in mean. Frankel grade was used to assess patients after operation and showed improvement in 70% of cases while 30% showed no improvement. Mean operative time was 110 minutes and no intraoperative complications were encountered. **Conclusion:** Infectious, metastatic, and traumatic lesions involving the anterior high dorsal spine can be treated safely with the mini transsternal approach, which is also the only one that allows for early and precise exposure of the anterior dura. With great functional patient outcomes, this approach has a greater accessibility to the cervicodorsal region with lesser anatomical limitations than other approaches and provides enough space for the best restoration and maintenance of the alignment of the cervico-dorsal region.

Keywords: ministernotomy, upper thoracic lesions, dorsal discitis, transsternal approach

Introduction
Upper dorsal vertebral pathologies are a range of disorders that can impact the upper dorsal spine, usually from the first thoracic vertebra (T1) to about the sixth or seventh thoracic vertebra (T6 or T7). These diseases might have many causes, symptoms, and treatment methods. Pathologies of the upper thoracic spine may be caused by different etiologies such as traumatic, infectious, degenerative, neoplastic and inflammatory [1,2].

Treatment for upper dorsal spinal diseases differs according on the underlying condition, severity, and related symptoms. Treatment options may include conservative methods such as medicines, physical therapy, and bracing, minimally invasive therapies like injections and vertebroplasty, or surgical procedures with various approaches including the posterior standard approach and anterior approaches [4].

Tumors, infection, disc pathologies, traumatic injuries, and severe kyphosis can all affect the anterior aspect of the dorsal spine. [5-7]
Anatomical restrictions, such as the aortic trunk and the change from cervical lordosis to dorsal kyphosis, have historically made it difficult to access the cervicodorsal junction and the upper dorsal spine [8–10].

To effectively treat pathologies of the upper dorsal spine and achieve adequate decompression through the anterior approach, discectomy with or without total or subtotal corpectomy should be done and the anterior

thecal sac must be properly visualized, to avoid injuries to the spinal cord and other complications that may result from improper visualization. [8, 9 ,14 -18].

In this study we provide our experience in treatment of various diseases affecting the anterior upper thoracic spine using the mini-sternotomy approach. By using the mini-sternotomy approach excellent visualization and access to the upper dorsal spine anteriorly is gained, which helps in maintaining stability and ensuring better neurological outcome.

Materials and Methods

From May 2018 to May 2021, 10 patients were admitted to Minia university hospital with affection of the upper dorsal spine from D1 to D4 with different pathologies and were treated using the mini-sternotomy approach.

All patients were presented with Dorsal myelopathy, The Frankel scoring system was used to grade the neurological status. Preoperative assessment, MRI spine and 3D CT scans were done.

All patients were anesthetized using General anesthesia with endotracheal tube. A midline linear incision was done at the upper sternum extending to the lower part of the neck along the medial border of the right sternomastoid muscle. The platysma muscle was cut, dissection was done to reach the pre-cervical and pre-tracheal fascia, The fascia were dissected, The sternal portion of the sternomastoid was then dissected from deep tissues. The upper portion of the manubrium was freed of the sub-hyoid muscle insertion. a rib retractor was placed after an inverted T-shaped mini-sternotomy down to the third rib was done. a plane between the esophagus and trachea medially and the carotid sheath laterally, was dissected and entered. A window of the brachiocephalic artery, bounded medially by the tracheoesophageal sheath and laterally by the brachiocephalic and common carotid arteries, was specifically used to gain access to the prevertebral space. Depending on the level of interest, vertebral bodies to D4 level could be widely exposed.

Intraoperative imaging in this region may be difficult so it is better to mark a lower cervical vertebra and start counting from it after exposing the upper dorsal vertebral bodies, also it is better to mark nearby landmarks in normal segments to identify the midline and lateral boundaries.

The neurosurgical microscope is brought up. Standard spinal microsurgery equipment is utilised. With a number 11 scalpel, the disc is cut from medial to lateral to reveal the Luschka joints and then discectomy is done to reveal the posterior longitudinal ligament (PLL). in cases where vertebretomy is indicated, Prior to corpectomy, the discectomy is performed above and below each vertebra for early exposure of the dura.

The corpectomy is made in a rectangle design to achieve appropriate decompression and graft recipient site. The PLL is gently removed after that, and the degree of decompression is determined by gently sliding the blunt nerve hook between upper and lower vertebral bodies. For appropriate fusion, the subchondral cortical bone must be preserved when the cartilaginous endplate is excised, and the endplates must be parallel.

Suction drains are used to close the wound. To prevent pseudarthrosis of the sternum, which would have required additional surgery, the sternum is closed with steel wires. The skin is then closed after restoring the soft tissue anatomy.

Results

There were no documented intraoperative complications. The typical surgery lasted 110 minutes (100–160 minutes). Intraoperative bleeding ranged from 250 to 550 mL (average: 320 mL), and it was caused more by the pathology being treated than by the surgical technique. In fact, during the approach phase, there was always a slight blood loss, mostly less than 150 ml. Ordinary transsternal approach would not have afforded greater space to access the anterior cervicodorsal junction since the great vessels were restricting the approach's lower extension not the sternal opening. No dural tears or CSF leaks were found.

In the postoperative period, good pain control was evident in all patients, with only 2 patients experiencing intercostal pain that improved by medication.

Table 1: preoperative and post operative Frankel grading scale among the studied group

It's noteworthy that none of the patients' neurological status deteriorated postoperatively. No patients experienced any wound complications. With a mean follow-up time of 12 months, follow-up was obtained for every patient (range 6-18 months). At the one year follow up, 3 (60%) of the 5 patients with grade D improved from grade D to E on the Frankel grading system , 1 of the 3 patients with grade C improved to grade E ,while another one improved from grade C to grade D and the 2 patients with grade B improved to grade D at the end of the 1st year follow up, with a total improvement percentage of 70% as shown in table (1).

Patient No	Pre-operative	Postoperative	Percent of change
1	B	E	**70%**
2	D	E	
3	D	E	
4	C	D	
5	B	D	
6	D	D	
7	D	D	
8	D	E	
9	C	C	
10	C	D	

Despite the fact that 3 patients (30%) 2 with grade D and one with grade C did not improve in Frankel grading postoperatively, they showed satisfaction due to relief of their back pain and no worsening of their neurological status happened. Each case received repeated radiographs and CT scans to verify the instrumentation's stability. There was no discernible difference in spinal alignment between the early postoperative condition and follow-up. None of the patients displayed any evidence of instrument failure or migration.

Case Illustration: Spine Metastases [fig 1-8]

A 65-year-old male was admitted with urinary retention needing catheterization. He suffered interscapular discomfort and pain for two months, bilateral upper limb numbness and pain for two weeks, and lower limb weakness for two weeks. He had no noteworthy medical background. D2 sensory level was found and quadriparesis (grip 3/5, right lower limb 3/5, left lower limb 2/5). The catheter could be felt by him. D2 vertebral collapse and cord compression were visible on MRI (Figures 1-3). D2 corpectomy through a mini transsternal approach. An anterior titanium plate was positioned from D1 to D3 for maintaining stability after insertion of a mesh cage filled with a bone graft (figures 4-8).

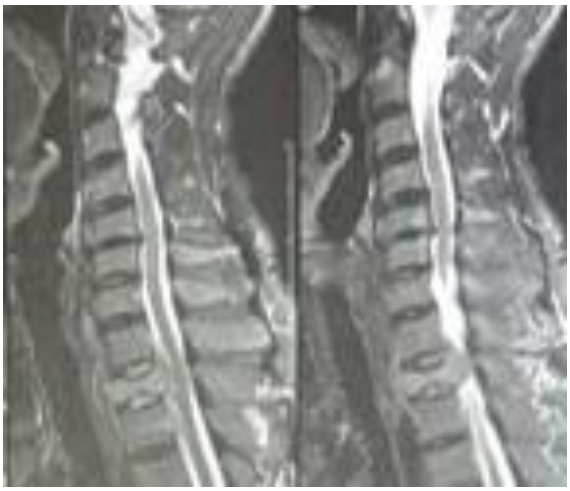

Fig. (1): STIR saggital image showing second thoracic vertebral pathological fracture

Fig. (2): T2 saggital image showing second thoracic vertebra pathological fracture

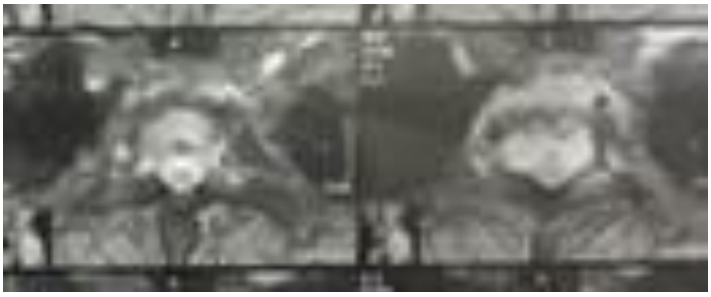

Fig. (3): T2 axial image showing pathgological fracture of second thoracic vertebra compressing the cord

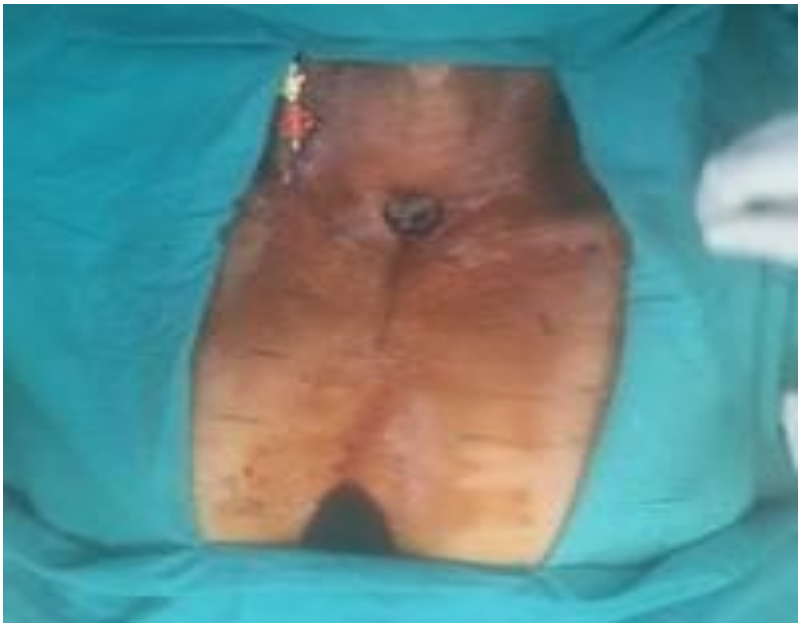

Fig. (4): preop preparation and planning of skin incision

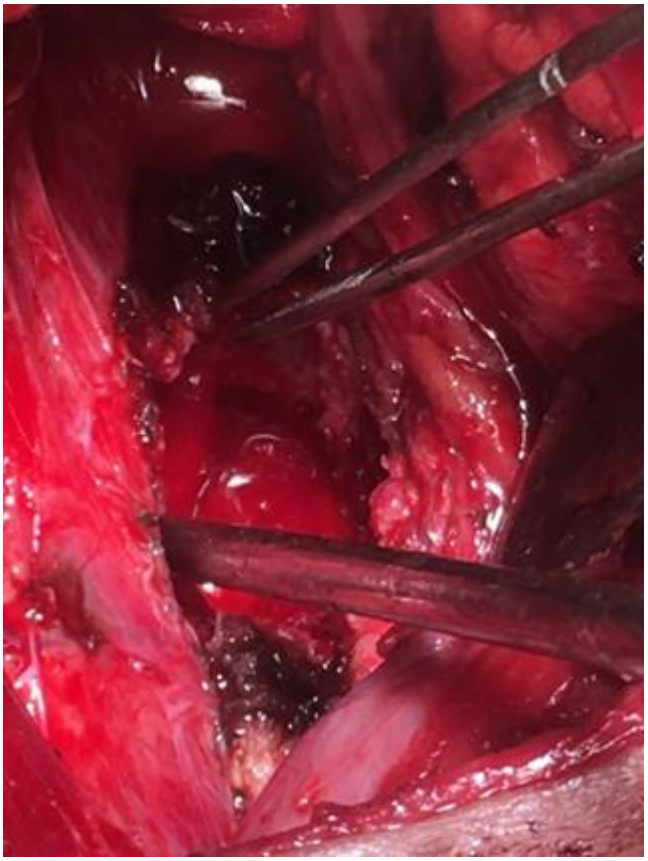

Fig. (5): Intraoperative Image

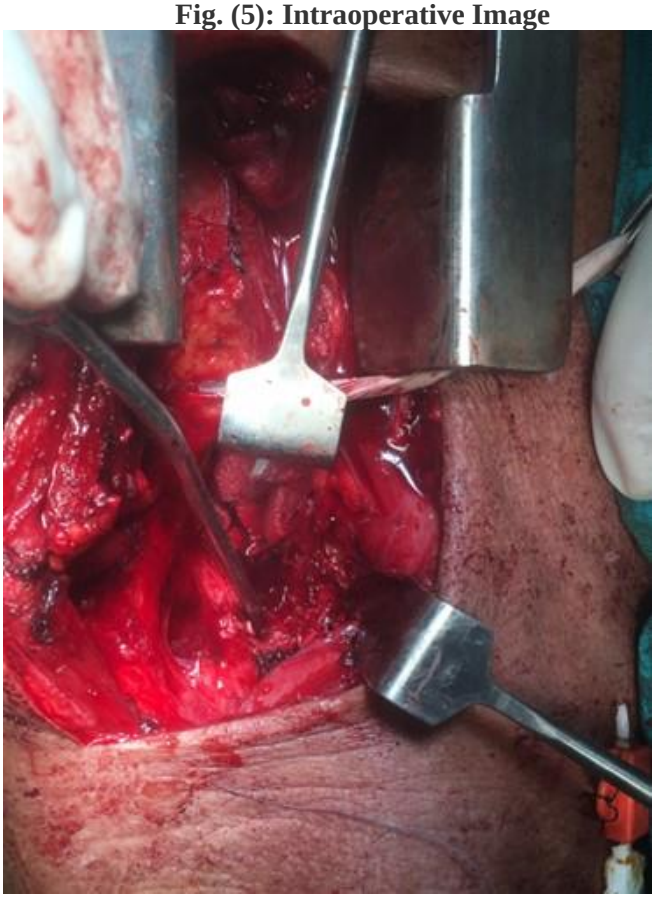

Fig. (6): Intraoperative Image Showing Corpectomy Of T2 Vertebra

Fig. (7): Intraoperative Image Showing Plate And Pyra Mesh Fixation

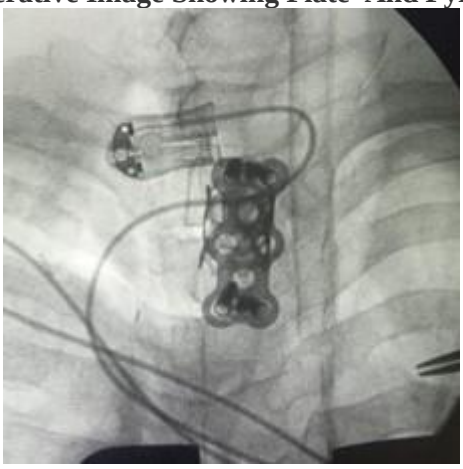

Fig. (8): Postoperative Xray Image Ap View Showing Plate and Pyra Mesh Fixation of T1 To T3 Vertebra

Discussion

There is significant evidence to support the usefulness of the anterior approach in providing improved visualization and results for vertebral body lesions. However, due to anatomical constraints, access to T1-T4 through the anterior approach is anticipated to be the most difficult [7, 9, 11-15, 19].

Pott's disease was historically the focus of many early surgical efforts,[6,7,20] but similar concepts were later used to manage primary and metastatic tumors, pathological fracture-dislocation causing direct posterior displacement of bone fragments, disc herniations, and severe kyphotic deformities with anterior cord compression. [1-9, 21]

Mirnard performed a costotransversectomy in 1894 in order to gain limited access to the

vertebral bodies[20].
Capener modified this procedure in 1954 by resecting a longer rib segment in order to allow an anterolateral spinal cord decompression. [22].

A median sternotomy direct approach to the cervicothoracic region was described by Cauchoix and Binet in 1957 [23]. Unfortunately, The transsternal approach was discontinued for more than 20 years after Hodgson et al. in 1960 [4] reported 40% intraoperative mortality in their study using the direct anterior access, advocating abandoning direct anterior exposure. Then, in 1984 [7], Sundaresan et al. showed that a direct surgical approach to the upper dorsal spine was technically feasible by performing a partial resection of the manubrium and clavicle. They also demonstrated low morbidity rate in their study. All patients postoperative outcomes were generally benign and comparable to those of patients having disc excision surgery using the Cloward or Robinson and Smith techniques.

The ventricle aspect of the spinal cord is decompressed indirectly with posterior, posterolateral, and anterolateral exposures, which raises the possibility of neurological damage. marked muscle dissection and rib resection are particularly necessary for dorsal lateral approaches from D1 to D4, which results in high morbidity. [24]

Because of the obliquity of the access, a cervical approach is not sufficient for effective decompression of the spinal cord below D1 nor does it allow good bone grafting. [21]
Anterior approaches, on the other hand, gives good exposure to the compressing elements and thus allowing adequate decompression to be done without harming neural structures. Furthermore, wide decompression can be easily done with grafting and fixation.

Because the heart and great vessels restrict the extending the exposure caudally, a full sternotomy is not required. A direct path to the T3 vertebra is provided by the transmanubrial transclavicular approach, which also offers autologous bone with no need for distant site bone grafting. A modified transmanubrial approach without clavicle resection was recently described by Xiao et al., in which sternotomy is done up to 2 cm below the sternal angle.

As a partial sternotomy is required, it cannot be regarded as a pure transmanubrial approach. To reach D3 to D5 using this technique you have to pass through the right space of the brachiocephalic trunk with an appropriate working angle. [16]

Our series demonstrates the technique's low morbidity rate as well as the feasibility of reaching the upper dorsal spine using the direct approach through a ministernotomy. In the Frankel scale, 70% of our patients showed a significant neurological improvement. Notably, none of the patients had any postoperative neurological decline. This is primarily because the dural sac can be seen clearly and early during surgery thanks to the direct surgical view of the anterior part of the theca. Moreover As shown in our series, it was simple to reconstruct the cervicothoracic junction due to better accessibility to the anterior column of the vertebral column, preserving neurological integrity, stability by instrumentation, relieving pain, maintaining alignment without deformity, and allowing for early mobilization.

We believe that the mini sternotomy approach to the upper dorsal spine can be used in treating various pathologies involving the anterior column of the spine and causing compression on the spinal cord for example; primary and metastatic tumors, pathologic fractures causing ventral compression, central or posterolateral disc herniations, infectious diseases like T.B involving the anterior column of the spine and marked kyphotic deformities causing anterior spinal cord compression.

Conclusions

The mini transternal technique is an effective and safe technique for addressing infective, metastatic, traumatic, and degenerative lesions that impact the anterior high dorsal spine. It is the only route that enables an early and direct visualisation of the anterior theca. This method effectively addresses the physical limitations of this area and allows for sufficient space to provide appropriate restoration and maintenance of spinal alignment in the cervicothoracic transition zone, resulting in

favorable functional and clinical outcomes for the patient.

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