Late treatment of tuberculosis-associated kyphosis: literature review and experience from a SRS-GOP site

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Abstract

Introduction Spinal tuberculosis (TB) accounts for approximately half of all cases of musculoskeletal tuberculosis. Kyphosis is the rule in spinal tuberculosis and has potential detrimental effects on both the spinal cord and pulmonary function. Late-onset paraplegia is best avoided with the surgical correction of severe kyphosis, where at the same time anterior decompression of the cord is

performed and the remnants of the tuberculosis-destroyed vertebral bodies are excised.

Material and methods Review of the literature on late surgical treatment of TB-associated kyphosis; description and comparative analysis of the different surgical techniques.

Results Kyphosis can be corrected either at the acute stage or at the healed late stage of tuberculous infection. In the late stage, the stiffness of the spine and chronic lung disease are additional considerations for the surgical approach and technique. Contrary to the traditional anterior transpleural approach used in the acute spinal tuberculosis infection, extrapleural approaches, either antero-lateral or direct posterior, are favored in late treatment.

Conclusion The correction of deformity is only feasible with three-column osteotomies, and posterior vertebral column resection (PVCR) is the treatment of choice in extreme kyphosis. The prognosis of the neurologic deficit (late paraplegia) is dependent on the extent of gliosis of the spinal cord.

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The incidence of tuberculosis is on the rise in both the developed and the developing world [1–3]. More than 30 million people suffer from overt tuberculosis and more than 2 million have the active spinal form of the disease [4]. The high success of disease cure achieved with anti-tuberculous drugs has made spinal tuberculosis a ‘medical disease’ [5], nevertheless, despite similar results in long-term outcome and neurologic recovery for surgically and medically treated patients, surgery results in a significantly

shorter hospital stay, superior rehabilitation, and spine deformity arrest [6, 7].

The development of kyphosis is the rule in spinal tuberculosis. Patients treated conservatively have a mean increase of spine deformity by 15°, and at the end of treatment 3–5 % of all patients have final deformity of more than 60° [8]. In the adult patient, this will occur with a loss of 1.5 or more vertebral bodies in the thoracic or the thoracolumbar spine [9, 10]. Children younger than 7 years of age with three or more thoracic or thoracolumbar vertebra affected have a 10 % chance of exponential kyphosis progression during the vertical “growth spurt” to produce kyphosis more than 90° [11].

Healed kyphosis with or without late paraplegia

Kyphosis has potentially severe consequences to spinal cord and pulmonary function, but can also be disabling due to biomechanical stresses on proximal and distal segments of the spine. It can also result in self-image, psychological, and social problems, especially in children and young adults. In long-term, after the spine has healed, late-stage neurologic deficit may develop, either from reactivation of quiescent disease in which case it shows characteristics similar to an acute disease including spinal cord compression, or from chronic changes of the spinal cord that is compressed due to the severe angular deformity [12]. Such chronic changes may be produced by a compressive bony ridge, or scarring around the dura creating soft-tissue compression, or stretching of the spinal cord over an anterior ‘internal gibbus’ (remnants of the vertebral bodies), all potentially contributing to interstitial gliosis in the spinal cord. The neurologic deficit is a combination of upper and lower motor neuron injury, along with sensory and bowel and/or bladder involvement [12]. In addition, severe kyphosis can produce progressive restriction of pulmonary function. In one study, out of 23 patients with severe kyphosis, 11 had more than 50 % restriction and 10 had 25–50 % restriction of pulmonary function (two patients had only mild restriction) [13]. The best treatment of spinal tuberculosis with paraplegia is to prevent paraplegia [12], and in those cases with significant spinal deformity, surgery may help to prevent or reverse the neurological deterioration, while improving pulmonary function, overall motor function, cosmesis, and psychosocial concerns.

Treatment

The mainstay of late treatment of TB kyphosis is anterior decompression of the spinal cord and stable fusion of the

spinal column. Significant deformity correction is typically only possible when three-column osteotomies of the spine are used, due to the frequent auto-fusions that occur and ensuing rigidity. The anterior vertebral body remnants compressing the spinal cord (internal gibbus) can be approached either through a direct anterior transthoracic transpleural approach, through an anterolateral costotransversectomy approach (kyphectomy), or through a direct posterior approach with pedicle subtraction osteotomy (PSO) or with posterior vertebral column resection (PVCR) osteotomy.

Anterior transthoracic approach

In general, the anterior transthoracic approach is not favored in these patients; it is mentioned here only for historical purposes. Anterior procedures are associated with difficulties in approaching the concavity of the angular kyphosis in deformities greater than 60°; the incidence of coexistent pulmonary tuberculosis is about 15 % and anterior approach is complicated by problems of fibrosis and adhesions [14]. Correction by purely opening up the anterior column can cause severe stretching of the spinal cord. Furthermore, fused posterior bony elements may preclude proper deformity correction, and combined anterior and posterior procedures are generally needed in cases of late TB kyphosis where the anterior column is addressed through an anterior approach. These combined procedures, irrespective of whether they are staged or performed as a single procedure, are a major surgical undertaking. Cost may also be prohibitive as many of these patients are of poor socioeconomic status and may be managed in a limited resource environment [14].

Yau et al. [13] described a multistage procedure with anterior decompression of the spinal cord, anteroposterior osteotomies, halopelvic distraction and final anterior and posterior fusion. In 29 patients treated, 2 patients died because of poor pulmonary function; the deformity corrected from a mean of 115.5 to 87.2 degrees [13]. The authors concluded that this was a relatively small reward for such a major undertaking; nevertheless in the neurological evaluation of their patients, five out of six patients showed relief of their spasticity and no late paraplegia developed [13]. Hsu et al. [15] treated 22 patients with late onset paraplegia with direct anterior transthoracic decompression; nine patients had an anterior spinal fusion at the time of the decompression and the other 13 had correction of the kyphosis by halo-pelvic distraction with staged anterior and posterior osteotomies and fusion. Although the authors were not detailed regarding the amount of correction of the kyphosis, they reported no death associated with the anterior approach and they found that neurologic improvement was better in the cases with reactivation of

the tuberculosis than in the patients with healed disease (gliosis) [15].

Anterior–lateral approach (kyphectomy)

In anterolateral costotransversectomy, the type of incision depends on the operative plan to include a posterior fusion, or to perform the anterolateral procedure only. Wong et al. [16] treated five patients with only removal of the cord compressing vertebral bodies, where a curved longitudinal 6–8 cm incision lateral to the midline was used, whereas Jain et al. [10] performed, at the same time, posterior osteotomy with correction of the deformity and fusion, using a T-shaped incision. The approach to the spine they described was a typical costotransversectomy, where 5 cm of each of the apical ribs was removed, along with the transverse processes, always remaining extrapleural or extraperitoneal. The intercostal nerves were preserved as a guide to the foramen, and next the pedicles at the apex were removed and the dura became visible. The pleura was elevated from the lateral and anterior vertebral body walls at the apex of the kyphosis, followed by removal of the apical vertebral bodies with a high-speed burr to anteriorly decompress the spinal cord. Wong et al. [16] ended the procedure here with the addition of a strut graft that fused in all cases. Jain et al. [10] completed the osteotomy of the posterior elements and used a Hartshill rectangle to fuse their patients after correction of the deformity. While Wong et al. [16] only decompressed the spinal cord in five patients with a mean kyphosis of 114°, Jain et al. performed a mean correction of 27.3 degrees in patients with a final mean kyphosis of 58.5 degrees. Of their 15 patients treated, two had healed disease and both showed neurologic improvement [10].

Posterior approach

In the healed stage of spinal tuberculosis, kyphosis can only be corrected when three-column osteotomies are performed, such as PSO and PVCR. Osteotomies of the posterior elements (V-type; Smith-Petersen or Ponte osteotomies) [17] can only add to the correction of the adjacent mobile segments proximal to the rigid kyphosis segments.

Pedicle subtraction osteotomy

Pedicle subtraction osteotomy, when placed in the lumbar spine in non-TB patients, can allow 30°–50° of correction per osteotomy and a 6–13.5 cm correction of the sagittal vertical axis [18, 19]. PSO is a closing wedge osteotomy with an anterior apex of correction and shortening of the spine rather than elongation; the vertebral body is decancellated through both pedicles after the removal of the

posterior elements. The posterior arches of the adjacent vertebrae are approximated under direct vision by manipulation of the table, extension of the spine and cantilever forces on the spine with the instrumentation. This procedure has a high complication rate including neurological injury and bleeding [20]; therefore, PSOs are best placed at the midlumbar spine to avoid working around the spinal cord. PSO is an excellent technique in cases of ankylosing spondylitis or iatrogenic flat-back [18, 19]; nevertheless, TB kyphosis, characterized by involvement of multiple vertebral bodies is potentially not an ideal indication for PSO and there are very few series in the literature describing treatment of late tuberculous kyphosis with PSO. Karla et al. [21] presented 15 patients with healed tuberculosis; those with no neurologic deficit were treated with a PSO and patients with neurologic deficit were directly decompressed anteriorly and fused circumferentially. Kyphosis corrected from 56.26° to 11.2° while the Oswestry score increased [21]. Bezer et al. [22] showed, in 16 patients, a mean correction of kyphosis from 30 to 12° and high fusion rates.

Posterior vertebral column resection

The cardinal difference of PVCR osteotomy, as opposed to PSO, is the amount of the spinal column resected. Although both are circumferential posterior osteotomies, in PVCR both the spinal cord and the bone/disc wedge fragment compressing it are identified under direct vision. Complete decompression can then be safely accomplished. Therefore, PVCR is safe when performed at cord level and more than one vertebrae can be excised, enabling translation and shortening if necessary to correct rigid deformities. PVCR is essentially a costotransversectomy approach that provides the needed three-column exposure of the spine. The challenges of performing a PVCR in post-tuberculous kyphosis, as opposed to congenital or other severe kyphosis, include that multiple vertebral bodies are involved in the post-infectious fusion mass, that anatomical landmarks are distorted, and that adhesions frequently tether the thecal sac to the anterior structures of the spinal column.

Posterior vertebral column resection, as described by Kawahara et al. [23], shortens the posterior column and lengthens the anterior column with the use of a cage; this addresses the ever-present shortened anterior column in post-infectious kyphosis, where multiple vertebra are destroyed and drive the kyphosis. The closing-opening maneuver in the PVCR osteotomy avoids undue stretching or kinking of the spinal cord that could happen in a typical one-level opening or closing wedge osteotomy. A balance between the amount of anterior column height restoration and posterior column shortening is essential to avoid cord damage. Given the prolonged compression over the

internal gibbus, the cord is already at the limits of its tolerance, but unfortunately there is no good method to assess the reserve of the cord in these patients [24]. To minimize cord damage during the deformity correction one should pay attention to overzealous correction and shortening of the cord to avoid excessive reduction and buckling. This can best be done by direct visual inspection and the parallel use of neurosurveillance (somatosensory_SSEPs and motor_MEPs). The correction is performed by sequential rod exchange and gradual straightening of each rod as it is removed and replaced; this keeps one rod in at all times. When correction and cord length are acceptable, the anterior column cage filled with bone graft is placed and compressed. Thus, PVCR allows excellent deformity

correction without significantly altering the length of the cord (Fig. 1).

Suk et al. and Hamzaoglu et al. [25, 26] have, respectively, reported on 27 and 12 patients with post-infectious TB kyphosis. Pappou et al. [27] reported a case where an anterior flank approach was deemed necessary in order to overcome difficulties related to extensive anterior column reconstruction. The majority of the osteotomies were placed at the thoracolumbar junction, and most patients showed substantial correction of the kyphosis (average correction from 47 to 56°) [25, 27, 28]. This represents a significant correction when compared to one-level closing wedge osteotomies, such as PSO, where safe correction is limited to 30–40° [21, 22]. Rajasekaran et al. [4] reported

Fig. 1 Anteroposterior (a) and lateral (b) radiographs of a 20-year-old female patient (c) with tuberculous kyphosis T9–L2 of 120°; thoracolumbar MRI (d) depicting the kyphus. A T10–12 PVCR with T8–L3 instrumentation was performed; intraoperative picture (e) at the completion of the correction where the spinal cord is completely exposed. Postoperative pictures (g, f) depicting kyphosis corrected to 60°

Fig. 1 continued

on 17 patients with severe late TB kyphosis (10 thoracolumbar, 6 thoracic and 1 lumbar) treated by one-stage closing-opening PVCr. The number of peri-apical vertebrae involved ranged from 2 to 5. Preoperative kyphosis averaged 69° , postoperative kyphosis 32° , with a mean kyphosis correction of 57 %. No patient with normal preoperative neurological status showed deterioration [4]. Wang et al. [29] described a modification of the PVCr where an anterior column multilevel decancellation is performed. This obviated the need of a formal costotransversectomy and exposure of the lateral wall of the vertebral body; the authors reported an average 84.1 % correction (from mean 100.3° – 15.9° ; mean correction of 84.4°) in nine patients [29].

Transient nerve root injury is the most common neurologic complication in PVCr. Suk et al. [26] reported permanent spinal cord injury in two patients, one with adult scoliosis and one with post-infectious kyphosis; both patients had clinical and radiologic evidence of neurological compromise before surgery. In their series, the spinal cord was monitored only by SSEPs and not by transcranial MEPs; they assumed that the permanent spinal cord injuries could also be associated with the blood supply of the thoracic cord.

Posterior vertebral column resection for kyphosis relieves the anterior pressure on the cord by improving the sagittal alignment and by direct anterior decompression.

This is beneficial to the chronically compressed spinal cord; however, the duration of the neurologic symptoms may be important [30]. Lonstein et al. [30] reported in 1980 on 43 patients with neurologic deficits secondary to spinal deformity (42 patients had kyphosis), with an average duration of symptoms of 34 months; in their series, anterior cord decompression gave the best results, with 16 of the 25 patients showing improvement. Hsu et al. [15] reported on 22 patients with late-onset Pott's paraplegia at a mean of 18 years after the initial symptoms; in those patients with reactivation of the tuberculosis and acute symptoms, decompression was more effective, whereas in those patients with healed disease and chronic neurological symptoms, recovery was less satisfactory.

Conclusion

In the late treatment of TB kyphosis, the goal of the surgery is the anterior decompression of the spinal cord and a secondary goal is the correction of the deformity. This will prevent the development of late paraplegia, while it will improve the pulmonary function, cosmesis, and pain related to costopelvic impingement. In cases of severe deformity, PVCr is an appropriate technique and proven to correct the rigid spine.

Conflict of interest None.

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