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Original Article

Does Mesh Cage Subsidence Have any Effect on Functional Outcome in Spinal Tuberculosis?

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Abstract

Introduction: Occurrence of mesh cage subsidence in patients undergoing anterior column reconstruction following Tuberculosis spine is frequent radiological finding as bone quality of affected vertebrae is poor. This study aims at determining effect of mesh cage subsidence on functional outcome. **Methods:** Retrospective demographics of 30 patients of consecutive series in age range 4-60 year were collected with Clinical outcome evaluation using VAS, ODI and ASIA scale. 30 patient having Dorsolumbar tuberculosis with vertebral involvement ranging from 1-6 with mean vertebral level involvement of 2.71, underwent anterior column reconstruction through posterior only approach between 2011-15 were reviewed. Patients were followed at regular intervals of 6 weeks, 12 weeks, 6 months & thereafter on yearly basis. They were evaluated for interbody height loss with subsidence, fusion & segmental angle. **Results:** Clinical parameters i.e. VAS & ODI showed improvement in postoperative period which continued to remain same even after subsidence ($P < 0.05$). Subsidence was categorized as combined anterior + posterior < 5mm; 5 -10mm; >10mm. ODI at follow up was 8.5 ±4.62, 9 ± 2 and 9 ± 4.2 ($P = 0.961$) respectively & VAS score in above group was 1.3 ± 0.51, 1.5 ± 1.2 & 1.5 ± 0.7 ($P = 0.975$) respectively. Subsidence was age, spinal level nonspecific. **Conclusion:** Study indicates that though Cage subsidence occurs to varying severity due to weakened vertebral bodies, it did not have significant impact on functional outcome in terms of VAS, ODI or radiological evidence of fusion following reconstruction in Spinal tuberculosis.

Keywords: *Cage subsidence, mesh cage, spinal tuberculosis*

Introduction

With the advent of newer instrumentation system of pedicle screws and cages, the outcome of spine surgery in terms of deformity correction and postoperative recovery interval has improved significantly. Biomechanical studies showed a significance of anterior column reconstruction in various spine pathologies ranging from fractures, infections, and deformities to tumors.[1] Posterior instrumentation alone cannot compensate for void in the anterior column as anterior column discontinuity significantly increases the chance of localized kyphosis and risks instrumentation failure.[1] Various devices such as mesh cage, peek cages, or tricortical bone graft are commonly used for anterior reconstructions. Tricortical bone graft option, though associated with the highest fusion rate, has a significant donor site morbidity.[2]

The approach of a surgeon in tuberculous spine affection is to debride necrotic infected part of the vertebral body, leaving behind unaffected portion of vertebral bodies. The most common variety of tuberculous affection is paradiscal type.[3] It is very common scenario to place the cage between unaffected parts of adjacent vertebral bodies rather than cage being placed exactly end plate to end plate. This along with weakened end plates leads to frequent occurrence of unavoidable cage subsidence. There is a paucity of literature on mesh cage subsidence and its effect on functional outcome in tuberculosis.

This study is a systematic effort to analyze the effect of cage subsidence on functional outcome in patients undergoing posterior instrumentation and anterior column reconstruction.

Materials and Methods

From August 2011 to December 2015, 30 patients having dorsolumbar tuberculosis

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who underwent posterior instrumentation and anterior column reconstruction were reviewed for this retrospective study after institutional ethics committee approval. All patients had culture-proven mycobacterial tuberculosis sensitive to conventional chemotherapy and progressive neurological deficit along with destruction of ≥2 columns causing instability and risk of kyphosis due to loss of vertebral body height.

Patients were followed up at regular intervals of 6 weeks, 12 weeks, 6 months, and thereafter – yearly follow-up was done. In those patients where fusion could not be established at the end of 6 months followup interval was kept at 3 months till the fusion mass was confirmed on Xray or CT scan.

Surgical procedure

The surgery was performed under general endotracheal anesthesia. Depending on the level of vertebral affection, corresponding midline posterior incision was taken. Two-level instrumentation with pedicle screw above and below the affection level was done in a case of 2 or <2 vertebral involvements. Instrumentation of three levels above and below the level of affection was done, in cases of ≥2 vertebral involvements. Before starting decompression through the transpedicular approach on the most affected side, a connecting rod was placed on the opposite side for stabilization. After adequate debridement of diseased vertebral bodies, anterior column reconstruction was performed with appropriate size titanium mesh cage (TMC) through the posterior extrapleural approach. Local kyphosis was corrected with guarded distraction with the help of pedicle screws and connecting rod. TMC was filled with autologous bone graft derived from decompression procedure/laminectomy or excised rib. Adequate bone grafting was done around cage as well.

Decortication of posterior elements was performed, and the layer of autologous bone was laid over it. Posterior instrumentation was done with titanium pedicle screw system (Apex Systems).

Clinical outcome was evaluated both preoperatively and at the final follow-up using the Visual Analog Scale (VAS) and the modified Oswestry Disability Index (ODI). VAS scale for back pain had a score range of 0–10 (0 = no symptoms and 10 = maximum pain). Modified ODI consisted of the Back Pain Disability Index Questionnaire about ten parameters which were pain intensity, personal care, lifting, standing, walking, sitting, sleeping, social life, traveling, and employment/homemaking. Thus, there are a total of 10 points with each having a score range of 0–5. Hence, total score had a range of 0–50. Severe the disc disease, more is the disability score. Neurological status was determined using the American Spinal Injury Association (ASIA) scale.

Radiological parameters studied were segmental angle (SA), anterior interbody height (AIBH), and posterior interbody height (PIBH). Dynamic lateral standing radiographs were obtained in each study patient after surgery and at the final follow-up. In case of difficulty in distinguishing fusion mass on radiographs, CT scan was performed in 11 cases. Anterior and posterior subsidence was indicated by reduction in AIBH and PIBH between postoperative and final follow-up values. SA was calculated by considering superior end plates of adjacent vertebrae to affected vertebra, for example, in case of tuberculous collapse of L1 vertebra, superior end plates of D12 and L2 were considered for calculation of SA [Figure 1]. In cases where there is multiple vertebral involvement, recognizable superior end plates of immediate contiguous vertebrae were considered, and the same vertebrae were used for calculation in follow-up [Figure 2]. For calculation of AIBH and PIBH, distance between anterior and posterior end points of the same vertebral end plates, which were considered for calculation of SA, was considered [Figure 1].

Fusion at instrumented level was said to be present on basis of the following radiologic criteria on lateral radiographs: no movement or motion on dynamic radiographs; absence of traction spur formation; absence of lysis around the screw or cage–bone interfaces; absence of screw or rod breakage (implant failure); continuity of osseous mass through and/or around the cage; and no gap between cage and adjacent end plates/vertebral body. An independent observer was completely blinded regarding patient details and was a qualified radiologist.

Written informed consent was obtained from all cases participating in the study after explaining the nature of study design. The institutional ethics committee clearance regarding the study was obtained.

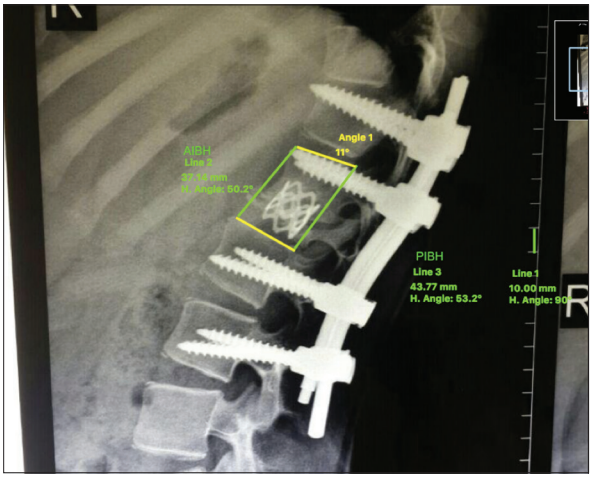

Figure 1: Depicting tuberculous collapse of L1 vertebra, superior end plates of D12 and L2 were considered for calculation of segmental angle. For calculation of anterior and posterior interbody height, distance between anterior and posterior end points of same vertebral end plates, which were considered for calculation of segmental angle, is considered

Observations and Results

The patient population consisted of 16 females and 14 males. Their age ranged from 4 years to 60 years, with a mean age of 25 years. The mean follow-up period was 20 months.

Statistical analysis

Qualitative data are represented in the form of percentages. Quantitative data were calculated using mean ± standard deviation. Analysis of quantitative data between a qualitative variable with two subgroups was done using unpaired *t*-test if data pass "normality test" and by Mann–Whitney test if data fail "normality test." When the analysis was on follow-up values in the same patients, paired *t*-test or repeated-measures ANOVA was used. Chi-square test was used for proportions. Microsoft Office 2013 and SPSS version 17 (IBM, SPSS Inc., Armonk, NY) were used for analysis. $P < 0.05$ was considered statistically significant.

Our group had vertebral involvement ranging from 5 vertebrae to 1 vertebra, with a mean of 2.36 vertebrae [Figure 3].

Clinical outcome

We had a preoperative ASIA scale of A in two patients, which did not improve even in follow-up. Three patients had a ASIA scale of B, six patients with ASIA scale C, eight patients with ASIA scale D, and the rest 11 with ASIA scale status of E. One patient with ASIA scale of B did not show any improvement on further follow-up. We did not encounter any neurological deterioration in either postoperative or follow-up period [Table 1].

Mean VAS score before surgery was 7.71 ± 0.91, after surgery was 2.14 ± 0.53, and at final follow-up was 1.42 ± 0.75. Using paired *t*-test, difference was found statistically significant compared with the preoperative scores ($P < 0.05$). Mean modified Oswestry disability score in preoperative period was 42.21 ± 4.23, postoperatively 13 ± 5.18, and at follow-up, it improved to 8.71 ± 3.72. Using paired *t*-test, difference was statistically significant compared with the preoperative scores ($P < 0.05$).

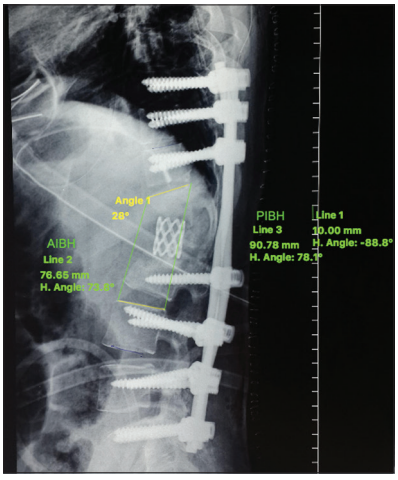

Figure 2: Two X-ray of tuberculosis of the spine showing D11, D12, and L1 complete destruction with partial destruction of D10 and L2 vertebral superior end plates of immediate contiguous vertebrae, that is, D10 and L3 were considered for calculation of radiological parameters, and the same landmarks were used for calculation in follow-up

Radiological outcome

We had a heterogeneous study group in terms of number of tuberculosis-affected vertebrae, which varied from 1 to 5. Postoperatively, mean percentage increase in AIBH over preoperative value was 0.66 ± 0.54. At the time of follow-up, mean percentage increase in AIBH over preoperative value was 0.53 ± 0.45, which was less than postoperative value. Similarly, postoperatively, mean percentage increase in PIBH over preoperative value was 0.21 ± 0.14. At follow-up, mean percentage increase in PIBH over preoperative value

Table 1: The level of involvement with respect to number of patients

Levels of involvement	Number of patients
1	5
2	14
3	7
4	3
5	1

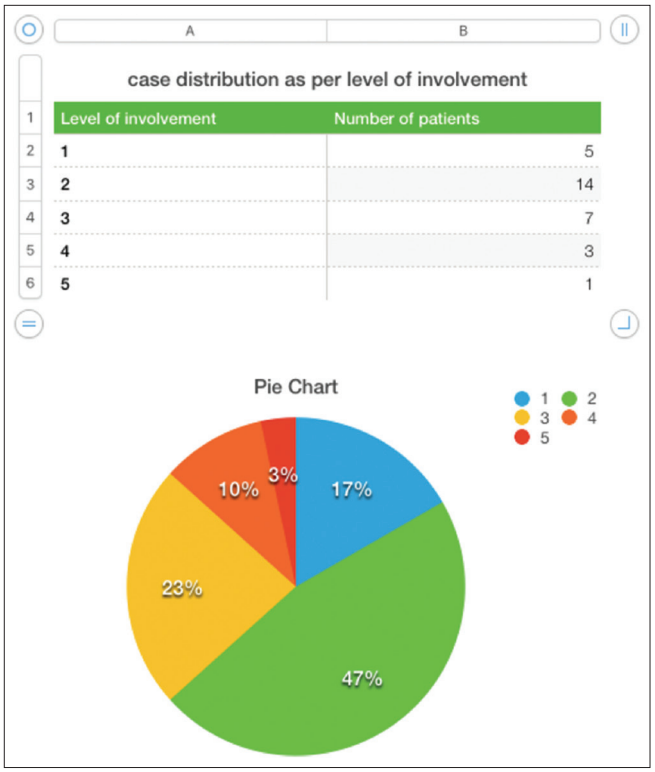

Figure 3: Pie chart depicting distribution of cases with respect to level of involvement

was 0.16 ± 0.12, which is less than postoperative value suggesting cage subsidence occurring between postoperative and final follow-ups [Figure 4 and Table 2].

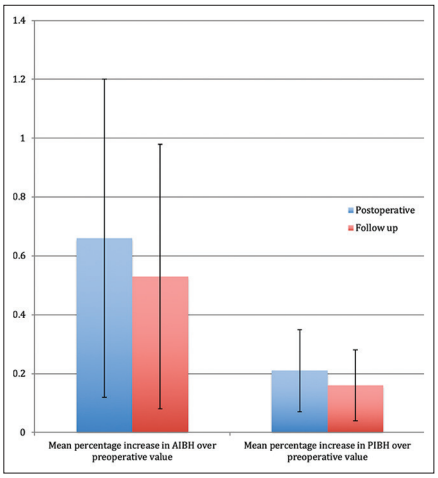

Figure 4: Bar diagram showing mean percentage increase in anterior interbody height and posterior interbody height during both postoperative and follow-up periods

Table 2: Comparison of American Spinal Injury Association Scale between preoperative and follow-up

Number of patients	ASIA scale preoperative	Follow-up ASIA scale score
2	A	A
3	B	E
6	C	E
8	D	E
11	E	E

ASIA – American Spinal Injury Association

Table 3: Mean percentage increase in anterior interbody height and posterior interbody height during postoperative and follow-up periods

	Mean percentage increase in AIBH over preoperative value	Mean percentage increase in PIBH over preoperative value
Postoperative	0.66±0.54	0.21±0.14
Follow up	0.53±0.45	0.16±0.12
*P**	0.0022	0.0093

*Calculated using paired *t*-test, $P<0.05$ is considered statistically significant. AIBH – Anterior interbody height; PIBH – Posterior interbody height

Mean anterior subsidence was 5.01 ± 2.96, and mean posterior subsidence was 4.00 ± 2.60. Table 3 shows the subsidence as per level of vertebral involvement.

Correlation analysis between level of involvement and degree of subsidence showed no statistical relation [Table 4]. We did not find any relation between subsidence and age group or region of tuberculous affection in the spine. We categorized subsidence based on combined anterior + posterior subsidence into the following three types and compared ODI and VAS score separately in each group [Figure 5]. ODI and VAS scores showed no statistical association in all the three subsidence subgroups, with $P = 0.9619$ and 0.9750, respectively [Table 5].

The mean sagittal angle preoperatively was 51.35 ± 28.06, postoperatively 20.92 ± 15.83, and at final follow-up 22.9285 [Tables 6 and 7].

We observed a significant difference in SA between postoperative and follow-up values. The SA decreased significantly after surgery, and the SA showed an increase compared to postoperative value at final follow-up. Solid fusion was achieved in all patients at the last follow-up. We observed subsidence in 21 cases at the end of 3 months and the remaining cases showed subsidence at the end of 6 months. Average fusion time was 7.07 months. Fusion was established in all patients of the study group as per the criteria mentioned previously.

Discussion

Tuberculosis of the spine accounts for 50% of the cases of skeletal tuberculosis, 15% of the cases of extrapulmonary tuberculosis, and 2% of all cases of TB.[4] Tuberculous involvement of the spine is usually of destructive nature starting typically in the paradiscal region culminating into involvement of adjacent vertebral bodies. Hodgson and Stock[5] first described surgical debridement of vertebral osteomyelitis in the setting of spinal tuberculosis.

Middle path regimen described by Tuli[6] still stands test of time. Indications for surgery are specific like neurological complication that failed to respond to conservative therapy, progressive bone destruction in spite of chemotherapy, and prevention of severe kyphosis in young children with extensive dorsal lesion. Surgery in tuberculous spine addresses issues of vertebral instability due to destruction, biomechanical malalignment due to deformity,

Table 4: Comparison of anterior and posterior subsidence with respect to preoperative anterior interbody height

Level of vertebral involvement	Anterior subsidence with percentage value in comparison to preoperative AIBH	Posterior subsidence with percentage value in comparison to preoperative PIBH
Single level	3.255±0.36 (16)	1.145±0.50 (7.4)
Two level	2.58±1.477 (14)	2.10±1.80 (6.75)
Multilevel	3.764±3.35 (19)	2.64±3.382 (2)
P[a]	0.6943	0.6021

Calculated using ANOVA, [a]$P<0.05$ is considered statistically significant. AIBH – Anterior interbody height; PIBH – Posterior interbody height

and neurological deficit due to compression.[7] Surgical debridement of the involved vertebral bodies leads to further disruption of compromised anterior column and demands reconstruction. Wang *et al*.[8] compared one-stage anterior approach debridement with posterior instrumentation and one-stage posterior approach debridement with instrumentation. They concluded that single-stage debridement, bone grafting, and posterior instrumentation yield better result. Similarly, Assaghir *et al*.[9] compared the anterior and posterior approaches in single-level dorsal tuberculosis with emphasis on graft options. They concluded that strut grafting is essential and anterior approach gives statistically better but clinically insignificant kyphosis correction and less correction loss. Although these studies did not involve the use of TMC, similar to our study they showed subsidence and postoperative loss of correction in almost all cases. Although structural autograft is the gold standard in anterior reconstruction with high fusion rate,[10] unfortunately it is associated with substantial morbidity.[11] In 1986, Harms and Biedermann designed the implant for anterior reconstruction of the spine. It was oval-shaped mesh cylinder intended to serve as vertebral body spacer. It was immune to common complications of graft fracture or collapse seen with autologous strut bone graft and further led to significant advancement in new generations of spine implants. TMCs confer immediate stabilization to the anterior column, limit donor site morbidity, and obviate need for obtaining large structural autograft. Titanium is also known to prevent bacterial adhesion to implants.[12]

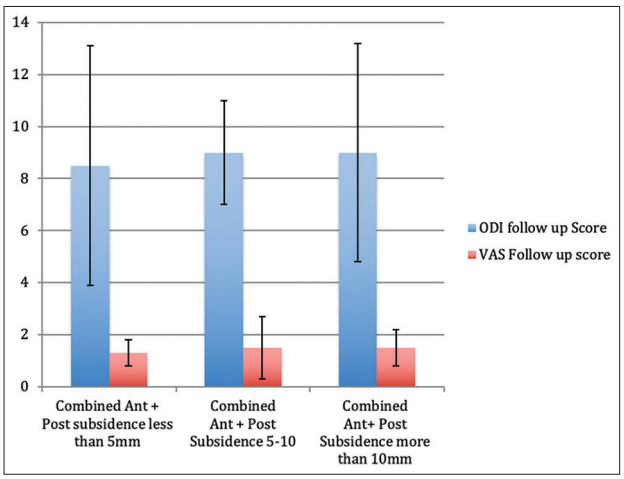

Figure 5: Depicting combined anterior + posterior subsidence and its relation with follow-up Oswestry Disability Index and Visual Analog Scale scores

Table 5: Correlation analysis between level of involvement and degree of subsidence

Characteristics	Correlation coefficient (r)[#]	P
Anterior	−0.07	0.8008
Posterior	−0.05	0.8405
Combined	−0.004	0.9869

[#]Calculated using Spearman's correlation coefficient. Since none of the P<0.05, there is no correlation between levels of involvement with degree of subsidence

Thirty patients having dorsolumbar tuberculosis, who underwent posterior instrumentation and anterior column reconstruction, were reviewed for the study. All patients received anti-Koch's medical treatment for 18 months, which included 4 months of intensive phase and 14 months of maintenance regimen. The study group had average 2.64 levels of vertebral involvement.

Average fusion time was 7.07 months. Fusion was established with minimum criteria of continuity of osseous mass through and/or around the cage and no gap between cage and adjacent end plates/vertebral body. There was no association between subsidence and fusion interval. We had minimal complication rate as we did not encounter neurological deterioration, infection, or implant failures. Two patients had cerebrospinal fluid leaks intraoperatively, which were not repaired, as dural tear was <5 mm in dimension in one case and other case had tear in inaccessible area near the axilla of nerve root. Postoperative wound healing was uneventful in those patients.

We had subsidence in all patients of our study group and it seemed unavoidable. The most common reason for cage subsidence was cages being not placed in absolute end plate-to-end plate manner. End plate-to-end plate cage placement is a common practice in degenerative pathologies which have sclerotic end plates. In contrast, infectious pathology like tuberculosis has predominant paradiscal involvement [Figure 6]. During anterior debridement, unhealthy necrotic portion of vertebral bodies is removed and the remaining healthy part of vertebral bodies is used as end surface for placing TMC for anterior reconstruction.

Table 6: Correlation between subsidence value and clinical score

	Combined anterior + posterior subsidence <5 mm	Combined anterior + posterior subsidence 5-10 mm	Combined anterior + posterior subsidence >10 mm	P[a] (ANOVA)
ODI follow-up score or should we consider score improvement	8.5±4.62	9±2	9±4.2	0.9619
VAS follow-up score or should we consider score improvement	1.3±0.51	1.5±1.2	1.5±0.7	0.9750
Implant failure	No	No	No	
Age	28±17.17	25±24	29.5±15	>0.05

[a]P<0.05 is considered statistically significant. Since none of the P<0.05, there is no correlation between clinical outcome and implant failure with degree of subsidence. ODI – Oswestry Disability Index; VAS – Visual Analog Scale

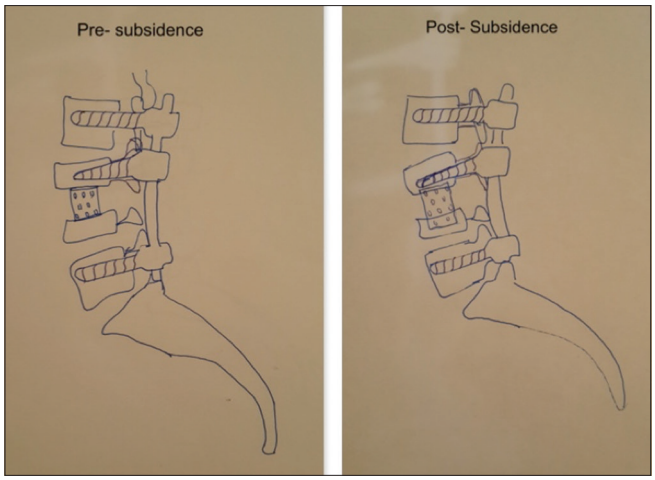

Figure 6: Diagrammatic representation of common mode of occurrence of subsidence in tuberculous destruction of vertebral body

Table 7: Comparison of preoperative, postoperative, and follow-up segmental angles

	Preoperative	Postoperative	Follow-up
SA	51.35±28.06	20.92±15.83	22.92±16.50

P<0.001 versus preoperative values, calculated using RMANOVA with *post hoc* Tukey's Kramer multiple comparison test.
SA – Segmental angle; RMANOVA – Repeated-measures ANOVA

Probably, these vertebral bodies weakened by inflammatory changes and edema could not resist axial loading, hence showing subsidence of mesh cage during follow-up. In few cases, even when cage was placed end plate to end plate, still subsidence was noted probably due to involvement and weakening of end plates [Figure 6]. Subsidence was observed before bony fusion. It was not possible to know the status of bone quality in adjacent affected vertebrae, and as mentioned previously, we assumed it to be of poor quality.

Subsidence observed in the study group was significantly higher than the subsidence observed in degenerative pathologies in the literature.[13] Our study group consisted of patients with different severity of tuberculous involvement. Hence, linear parameters such as AIBH/PIBH could not be considered for comparison. Hence, to get uniform baseline agreement, percentage increase in AIBH/PIBH from preoperative value was calculated postoperatively and at follow-up. Postoperatively, mean increase in AIBH over preoperative value was 0.66 ± 0.54. At the time of follow-up, mean increase in AIBH over preoperative value was 0.53 ± 0.45, which is less than postoperative value. Similarly, postoperatively, mean increase in PIBH over preoperative value was 0.21 ± 0.14. At follow-up, mean increase in PIBH over preoperative value was 0.16 ± 0.12, which is less than postoperative value suggesting cage subsidence occurring between postoperative and follow-up times.

We had no evidence of implant failure in our study group. Clinical parameters consisting of VAS and modified ODI showed a significant improvement at both postoperative and follow-up intervals compared to preoperative level. For the study purpose, we classified combined anterior and posterior subsidence into three categories (mild <5 mm, moderate 5–10 mm, and severe ≥10 mm). Differences in age and sex in these three groups did not have statistical significance. We did not find any statistically significant difference between clinical outcome measures such as VAS and ODI scale with subsidence. Contrary to expectation, the present study showed that cage subsidence in infectious pathology like tuberculosis needs not to be associated with poor clinical outcome measures. Tosun *et al*.[14] compared expandable cage with autogenous iliac crest bone grafting with anterior approach and anterior instrumentation. They concluded that expandable cage reconstruction from anterior approach with posterior instrumentation shows minimal subsidence and kyphosis progression as compared to anterior grafting without instrumentation and anterior column grafting with anterior instrumentation. Although our study involved anterior column reconstruction through all posterior approaches, kyphosis progression was insignificant in our study as well.

Moreover, we observed subsidence conferred more stability to the construct and essentially was a step prior to the bony fusion. This was similar to findings in the study conducted by de Ruiter *et al*.[15] who studied expandable cages in spinal metastasis. They noted subsidence in 29 of 52 patients (56%). They did not find subsidence rate to be significantly different for one-level, two-level, and three-level corpectomies nor there was a difference of subsidence with respect to region of involvement. This finding was similar to finding observed in our study as well. None of their cases with a significant subsidence of ≥4 mm were symptomatic. Yin *et al*.[16] in a retrospective study used autogenous bone graft, allograft, and mesh cage for anterior column reconstruction. The authors in this study have not measured outcome separately for individual grafting option, but they mentioned a good kyphosis correction with minimal subsidence and improved VAS score which was maintained in spite of subsidence. This was similar to our study, in that after comparing clinical outcome scores in postoperative versus follow-up period (i.e., postsubsidence), we did not find any statistically significant difference in functional outcome scores. After going through various studies with regard to cage subsidence in tuberculosis, our study has uniquely analyzed a functional and radiological outcome of mesh cage subsidence in isolation after tuberculous spine affection.

Mean anterior subsidence was 5.01 ± 2.96 higher than mean posterior subsidence 4.00 ± 2.60. Probable reason for higher anterior subsidence was placement of cage in posterior half of vertebral bodies. Postoperative SA showed a significant difference from preoperative value due to restoration of vertebral height. SA in

follow-up period did show a significant difference from postoperative value. It was probably because difference in subsidence between anterior and posterior sides was sufficient enough to change the angle between adjacent vertebral bony end plates.

One of the potential shortcomings of our study was small number of cases. To reaffirm the utility of this approach, it needs to be conducted on a larger number of cases.

Conclusion

This study is unique as it specifically examines the functional and radiological outcomes of TMC subsidence following reconstruction of the anterior column in tuberculosis. Clinical and radiologic parameters in the study indicate that cage subsidence in tuberculous affection was with no caps and it did not have a significant impact on functional outcome in terms of VAS, ODI, or radiological evidence of fusion. Thus, this study showed that anterior column reconstruction could be done successfully and without undue risk in tuberculous spine using a TMC packed with autologous bone graft.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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