Review Article

Surgical management of posttraumatic thoracolumbar Kyphosis: A review

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Abstract

Kyphosis is a condition in which there is a curvature of the spine that causes a bowing of the back, which in turn leads to slouching posture or hunchback. There are several types of Kyphosis, including posttraumatic Kyphosis, which usually occurs in the thoracic region. There are several techniques used for the surgical management of posttraumatic thoracolumbar Kyphosis. We aimed to discuss the surgical treatment of posttraumatic thoracolumbar Kyphosis. We searched for articles included in this review through scientific websites using different keywords. The articles were chosen based on inclusion criteria. The articles included in this review were published between 2006 and 2018. The review was written under titles in the discussion part. The outcome of the surgical management of posttraumatic thoracolumbar Kyphosis depends on the accurate selection of the proper surgical approach.

Keywords: Outcome, posttraumatic, surgical management, thoracolumbar Kyphosis

Introduction

Kyphosis is a term that describes the curvature of the spine that results in an abnormally rounded back, and it may occur at any age.[1] Thoracolumbar fractures are the most common spinal fractures, and their management remains controversial.[2,3] Inadequately treated or untreated thoracolumbar spinal injuries can result in posttraumatic Kyphosis (PTK).[4] PTK can lead to different changes such as spinal instability, disc degeneration, and spinal canal stenosis with neurological insult development.[5] Physical therapy for mild PTK may be useful in relieving pain and discomfort, whereas in severe cases, surgical intervention can be mandatory. The management of PTK is challenging, and there is no treatment plan.[6] Surgical management is indicated in patients with deteriorating neurological status or those with back pain with a sagittal index of 20 degrees as the cutoff for the surgical treatment.[7,8] The surgical procedures for correcting thoracolumbar PTK have been described since 1945. This review aims to overview thoracolumbar PTK and discuss its surgical management.

Materials and Methods

We searched for scientific articles to write this review by searching for articles related to our subject through the Google Scholar website. Several keywords were used for the search process to obtain articles related to our subject, including Kyphosis, surgical management, surgical intervention, thoracolumbar Kyphosis, and posttraumatic Kyphosis. We reviewed all the obtained articles and excluded irrelevant articles, duplicated articles, and articles discussing other irrelevant points such as conservative treatment. The articles included to write this review were published between 2006 and 2018.

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Discussion

Kyphosis

During life, the sagittal alignment of the spine always changes. The spine remains in the kyphotic posture, extending from the occipital to the sacrum at birth. Whereas when the individual starts standing in the upright posture, lordosis occurs in the lumbar region, then Kyphosis occurs in the thoracic region.[1] The mean angle of Kyphosis was reported by Bernhardt *et al.* to range from 9 to 53 degrees measured from the level above T3 and the one below T12.[9] In contrast, Stagnara *et al.*[10] reported that the angle of Kyphosis ranges from 30-50 degrees and is measured from the posterior endplate of T4 and the inferior endplate of L1. It was stated that the normal range of thoracic Kyphosis is 10-40 degrees.[11] Thoracic Kyphosis is more prevalent among males compared to females (9.6%).[12] Thoracolumbar Kyphosis has a greater impact on sagittal balance compared to that of thoracic Kyphosis.[13]

Etiology of Kyphosis

The pathophysiology and etiology of Kyphosis are not exactly known. However, there are several factors that can cause Kyphosis, including trauma, degenerative, inflammatory, and infectious diseases. Neurological diseases such as cerebral palsy, neurofibromatosis, and macular diseases such as muscular atrophy also can cause Kyphosis.

Classification of Kyphosis

Kyphosis has had several classifications over the years; one classification is dependent on the pathological diagnosis, and the other classification is based on the structural abnormalities shown on radiographs [Table 1].[11]

Table 1: Classification of Kyphosis

Pathophysiologic classification	Morphological classification
1. Congenital	-Pure Kyphosis
Defects of segmentation	-Kyphosis with vertebral subluxation
Defects of formation	-Angular Kyphosis-severe types
Fixed	(Kyphosis with rotary subluxation
2. Developmental	and hairpin Kyphosis)
Scheuermann's Kyphosis	
Developmental round back	
Spondylolisthesis	
3. Inflammatory	
Infective (pyogenic, tuberculosis)	
4. Metabolic	
Osteoporosis	
Osteomalacia	
5. Posttraumatic	
6. Tumor	
Metastatic	
Neurofibromatosis	
Other	
7. Chondrodystrophic	
Achondroplastic dwarf	
Mucopolysaccharidoses	
Spondylo-epiphyseal dysplasia	
8. Latrogenic	
Postlaminectomy	
Postirradiation	

Thoracolumbar Kyphosis and thoracic Kyphosis have been associated with pathologic entities such as Scheuermann disease, where Scheuermann Kyphosis usually occurs in the thoracic region.[1,14] Posttraumatic conditions, congenital vertebral malformation, inflammatory conditions, and paralytic conditions.[11]

Although the classification scheme showed or described the associated pathology and underlying structural etiology of the deformity, it does not help in the surgical treatment plan.[11]

Posttraumatic Kyphosis

Posttraumatic Kyphosis usually occurs at the thoracolumbar junction. This type of Kyphosis occurs after surgery and spinal trauma.[15,16] Late posttraumatic Kyphosis is observed after spinal fractures.[17]

The symptoms of posttraumatic Kyphosis are variable and depend on several factors, of which individual nociceptive sensitivity is not the least. Several factors contribute to poor tolerance, including the level and severity of the deformity, angular deformity, canal or neuroforamen compromise with or without peripheral symptoms, disc degeneration, focal instability, and nonunion. In case of a failed previous surgical treatment to restore the normal anatomy, less tolerated posttraumatic Kyphosis is expected.[18]

The surgical treatment of posttraumatic Kyphosis

The surgery is indicated for symptomatic patients with thoracolumbar Kyphosis exceeding 65 degrees and thoracic Kyphosis exceeding 80 degrees.[12,19] The surgical indications for posttraumatic Kyphosis are pain and progressive neurological deficit with a posttraumatic deformity exceeding 20 degrees of sagittal index.[1,17] The surgery can also be considered for posttraumatic deformity in case of increasing back pain, breakdown of levels below or above the deformity, pseudarthrosis or malunion, radiculopathy, or increasing neurological deficit.[20]

The surgical correction of posttraumatic deformity improves the pain of the patients.[21,22] A significant reduction among the majority of posttraumatic patients has been reported as a result of correction after spinal osteotomy,[32] and after anterior stabilization with instrumentation and decompression for late traumatic Kyphosis.[24] Also, Bohman *et al.*[25] revealed that chronic pain was improved among patients after late anterior decompression of thoracolumbar fractures with canal compromise.

It is necessary to evaluate the overall sagittal counters and alignment as well as the focal deformity. The correction of the focal deformity is important as it can affect the overall sagittal balance; patients with focal Kyphosis of 30 degrees or greater

have an increased risk of chronic pain in the region of focal Kyphosis deformity.[26-28]

The treatment goal of surgical management of posttraumatic Kyphosis is to remove the neurological compression, restore the function by a sagittal balance returning to the normal range, allowing a straight standing position with no muscular efforts, straight vision, and relieve the pain related to the curvature above and below the deformity.[1,17]

Several approaches are available; posterior, anterior, or both can be performed for surgical management.[1] The combined interventions can be preferred, and it is possible in a single session to achieve the sagittal balance by choosing appropriate osteotomies. Osteotomy was revealed to be a better alternative.[29] The choice of intervention should be based on the situation of the patient. The optimal types of equipment as well as an experienced team including surgeons and anesthetists are required.[17] Other clinical situations should be considered for the surgical plan, including an acute or subacute case of unstable posttraumatic Kyphosis, late, and fixed posttraumatic Kyphosis with no previous surgery, the presence of pathological fractures, and posttraumatic Kyphosis with a previous history of surgery.[17] Once the suitable approach is selected, it should be focused on the main goal of surgery which involves decompression if there is symptomatic stenosis.[20,23]

One study reported neither of the two approaches (anterior and posterior) was superior to the other.[30] Other studies.[15,31] reported that the anterior approach resulted in easier neural decompression and easier correction of the deformity. Posterior intervention is mandatory in the case of previous posterior surgery.[17]

The surgical approaches for the management

Anterior approach

It is a minimally invasive intervention performed through an incision of 7-12 cm with a muscle-splitting technique; it results in minimal morbidity. Caution should be considered when using a powerful distractor to obtain correction via the anterior approach to avoid fracture or impaction of the adjacent vertebral bodies.[17] Once the spine has been localized and the correction of the deformity occurs, there should be no recoil into the deformed situation. The osteosynthesis should not be for providing reduction; it should be only constricted only for compression in the osteotomy site. The reduction in the construct should be minimum.[17] Anterior reconstruction is performed with a segmental femoral allograft cut to fit exactly the defect; allografts fill its medullary cavity.[32]

It seems that the anterior approach is not obligatory when performing surgery for an increasing neurological deficit; however, it is necessary to perform a thorough decompression of the neural elements and remove all the bone from the posterior vertebral body that is impinging on the spinal cord.[20]

The morphological outcomes of this intervention are reliable when a correction of 50-70% of the initial deformity has been informed to the patient. It is difficult to predict neurological recovery in case of preexisting neurological deficit. It is more difficult to predict the pain relief of the patient. However, almost 60-70% of the patient considerably improved.[17]

This procedure is contraindicated in case of greater age as it is a negative prognostic factor. Minor deformity with severe unexplained pain is the major contraindication.[17]

Greater neurological recovery has been demonstrated after the anterior procedure in the setting of an incomplete deficit compared to posterolateral procedures, even as late as two years after experiencing the injury.[33-36] In contrast to the previous findings, a literature review stated that it would appear that partial neurological deficits have the potential to resolve regardless of the approach used.[37]

Posterior approach

This intervention involves the fusion and insertion of anchoring implants, which can be hooks or screws. The instrumented number of levels is dependent on the extent of instability induced to permit the correction of the deformity. If the anterior and posterior ligaments must be incised, it is preferable to include four levels; two levels above and two levels below the osteotomy. In the case of a thoracic side of a thoracolumbar junction deformity and thoracic spine, three pairs of anchoring points are preferred and should be used if it does not interfere or interferes less with mobility.[17]

The soft tissue encircling the spinal canal and the vertebrae must be released carefully before correcting the deformity. It is necessary to prevent compression on the nerve roots and impingement of the dural sac at the osteotomy site during the correction.[17]

After the insertion of the implants and complete release of the soft tissues occurs, osteotomy corpectomy, or discectomy can be performed. A temporary rod contoured to shape the deformity should be inserted if major instability is expected to temporarily stabilize the spine. The deformity correction should be obtained by external maneuvers, by the mobilization of the operating table or the patient. The correction of the deformity by acting on the anchoring implants should be carried out only through rods connecting several anchoring points on each side of the osteotomy.[17]

Posterior vertebral column resection in severe posttraumatic thoracolumbar Kyphosis resulted in satisfactory correction and improvement in the functional outcome.[5]

Osteotomy

The most common osteotomies are pedicle subtraction osteotomies (PSOs) and Smith-Petersen osteotomies (SPOs). Both SPO and PSO can be used for the treatment of sharp angular posttraumatic Kyphosis and minor sagittal imbalance when the deformity is present in the thoracic spine.[20]

PSO was first described by Thomasen, who first published the description of transpedicular cortical decancellation osteotomy, which is now indicated as PSO.[38] Performing PSO involves the removal of all the posterior elements at the level of planned correction.[39] This involves the lamina, spinous process, and inferior and superior facets that are adjacent to the pedicle. The pedicle is then taken down, and decancellating of the vertebral body is performed. This is followed by the removal of the lateral and posterior vertebral body walls in the shape of the closing wedge in the eggshell modification.[39,40] Then, the spine is hyperextended, hinging on the anterior margin of the vertebral body. Further correction and decompression can be obtained using compression techniques across the instrumentation in the posterior column. However, caution should be taken at each step of compression and correction to ensure the neural elements are not compressed.[21,22,39,41,42]

PSO has several advantages over PSO, although PSO is associated with increased blood loss. PSO can correct the segmental Kyphosis with no lengthening of the anterior column, whereas SPO has an axis of correction through the posterior margin of the vertebral body that leads to lengthening the anterior column.[20]

SPO is the posterior chevron osteotomy that was described for the first time for the treatment of kyphotic deformities in 1945.[43] This approach shortens the posterior column at the desired level by resecting the posterior elements. Posterior compression is used across the segments with sagittal correction through the closure of the posterior column. The complications associated with SPOs include rare traction injuries to vessels leading to death and reports of superior mesenteric artery syndrome.[44-49]

Single or multiple SPOs should be indicated when the patient suffers s smooth posttraumatic deformity in the thoracic or lumbar spine. SPOs are also used routinely for sharp angular posttraumatic Kyphosis in the thoracic spine.[20]

Conclusion

The surgeon needs to understand the magnitude and flexibility of the deformity to develop a surgical treatment plan. There are many surgical approaches for the treatment of posttraumatic thoracolumbar Kyphosis. Choosing a surgical approach is dependent on the conditions and the case of the patients. An appropriate selection of a treatment approach results in a good outcome, including pain relief and functional outcomes with the removal of the deformity. The surgical correction of posttraumatic Kyphosis in well-selected patients is a beneficial and rewarding procedure for patients with a low rate of significant lasting complications.

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Conflicts of interest

There are no conflicts of interest.

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