EMBJ.ORG FOR YOUNG DOCTORS

EUROMEDITERRANEAN BIOMEDICAL JOURNAL
2020,15 (15) 64–68
(*FORMERLY: CAPSULA EBURNEA*)

Original article

CLINICAL OUTCOMES AFTER POSTERIOR SURGICAL CORRECTION OF SEVERE THORACIC OSTEOPOROTIC KYPHOSIS.

Massimo Balsano [2], Gianluca Maestretti [3], Veronica Amorese [1], Mauro Argiolas [1], Andrea Baioni [1], Francesco Pisanu [1], Gianfilippo Caggiari [1], Carlo Doria [1]

1. Orthopaedic Department, University of Sassari, Sassari, Italy
2. Regional Spinal Department, UOC Ortopedia A, AOUI, Verona, Italy
3. Spinal Unit, Cantonal Hospital Fribourg, Fribourg, Switzerland

ARTICLE INFO

Article history:
Received 17 February 2020
Revised 12 April 2020
Accepted 01 May 2020

Keywords:
kyphosis, osteoporosis, osteotomy, corrective, deformity, fracture.

ABSTRACT

The aim of this study was to report the clinical and radiographic outcomes of 21 patients with severe thoracic kyphosis who underwent surgical correction by pedicle subtraction osteotomy. A retrospective multicentric study was conducted among a sample of patients who underwent single-stage correction via a posterior surgical approach. Pedicle subtraction osteotomy (PSO) was performed in all patients who presented a kyphotic deformity exceeding 70°. The cohort included 5 males and 16 females, with an average age of 62.7 years at the time of surgery. The minimum follow-up was 36 months, and the mean follow-up was 39.3 months. Following surgery, kyphosis across the treated segments was reduced by an average of 26.5°. Both back pain and neurological function improved after surgical treatment. There was a 68.2% improvement in VAS scores. Severe thoracic kyphosis can be improved through corrective surgery, and deformity correction can be accompanied by improvement in clinical symptoms.

1. Introduction

Severe kyphosis can occur when the anterior column becomes structurally incompetent after progressive multiple osteoporotic fractures [1]. Vertebral fractures are a common complication in osteoporotic women, and the onset of kyphosis represents a turning point in the clinical history of these patients, with consequent back pain, functional limitation and deterioration in health-related quality of life (HRQoL). Drug therapy plays a fundamental role in the management of back pain, and is essentially based on the use of acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids. The use of bisphosphonate (BP), teriparatide and anti-bone resorption drugs [2-4] is important for the prevention of fractures with subsequent kyphotic and sagittal balance alteration. Kyphosis is mainly related to osteoporotic degenerative fractures, rather than metastatic localization fractures [5]. Patients with significant kyphosis typically present with cosmetic and functional problems related to the biomechanical changes associated with the deformity. The influence of spinal balance on function and quality of life is well established [6,7]. Substantial back pain and functional disability are common in patients with kyphosis [8,9].

Many patients with severe kyphosis also present with neurological symptoms. These symptoms can be determined by compression of the spinal cord or by excessive distraction of the marrow due to kyphotic deformity. In addition to pharmacological methods, a conservative method may be the use of platelet rich plasma (PRP). The mechanism of action and the points of influence that the fundamental growth factors PDGF and TGF-b exert on bone regeneration, through the technique of platelet sequestration and concentration in a PRP is seen as a useful and practical tool to improve the rate of bone formation and the final amount of bone formed [10-14]. When symptoms related to significant deformities cannot be adequately managed conservatively, surgical correction may be required. An increasing number of vertebral lesions and spinal pathologies can currently be treated with surgery, thanks to new devices and new surgical techniques [15,16]. Surgical correction, however, may be associated with significant risks and challenges. A variety of deformity correction techniques have been reported [17-19]. The majority of these reports focus on improving deformity correction and reducing surgical complications. However, decisions regarding surgery remain a challenge.

* *Corresponding author*: Mauro Argiolas, *mauroargiolas.orto@gmail.com*
DOI: 10.3269/1970-5492.2020.15.15
 ISSN: 2279-7165 - Available on-line at www.embj.org

2. Material and methods

Between January 2013 and January 2018, 21 patients (5 male and 16 female) with severe kyphosis related to multilevel osteoporotic fractures underwent posterior surgical correction; operations were performed by 3 different surgeons at 3 different institutions (Orthopaedic Department - University of Sassari - Italy, Cantonal Hospital Fribourg - Switzerland; Regional Spinal Department, Ortopedia A, AOUI, Verona - Italy). In all cases, the apex of the kyphosis was at T5-T6. All patients presented with backache, spinal insufficiency, disorders of pulmonary ventilation and deformity-related cosmetic concerns not associated with neurological symptoms related to spinal cord compression. All patients had undergone ineffective conservative treatment for at least 12 months. All patients underwent standing full-length spine radiography before surgery and at each postoperative follow-up (3, 6, 12, 24, 36 months).The sagittal plane balance was evaluated, and the kyphosis angle was measured in each case. Overall sagittal plane balance was measured using the C7 plumb line on full-length standing lateral spine radiographs. The kyphosis angle was defined on lateral standing radiographs as the angle between the superior endplate of the first morphologically normal vertebra above the deformity and the inferior endplate of the first morphologically normal vertebra below the deformity. Lumbar lordosis was defined as the angle between the superior endplate of L1 and the superior endplate of S1 on lateral standing radiographs. Thoracic kyphosis was defined as the angle between the superior endplate of T1 and the inferior endplate of T12.

All patients underwent posterior surgical correction of kyphotic deformity by Pedicle Subtraction Osteotomy (PSO). After general endotracheal anesthesia, the patients are placed in the prone position on an operating table. Pedicle screws with cement augmentation are inserted into two or three segments above and below the pedicles to be resected. After identifying both pedicles to be resected, holes are made through the pedicles into the vertebral body. Curettes are used to increase the size of the pedicle holes. The transverse processes are excised at their bases. Using angled curettes, the cancellous bone in the body is pushed anteriorly into the body to create a cavity in the vertebrae.

3. Results

All 21 patients (5 male and 16 female) had a history of osteoporotic disease. The average patient age at the time of surgery was 62.7 years old (range 56.4–68.5 years). All patients had a kyphotic angle > 70° (Figure 1a and b). CT scan was performed in all patients before and after surgery to evaluate the surgical correction of the deformity (Figure 2a and b).

Magnetic Resonance Imaging (MRI) was performed in 5 cases (Figure 3). A laminectomy and facetectomy were performed using an ultrasound bone scalpel (Figure 4). After thinning the posterior and lateral cortical walls with curettes, the posterior cortex of vertebral body was pushed down into the body. The pedicle screws were connected to modeled rods before closing the wedge of osteotomy after confirming that the exiting nerve roots were free (Figure 5).

Figure 1 a and b. Posteroanterior (a) and lateral (b) radiographs demonstrating the preoperative deformity in the upper thoracic spine

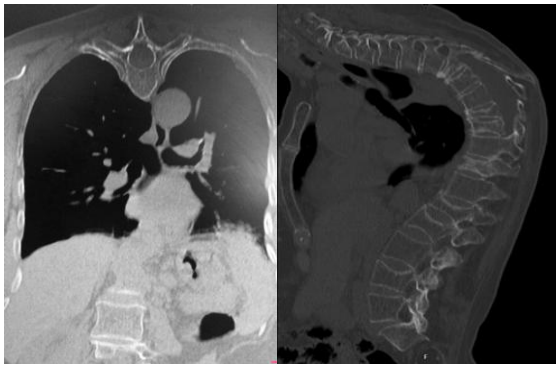

Figure 2 a and b. CT coronal (a) and sagittal (b) plane shows severe kyphotic deformity of the thoracic spine with a significant increase of the space between the sternum and the column.

Figure 3. Sagittal T2-weighted MRI of the thoracic spine showing multilevel osteoporotic fractures without spinal cord compression

Figure 4. Intraoperative picture shows laminectomies and facetectomies achieved using ultrasonic osteotome - Bone Scalpel

Figure 5. Intraoperative picture shows the placement of the rod and the maneuver of cantilever for correction of the deformity

After surgery all patients showed good correction of kyphosis (Figure 6). The average preoperative thoracic kyphosis angle was 83.2° (range 78.2°–95.3°). The average preoperative C7 plumb line fell 42.7 mm anterior to the posterior-superior corner of S1 (range 34.8 to 61.3 mm). The radiographic measurements before surgery are listed in Table 1. After surgery, patients were followed up for a minimum of 3 years, with an average follow-up of 39.3 months (range 36–60 months). The kyphosis angle decreased to 26.5° on average following surgical correction, with a correction rate of 70.2% (Figure 7). These preoperative to postoperative spinal alignment changes were statistically significant ($p < 0.05$). The average postoperative C7 plumb line fell 5.2 mm (range 11.7 to 3.6 mm) anterior to the posterior-superior corner of S1. The C7 plumb line shifted posteriorly by an average of 37.5 mm following surgery, which was a statistically significant change ($p < 0.05$). The average back pain VAS score was 0.9 after surgical correction; this value represented a 68.8% improvement compared with preoperative back pain and was statistically significant ($p < 0.05$). The average pre and postoperative VAS and ODI values are listed in Table 1. In this case series, one complication in a patient who underwent surgery for T5–T8 kyphosis was reported. Specifically, the patient had a transient postoperative palsy related to spinal cord ischemia secondary to hypotension but showed satisfactory recovery 3 months after surgery.

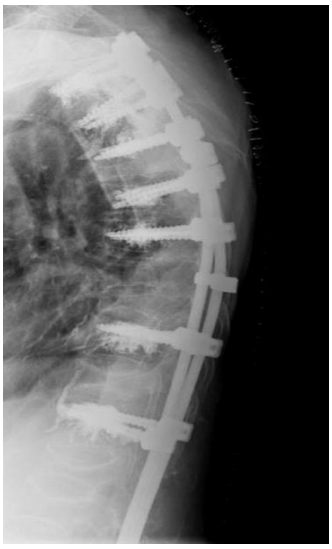

Figure 6. Intraoperative picture shows the placement of the rod and the maneuver of cantilever for correction of the deformity

Time	Kyphotic Angle (°)	C7 Plumb Line (mm)	Back Pain VAS Score (0-5)	ODI Score (%)
BS	78.2-95.3	34.8-61.3	2.0 ± 2.6	72-88
At FU	31.4-20.6	11.7-3.6	0.6 ± 1.1	18-34

Table 1. Preoperative and postoperative radiographic measurements and clinical data (*Radiographic measurements and VAS/ODI scores are averaged, with all patients included in the average. Abbreviations: BS = before surgery; FU = follow-up.)

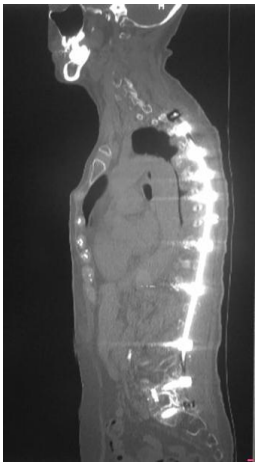

Figure 7. Postoperative CT scan on sagittal plane showing perfect correction of thoracic kyphotic deformity with restoring of physiological angle of kyphosis

4. Discussion and conclusions

While some patients with thoracic kyphotic deformity present with cosmetic symptoms alone, the majority of patients suffer significant back pain and sometimes neurological symptoms.

Backache is typically related to mechanical insufficiency of the fractured vertebrae, the secondary profile change of the thoracic and lumbar spine, and sagittal plane imbalance of the spine. The neurological symptoms manifested by patients may be due to direct compression of the spinal cord, but also from excessive tension on the spinal cord at the apex of the kyphosis. Fundamental in patients undergoing this type of surgical procedure is prophylactic protocol therapy with LMWH which has shown a very low risk of bleeding and a low rate of PE and DVT. Therefore, it is important that all patients undergoing major spinal surgery are supported by pharmacological prophylaxis with LMWH, particularly where VTE risk factors are present [20]. Surgical results have been related to improving sagittal balance. Patients with poor sagittal profile correction showed a lower level of well-being. A posterior closing wedge osteotomy, such as the PSO, is the most widely used surgical technique to address regional kyphosis [21-24]. Furthermore, direct osteotomy closure may lead to over-shortening of the spinal cord, increasing the risk of iatrogenic neurological injury [25-28]. For these reasons, many authors have suggested that posterior closing osteotomies should be limited to treating kyphotic deformities less than 40° [29-33]. Patients in the current series all had severe kyphosis exceeding 80°-90°. Each of these deformities was adequately corrected with PSO. It is important to note, however, that there is a substantial risk of complications associated with this procedure. We reported only one transient palsy. Careful vigilance should be maintained when treating these patients with severe focal kyphosis, as they do have a high risk of complications, including neurological injuries, during surgical correction. Radiographically and clinically the results were good in this group of patients treated with surgical correction. For a patient evaluation the Oswestry questionnaire is useful , it was developed to provide information about the problems of the spine and the influence of these on the person's everyday life. [34-37]. The adequacy of the deformity correction and the restoration of the sagittal balance are related to better clinical results.

In conclusion, adequate prevention is possible, with the treatment of osteoporosis, but for the most serious cases, surgery with correction of sagittal deformity and balance in severe thoracic kyphosis can lead to an improvement in clinical symptoms. This type of approach is essential for improving the quality of life in these patients.

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