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ORIGINAL ARTICLE

Clinical and radiological outcomes of posterior closing wedge osteotomy in post-tubercular thoracolumbar kyphosis.

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ABSTRACT… Objective: To critically evaluate the clinical, radiographic and neurological outcomes after posterior closing wedge osteotomy (PCWO) in persons suffering from post-tubercular kyphosis (PTK). **Study Design:** Quasi-experimental study. **Setting:** Department of Orthopaedic Surgery in the Lahore General Hospital. **Period:** February 2021 to January 2022. **Methods:** This was a quasi-experimental study in which thirty patients with Post-Tubercular Kyphosis were treated by Posterior Closing Wedge Osteotomy. Clinical function was measured by the Oswestry Disability Index (ODI), the neurological status was graded according to the Frankel classification, and radiologic correction was assessed according to Cobb's angle measured from lateral spinal radiographs. **Results:** The mean age of the cohort of patients was between 25 and 40 years, with a predominance of female patients 60%. Cobb's angle showed a statistically significant reduction from baseline to final follow-up ($p < .05$). Neurological recovery was noted in most patients, with most reaching Frankel grade E at final follow-up. ODI scores indicated a significant functional improvement over time ($p < .05$). Complications were mostly low-grade (Dindo-Clavien Grade I), with only one grade III in one patient (3.3%). **Conclusion:** Posterior closing wedge osteotomy is a safe and effective surgical modality for correction of post-tuberculous kyphosis with promising results in terms of significant deformity correction, neurological restitution and functional enhancement.

Key words: Disability Evaluation, Kyphosis, Osteotomy, Postoperative Complications, Treatment Outcome, Tuberculosis.

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INTRODUCTION

Spinal tuberculosis comprises almost half of all musculoskeletal tuberculosis cases and is a major burden of tuberculosis in terms of health in developing countries, despite progress in treatment with anti-tubercular drugs.[1] The thoracic and thoracolumbar regions are most commonly involved, and progressive vertebral destruction often results in the development of kyphotic deformity.[2] Despite the possibility of successful arrest of the infectious process by early diagnosis and intravenous chemotherapy, the structural collapse of the vertebral column may still occur, and this gives rise to post-tubercular kyphosis (PTK).[3] Kyphotic deformity after spinal tuberculosis is more than an aesthetic issue, though: Chronic back pain, sagittal imbalance, respiratory restriction and delayed neurological deficit are invariably linked.[4]

Empirical data suggest that a kyphosis angle above 60 degrees greatly increases the likelihood of neurological impairment, and deformities greater than 90 degrees are associated with severe loss of function and cardiopulmonary stress.[5] Children are particularly at risk, however, since posterior spinal column continued growth may make deformity worse even after active disease has resolved.[6] Conservative management is successful in most patients with no neurological compromise and no significant deformity; however, surgery is indicated by the presence of progressive kyphosis, pain, neurological deterioration of function or disability.[7] A variety of surgical approaches have been described, ranging from anterior only, combined anterior and posterior and posterior only approaches.[8] While anterior approaches, which allow for direct decompression, are related to an increase in morbidity, operative duration, and intra-operative blood loss, especially in severe angular deformities.[9]

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Posterior-only corrective procedures have become popular because of refinements in instrumentation and an increase in the knowledge of spinal biomechanics.[8] Posterior closing wedge osteotomy (PCWO) reduces kyphosis by shortening the posterior column without excessive stretching of the neural axis, reducing the possibility of neurologic damage.[10] This technique provides the ability to see the neural elements directly, secure fixation and achieve deformity correction in a single-stage procedure.[10] Although favourable results of PCWO have been described in several international centres, information from Pakistan is sparse, and most series have a small sample size. Accordingly, the present study aims to assess the clinical, radiological, and neurological outcomes of posterior closing wedge osteotomy in post-tubercular kyphosis patients, to provide local evidence to demonstrate the efficacy and safety of the procedure.

METHODS

This quasi-experimental study was carried out in the Department of Orthopaedics and Spine Surgery at the Lahore General Hospital, Lahore, over 1 year, from February 2021 to January 2022, following approval by the Institutional Ethical Review Committee (reference number 00/218/20, dated 10/12/2020). Thirty patients with post-tubercular kyphotic deformity were selected using convenience sampling. The calculation and required sample size were based on the literature's expectation of differences in pre- and postoperative kyphotic angles, with 80% power and 95% confidence level. Inclusion criteria included both male and female subjects aged between 12 and 60 years, healed spinal tuberculosis with the effect in the thoracolumbar region, and progressive kyphotic deformity. Exclusion criteria were kyphosis due to neurofibromatosis, ankylosing spondylitis, tumor, severe concurrent medical illness, loss to follow-up or refusal to provide informed consent. All patients underwent an in-depth pre-op evaluation including demographic information, clinical history and a thorough physical examination. Functional disability was measured using the Oswestry Disability Index (ODI), and neurological status was graded according to the Frankel classification. Radiological evaluation included plain anteroposterior and lateral spinal radiographs, CT, and MRI scans as indicated. Kyphotic angle was measured on preoperative, immediate postoperative, and final follow-up lateral radiographs using Cobb's method. Postoperative management: close observation was provided, with encouragement to early mobilization once surgical drains were removed. A thoraco-lumbosacral orthosis was prescribed in all cases. Neurologically intact patients started ambulation early in the recovery course, while patients with deficits were mobilized according to their recovery course. Follow-up evaluations were performed at 2 weeks, 1 month, 6 months, and 1 year after the surgery. Data was analyzed using the Statistical Package for Social Sciences (SPSS) version 31.0. Quantitative variables were presented as means and standard deviations, and qualitative variables as frequencies and percentages. A paired sample t-test was used to compare preoperative and postoperative Cobb's angle and ODI scores, with a p-value ≤0.05 considered statistically significant.

RESULTS

A total of 30 patients with post-tubercular kyphosis were included in the final analysis. The mean duration of surgical treatment was 238.33 ± 44.52 minutes; surgical procedures lasted 170-310 minutes. Regarding body mass index, 50 patients had a normal BMI, 36.7 were overweight and 13.3 were obese (Table-I).

TABLE-I

Demographic and baseline characteristics of study participants (N = 30)

Variable	Value
Age (years), M ± SD	39.50 ± 13.98
Age range (years)	20–60
Gender, n (%)	
• Male	12 (40.0)
• Female	18 (60.0)
Surgical time (minutes), M ± SD	238.33 ± 44.52
Surgical time range (minutes)	170–310
Body mass index, n (%)	
• Normal (18.5–24.9)	15 (50.0)
• Overweight (25–29.9)	11 (36.7)
• Obese (≥30)	4 (13.3)

TABLE-II

Radiological and functional outcomes over time

Parameter	Value
Preoperative Cobb's angle (°)	68.83 ± 13.50
Immediate postoperative Cobb's angle (°)	35.23 ± 7.92
Cobb's angle at 2 weeks (°)	33.57 ± 7.56
Cobb's angle at 1 month (°)	33.50 ± 7.67
Cobb's angle at 1 year (°)	33.83 ± 8.27
Preoperative ODI category	
• Severe disability (41–60)	16 (53.3)
• Crippled (61–80)	7 (23.3)
• Bed bound (81–100)	7 (23.3)
ODI at 1 year	
• Minimal disability (0–20)	24 (80.0)
• Moderate disability (21–40)	6 (20.0)

TABLE-III

Neurological status (Frankel Grading) over time

Frankel Grade	Pre-op	Immediate Post-op	1-Year Follow-up
C	15 (50.0%)	1 (3.3%)	1 (3.3%)
D	9 (30.0%)	10 (33.3%)	4 (13.3%)
E	5 (16.7%)	19 (63.3%)	25 (83.3%)

Statistical analysis using paired sample t-tests demonstrated a statistically significant association between Cobb's angle correction and ODI improvement at all evaluated time points ($p = 0.000$). Greater kyphotic correction was consistently associated with improved functional outcomes (Table-IV).

TABLE-IV

Paired Sample t-Test Comparing Cobb's Angle and ODI

Comparison Pair	Mean Difference	Std. Deviation	t-value	df	P- Value
Pre-op Cobb's angle vs Pre-op ODI	65.13	13.60	26.23	29	<0.001
Immediate post-op Cobb's angle vs Post-op ODI	32.33	8.22	21.55	29	<0.001
1-month Cobb's angle vs 1-month ODI	31.06	7.94	21.42	29	<0.001
1-year Cobb's angle vs 1-year ODI	32.63	8.08	22.11	29	<0.001

Postoperative complications were mostly minor. Intraoperative dural tears occurred in 30% of patients, while 6.7% developed persistent cerebrospinal fluid leakage. According to the Dindo–Clavien classification, 73.3% of patients had Grade I complications and 23.3% had Grade II complications in the immediate postoperative period. Only one patient (3.3%) developed a Grade III complication. During follow-up, complications decreased, with 96.7% having Grade I and 3.3% Grade II complications, and no Grade III–V complications at later follow-up.

DISCUSSION

Post-tubercular kyphosis remains a challenging sequela of spinal tuberculosis, particularly in developing countries where delayed diagnosis and advanced disease presentation are common. Severe kyphotic deformity may result in chronic pain, sagittal imbalance, neurological compromise, and significant functional disability. Surgical correction is therefore indicated in selected patients to restore alignment, improve neurological function, and improve quality of life.[11,12] In the present study, significant and sustained correction of the kyphotic deformity occurred with posterior closing-wedge osteotomy, with a mean Cobb angle of the deformity. These results are not dissimilar to the findings reported in earlier studies showing that the posterior-based osteotomy techniques may achieve substantial deformity correction without compromising long-term stability.[13,14,15]

The maintenance of correction during one year is suggestive of adequate biomechanical stability and successful fusion, an important issue in post-infectious spinal deformities. Neurological recovery was another important result identified by this study. Preoperatively, most patients had neurological impairment. Neurological improvement was seen postoperatively. 83.3 per cent of patients were Frankel grade E at final follow-up. Similar neurological outcomes were disclosed in studies evaluating posterior-only osteotomy techniques in which controlled shortening of the posterior column minimize spinal cord stretch and reduces the risk of neurologic deterioration.[16,17] Importantly, there was no evidence of worsening of neurological state in any patient in the present study, which provides

further evidence of the safety of this technique. Functional outcomes, which were measured by the Oswestry Disability Index, showed significant improvement after surgery. Preoperatively, all patients exhibited severe functional limitation, with over half being severely disabled and the remaining being crippled or bed-bound. At 1-year follow-up, 80% of the patients showed little disability, and 20% of the patients showed moderate disability. This progressive improvement in function paralleled the improvement in spinal alignment and in neurological status, and is comparable with results found in similar cohorts undergoing corrective osteotomy for post-tubercular kyphosis.[18,19]

The statistically significant relationship of Cobb's angle correction and ODI improvement further adds to the validity of the relationship between correction of deformity and recovery of function. The complication profile revealed in this study was acceptable and similar to the complication series previously reported. Intraoperative dural tears were observed in 30% of patients, which is based on the range reported for complex spinal osteotomies.[20] Persistent cerebrospinal fluid leakage was noted in only 6.7% of the patients and handled appropriately. According to the Dindo-Clavien classification terms, most of the complications were in the grade of I/II, and just one patient (3.3%) developed a grade III complication with the need for intervention. Of interest, no Grade four or five complications were observed. Other authors have reported a similar finding in that although posterior closing wedge osteotomy is a technically challenging procedure, most complications are manageable and do not have an adverse effect on outcomes when performed by experienced surgeons.[10,21]

The posterior-only approach adopted in this study permits many advantages over the anterior or combined approach, such as avoidance of exposure of the thoracic or abdominal cavity, reduction of operative morbidity, one-stage correction, and an improved ability to manage the neurological structures.[22] Advances in pedicle screw fixation and posterior instrumentation have further increased the safety and efficacy of the technique, which has again reasserted itself as the preferred technique for correction of rigid post-tubercular kyphotic deformities.[23] Despite the increasing amount of literature, there are still a number of gaps in understanding surgical outcomes in post-tubercular kyphosis. Many studies are confounded by low patient numbers, diverse patient cohorts, and variations in surgical technique and had to be evaluated with the caution discussed above, making direct comparisons difficult. Additionally, there is little long-term follow-up data assessing the durability of correction and late complications. There is also a need for more region-specific data, including from developing countries, where the burden of spinal tuberculosis is higher, and the presentation of the disease is often more advanced. Furthermore, the relationship between radiological correction, neurological recovery, and functional improvement has not been consistently quantified between studies, and there is a need for integrated outcome assessment.

In the present study, posterior closing wedge osteotomy provided significant and sustained correction of kyphotic deformity, with a mean Cobb's angle improved from 68.83 degrees preoperatively to 35.23 degrees postoperatively and remained stable at 33.83 degrees at 1-year follow-up, showing good biomechanical stability. Neurological results were significantly improved, and all patients improved from Frankel grade E, with no worsening in their neurological conditions. Functional status also improved significantly, with most patients changing from severe disability to minimal or moderate disability at 1 year. A significant association between Cobb's angle correction and ODI improvement is also a strong indication of the correlation between deformity correction and functional recovery. Complications were largely mild and controllable without any life-threatening events. These results indicate the efficacy and safety of posterior closing wedge osteotomy in post-tubercular kyphosis. There are some limitations in this study. The sample was relatively small, and the study was conducted at one center, so this may prevent generalizability. Additionally, longer-term follow-up beyond 1 year would be helpful to determine the durability of correction and late complications. Despite these limitations, the study has valuable local information supporting the use of posterior closing wedge osteotomy in post-tubercular kyphosis.

CONCLUSION

Posterior closing - wedge osteotomy is a safe and effective surgical technique for the correction of post-tubercular kyphosis. In this study, this resulted in significant and sustained correction of the kyphotic deformity, progressive neurological recovery and marked improvement in functional outcomes over a 1-year follow-up period. The majority of patients achieved normal neurological status and minimal disability at final follow-up. Although the procedure is technically demanding, the profile of complications was acceptable and mostly manageable. Posterior closing wedge osteotomy should be considered a reliable option for posterior-only surgery for appropriately selected patients with rigid post-tubercular kyphotic deformity.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Muhammad Usman:** Conceptualized, study design.
2	**Hafiz Muhammad Jamal Fareed:** Drafting.
3	**Muhammad Siddique Hamid:** Data collection.
4	**Aqeel Moazzam Dhillon:** Critical revisions.
5	**Khizer Ghalib:** Acquisition of data, interpretation of data.
6	**Naveed Ali Sher:** Conception, design.