

# Standalone Instrumented Posterior Approach Used as Universal Approach for Tuberculosis Spondylodiscitis

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## ABSTRACT

**Background:** Surgical management of spinal tuberculosis (TB) has been classically the anterior, then combined, and of late increasingly by the posterior approach. The posterior approach has been successful in early disease. There has been a paradigm shift and inquisitive to explore this approach in the more advanced and even long-segment disease. Our study is a retrospective analysis by authors in variable disease pattern of TB Spine operated at an institute using a single posterior approach. **Settings and Design:** A retrospective case study series in a tertiary level hospital. **Aims:** The aim of this study is to evaluate the functional and radiological results of an all posterior instrumented approach used as a “universal approach” in tubercular spondylodiscitis of variable presentation. **Materials and Methods:** The study is from January 2015 to May 2018. Twenty-four of 38 patients met the inclusion criterion with a male: female = 8:16, and mean age 44.26 years. The initial diagnosis of TB was based on clinic-radiologic basis. Their level of affection, number of vertebrae affected, and vertebral body collapse, the kyphosis (preoperative, predicted, postoperative, and final residual) and bony fusion were measured in the preoperative, postoperative, and final X rays. Functional scoring regarding visual analog scale and Frankel neurology grading was done at presentation and follow-up of patients. Histopathological data of all patients were collected and anti-tubercular therapy completed for a period of 1 year with 4 drugs (HRZE) for 2 months and 2 drugs (HR) for rest of period. **Statistical Analysis Used:** The descriptive data were analyzed by descriptive statistics, and other parameters were calculated using the appropriate statistical tests such as the Student paired *t*-test for erythrocyte sedimentation rate, visual analog scale score, and kyphosis. **Results:** The mean number of vertebrae involved was  $3.29 \pm 0.86$  (2–6) with mean vertebral body destruction was 0.616. Preoperatively, the mean kyphosis angle was  $22.42^\circ \pm 12.56^\circ$  and was corrected postoperatively to  $13.08^\circ \pm 11.34^\circ$  with an average correction of  $9.34^\circ$  (41.66%). At the latest follow-up, there was mean loss of correction of  $0.80^\circ$  resulting in  $13.88^\circ$  of final correction. Bony fusion was achieved in 20 patients (83.33%) cases. Neurological recovery occurred in all patients (100%), and 92% could be ambulatory at 1 year follow-up. There was improvement of visual analog scale from  $6.33 \pm 1.05$  preoperatively to  $1.042 \pm 0.75$  at 3 months of postoperative period. Two patients had bed sore, two had urinary infection, and one had neurological worsening requiring re exploration and cage removal eventually recovering to Frankel E. Two patients died due to unrelated cause. **Conclusions:** The procedure is safe and

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has satisfactory results in variable group affection of Pott's spine including early and late disease, multisegment involvement using pedicle screw fixation with/without cage support.

**KEYWORDS:** *Instrumented, posterior approach, standalone, tuberculosis*

## INTRODUCTION

Spinal tuberculosis (TB) is a common presentation in Indian subcontinent and about half of these patients present with the most dreaded complication, i.e., paraplegia.<sup>[1,2]</sup> Although medical treatment has shown good response in spinal tuberculosis, it heals with an altered spinal alignment in advanced stage.<sup>[3]</sup> The final collapse depends on the intravertebral site involvement (softening and destruction caused by disease) and the number of segments involved. Therefore, surgical treatment now forms an integral part of management not only in neurological deficit patients but also in patients potential to develop significant deformity as predicted by Rajasekaran and Shanmugasundaram *et al.*<sup>[4]</sup> Surgery is done to remove the compressive elements, to increase the drug delivery to the affected site and to enhance the healing in an acceptable position.<sup>[5]</sup> Pott's spine usually involves the anterior column of the spine, and hence, an anterior approach remains the gold standard for decompression and fixation.<sup>[6]</sup> The popularity of pedicle screws have transcended the existing limits and many surgeons (with varying levels of skills) prefer the posterior approach to replicate the results of an anterior approach that is associated with higher morbidities.<sup>[7]</sup> The posterior approach surgery (PAS) has been studied by some authors with a satisfactory outcome in selective early-stage disease and found to have lower complication rates.<sup>[8-10]</sup> Gradually, PAS is adopted in the more advanced disease. This study is a retrospective analysis of results of outcome measures (functional and radiological) of one stage standalone PAS with instrumentation in a variable group of patients (having the early and advanced, single and multilevel active thoracolumbar TB) at a single center.

## MATERIALS AND METHODS

This was an institutional-based retrospective study conducted at a tertiary level hospital from January 2015 to May 2018. Out of 38 patients of dorsolumbar TB operated, 24 patients had complete data with at least 1-year follow-up. Their data were analyzed from past medical records. The initial diagnosis of TB was based on the clinicoradiologic basis. The level of affection, the number of vertebrae involved, the vertebral body collapse, and the kyphosis (preoperative and predicted)

were recorded from the supine preoperative X-rays (as standing X-ray was not possible and advisable). In the postoperative X-rays, the number of instrumented vertebrae and the postoperative kyphosis were noted. Among the blood parameters, notably, the erythrocyte sedimentation rate (ESR) and HIV status were recorded at the admission along with the functional neurological assessment as per Frankel's grading and pain scoring using the visual analog scale. The follow-up was done at 8 weeks of surgery and subsequently at 2 months interval for a minimum period of a year. The hematological, radiological, and functional (neurology/pain) parameters were recorded similarly (except for HIV). The histopathological data of all patients were collected and antitubercular therapy completed for a period of 1 year with 4 drugs (HRZE) for 2 months and 2 drugs (HR) for the rest of the period.

## Operation

All surgeries were performed under general anesthesia. The patients were placed in prone position after adequate padding with a silicone gel bed with gel headrest for head and face. A pillow was placed below the ankle for the knee flexion. In such position, some amount of kyphosis is reduced because of gravitational pull.<sup>[9]</sup> The involved site was exposed through a midline incision. Paravertebral muscles were stripped to expose the landmarks for pedicular screw insertion. The pedicle screws were inserted at the desired/planned vertebrae and confirmed under fluoroscopy. The sequence was always the unaffected vertebrae followed by affected vertebrae. The levels were increased in case of poor screw hold in the vertebrae. The affected vertebrae were awled and when adequate pus came out (transpedicular decompression) the decompression was completed. When pus was absent/scanty, then laminectomy (hemi/total) was contemplated. In severe kyphosis with collapse, the contralateral side was stabilized using a temporary rod and costotransversectomy was completed from one side. The nerve root was sacrificed if needed and an appropriate size titanium cage filled with autologous bone graft (harvested locally) was inserted. Paravertebral abscesses were also drained through the same. The remaining kyphosis was corrected as far as possible using the compression maneuver of the screw over the rod. The granulation tissue was sent for histopathological study.

## Postoperative regime

As the pain subsided, the patients were encouraged to sit with the support of a thoracolumbar-sacral-orthosis. We advised to use the brace till the patient became free of pain or showed signs of radiological fusion and usually discarded in 6–12 months. All patients with neurological deficit <3 who had difficulty in active physiotherapy were given deep vein thrombosis prophylaxis. Bladder care, physiotherapy to prevent joint stiffness care to skin was taken routinely like other paraplegics. Depending on the recovery of the lower limb muscle power, the patients were gradually ambulated under supervision. At about 2 weeks, the suture removal was done and patients were advised for review at 2-month intervals from the date of surgery. In each follow-up, the radiographs were taken to see remineralization of the diseased osteopenic vertebrae, resolution of the abscess shadows, vertebral endplate demarcation with sclerosis, alignment of the spinal column, angle of kyphosis, position of the implants and status of fusion. Follow-up magnetic resonance imaging (MRI) was not performed routinely as a costly investigation for a disease affecting the poor burden is not warranted.

The kyphosis angle was calculated from plain lateral view radiograph as described by Konstam.<sup>[11]</sup> The initial vertebral body loss (VBL) was calculated as described by Lee *et al.*  $VBL = C/D$ , where D = presumed normal height of one affected vertebra (mean of anterior body height of unaffected vertebra above and below) and C = summed-up loss of height of each affected vertebra.<sup>[10]</sup> If managed nonsurgical, the predicted angle of kyphosis (Y) is equal to  $5.5 + 30.5 \times VBL$  was calculated from the lateral radiograph as described by Rajasekaran.<sup>[12]</sup> Loss of correction was calculated as the difference between final kyphosis angle and the immediate postoperative kyphosis angle.

The descriptive data were analyzed by descriptive statistics, and other parameters were calculated using the appropriate statistical tests such as the Student's paired *t*-test for ESR, visual analogue scale (VAS) score, and kyphosis.

## RESULTS

Twenty four cases were included in our study shown in [Table 1]. The mean age at the time of presentation was 43.33 years (17–65 years) with a male and female ratio of 1:2 (8:16). One patient had disseminated TB with skin lesion and in another patient; a primary pulmonary focus was seen. Associated comorbidities were seen in 8 patients, of which four patients were diabetic and 6 were known hypertensive on medications. Preoperative routine screenings for HIV was done and found negative in all patients. The mean fluorouracil was 19.08 months (15–29 months).

The mean number of vertebrae involved was  $3.29 \pm 0.86$  (2–6) of which three patients had a single segment (single intervertebral disc with two adjoining vertebral involvement [VI]) involvement, 12 patients with two segments (two intervertebral discs with three adjoining VI) involvement, and 6 patients had three segments involvement (three intervertebral discs with four adjoining VI) which were contiguous vertebrae involvement. Two patients had skipped noncontiguous lesion, and both were fixed transcending the involved levels. One had kyphosis angle of  $58^\circ$  without neurological deficit; Frankel E [Figure 1]. The other patient had severe neurological deficit with a large abscess.

The average blood loss (BL) in our procedure was  $492 \pm 51.41$  ml (400–600 ml). The mean number of vertebrae fixed (within the end instrumented segment) was  $5.50 \pm 1.28$  (3–10), and a cage was given in three of the patients. The mean operating time (OT) was



**Figure 1:** Patient with the double level noncontiguous skip lesion with a preoperative kyphosis of  $58^\circ$  corrected to  $25^\circ$

**Table 1: Results of posterior decompression and fixation**

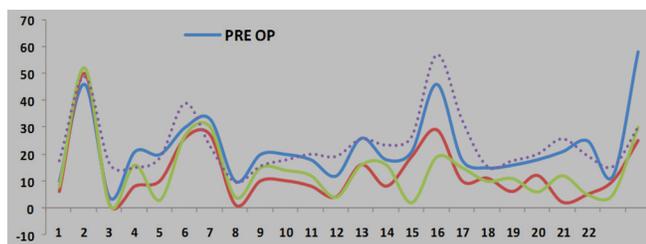
Age	Sex	Number of vertebral involvement	Level of involvement	Number of vertebrae fixation	Level of fixation	Blood loss in ml	Vas score		Involvement of bladder and bowel		Frankel grade		Angle of kyphosis		VBL	Follow up in months	Fusion	Complications	
							Pre op	Final op	Pre op	Final op	Pre op	Post op	Pre op	Final op					Pre op
59	M	3	L2-3	4	D12-L3	450	6	1	NO	NO	D	E	10	6	8	17.7	0.4	F	NO
25	F	3	D8-10	6	D7-12	550	5	0	NO	NO	D	E	46	50	52	48.84	1.42	F	Slipped cage
58	M	3	D6-7	6	D4-9	500	7	1	YES	NO	A	C	4	1	1	16.48	0.36	NF	NO
65	M	4	D7-9	6	D5-10	520	7	2	YES	NO	B	D	21	8	16	15.19	0.46	F	Disseminated TB
48	M	2	D8,9	5	D7-11	400	5	0	NO	NO	E	E	20	10	3	18.92	0.44	F	NO
50	F	4	D8-10	6	D7-12	540	6	1	NO	NO	D	E	30	26	27	39.05	1.1	F	NO
55	F	3	D7-8	6	D5,6, D9-10	480	7	1	NO	NO	A	D	33	27	30	22.9	0.571	F	DM BED SORE*
55	F	4	D7-9	5	D8-12	500	8	2	YES	NO	A	D	10	1	4	9.76	0.238	F	BED SORE*
21	F	4	D9-11	6	D9-L3	520	8	2	YES	YES	A	B	20	10	15	15.77	0.32	F	UTI dura pulsatile
27	F	2	L2-3	5	L1-5 CAGE	550	6	0	YES	NO	C	E	20	10	14	18	0.41	NF	NO
35	F	3	D3-4	5	D2-6	460	6	1	NO	NO	C	E	18	8	12	20.14	0.48	F	NO
26	F	2	L3,4	3	L2-4	470	6	1	NO	NO	D	E	12	4	4	19.3	0.46	F	ABC
17	F	3	D8-9	4	D7-10	420	6	0	NO	NO	C	E	26	16	16	25.83	0.67	F	NO
40	M	3	D7-8	6	D5-10	460	6	1	NO	NO	C	E	18	8	16	23.49	0.59	F	NO
63	F	3	D6-7	5	D5-9	480	7	1	NO	NO	C	E	21	19	2	26.62	0.69	NF	DM S.BED SORE
28	F	3	D12-L1	6	D11-L3CAGE	450	5	0	YES	NO	B	D	46	19	19	57.01	1.69	F	NO
63	F	3	D5-6	4	D4-7	480	7	2	YES	NO	A	D	18	10	15	32.95	0.9	F	NO
26	F	4	D8-9	6	D6-11	520	8	2	YES	NO	C	E	15	11	10	15.65	0.33	F	UTI
40	M	4	D9-11	6	D7-12	430	5	1	NO	NO	D	E	16	6	11	17.7	0.4	F	NO
50	F	6	D2-3/D5-7	6	D2-7CAGE	600	5	0	NO	NO	B	D	18	12	6	20.14	0.48	F	Death after 20m
54	M	3	D11-12	5	D10-L2	500	6	2	YES	NO	C	E	21	2	12	25.83	0.67	NF	NO
52	F	3	D11-12	5	D9-L2	480	5	1	YES	NO	B	D	25	5	5	19.5	0.56	F	THALASEMIA
61	F	3	D10-11	6	D9-L2	450	7	1	YES	NO	C	E	12	10	5	15.56	0.33	F	NO
22	M	4	D3-4, D8-9	10	D2-11	600	8	2	NO	NO	B	D	58	25	30	30.21	0.81	F	NO

VBL-Vertebral body loss, VA-Visual Analogue score S.bed sore-superficial bed sore, Bed sore\*-Pre Op Bed Sore

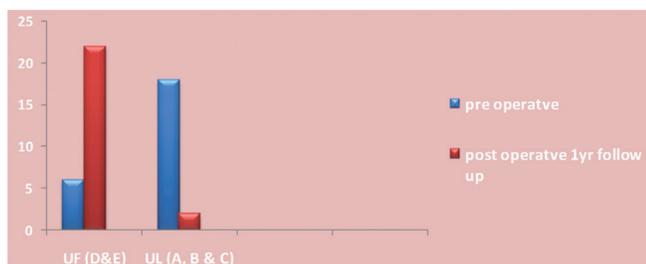
135 min (108–168 min). Both the BL and OT were higher among patients where >4 vertebrae fixation was done or a when a cage was used. The decompression was in the form of laminectomy/hemilaminectomy in 15 patients, costotransversectomy in three patients (patients with cage fixation), and transpedicular decompression among six patients.

The laboratory parameter, such as ESR, was found to be elevated in all cases ranging from 40 to 80 mm/first hour which showed a downfall by 2–3 months of time progression and remained baseline subsequently till completion of treatment. All patients had a significant pain relief and the VAS score improved from  $6.33 \pm 1.05$  preoperatively to  $1.042 \pm 0.75$  at 3 months of postoperative period [Graph 1].

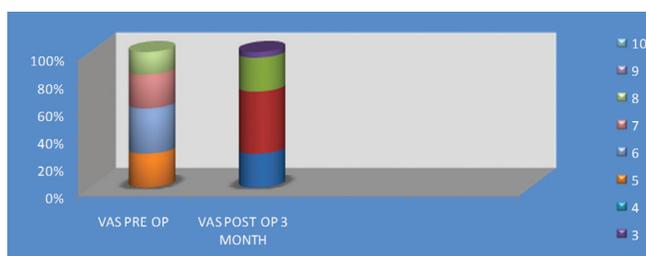
Signs of neurological recovery were reported among the entire patient [Graph 2]. For our convenience of utility and grading the mobility (ambulatory vs. nonambulatory), we sub-grouped the Frankel's grading into two groups-Frankel A to C as a useless functional group (UL) and Frankel D and E as the useful functional (UF) group.



**Graph 1:** Comparison of angle of kyphosis between preoperative, postoperative, final and predicted loss



**Graph 2:** Comparison of useless function and useful function of the lower limb between pre- and postoperative patients



**Graph 3:** Visual analog scale score comparison between pre- and post-operative

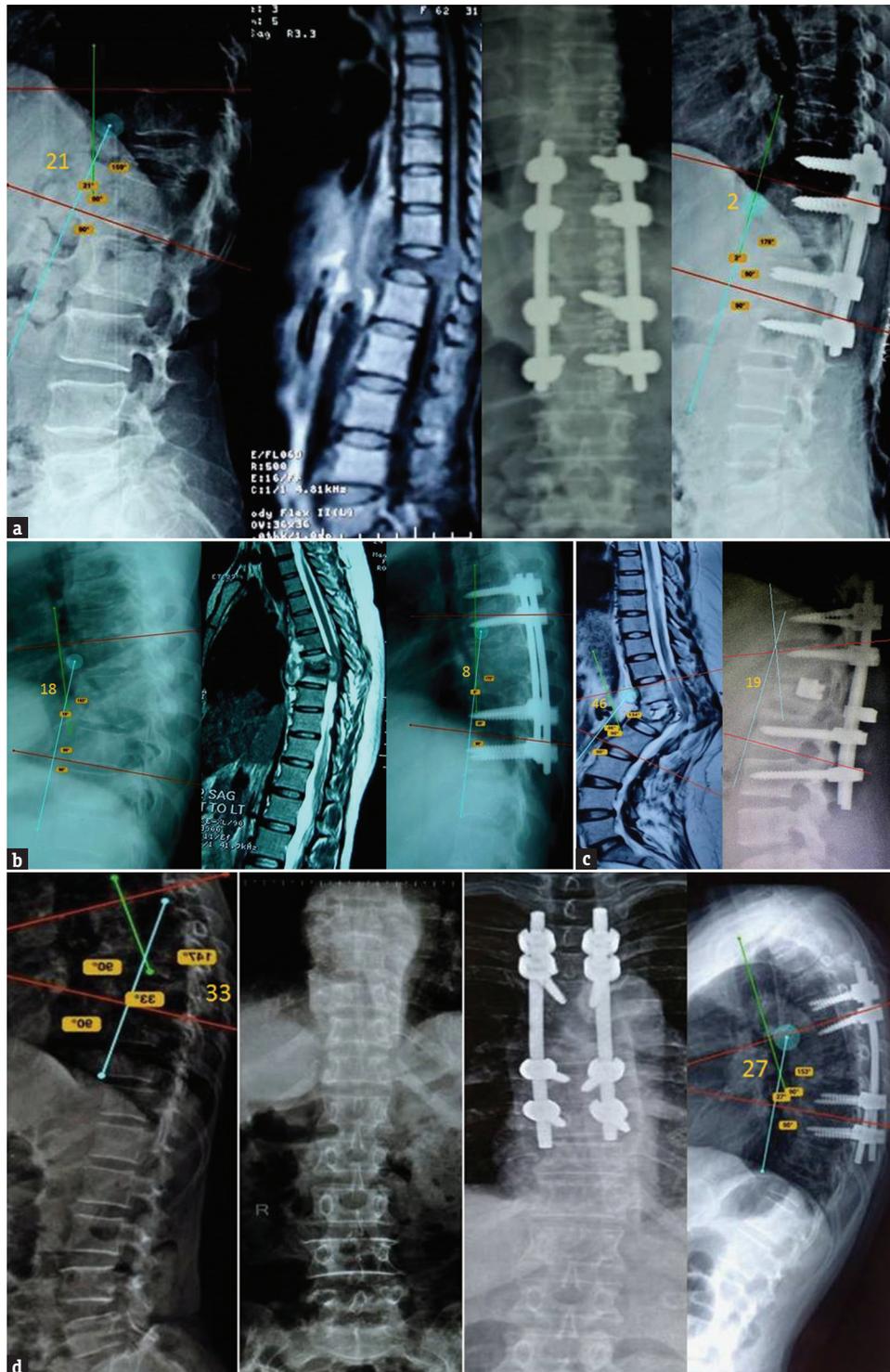
Of 18 patients from UL group (5 Frankel's Grade A, 5 Grades B and 8 Grades C), 16 patients improved to the UF group whereas 2 patients had Frankel's grade improvement but remained in the UL functional group even after 1 year of operation which was significant. The remaining six patients were UF motor (5 patients Grade D and 1 patient Grade E) and all attained Grade E after 1 year of the postoperative period.

On a whole, 14 patients (58.3%) achieved complete neurological recovery; 8 patients were in Grade C, 5 in Grade D, and 1 was already in Grade E preoperatively. Eight patients (33.3%) achieved Frankel Grade D, 4 of them were in Grade B, and 3 in Grade B preoperatively. One patient (4.17%) of Grade A severity improved to Grade C and another patient improved to Grade B only. Thus, at the end 22 (91.7%) were in UF, and 2 (8.34%) remained in the UL group.

The mean vertebral body destruction was 0.616. Preoperatively, the mean kyphosis angle was  $22.42^\circ \pm 12.56^\circ$  and was corrected postoperatively to  $13.08^\circ \pm 11.34^\circ$  with an average correction of  $9.34^\circ$  (41.66%). At the last FU, the mean loss of correction was of 0.80 resulting in 13.88 of final correction (6.11% of deformity). The mean final kyphosis angle of  $13.88^\circ$  was found to be significantly less compared to the preoperative kyphosis and predicted angle of kyphosis (mean  $23.92^\circ \pm 11.061^\circ$ ) as shown in Graph 3. Twenty patients (83.33%) had radiologic fusion whereas 4 patients (16.67%) did not achieve fusion. However, the nonfusion patients remained clinically asymptomatic performing their normal day to day activities. Their radiographs showed signs of healing without any signs of instability. Figure 2a-d demonstrates the imaging profile of some patients with their pre- and post-operative pictures.

### Complications

Bedsore was the most common complication. Bedsore was present in two patients (8.34%-Grade 2 in one and Grade 3 in one, both at sacral location) during the presentation to the hospital and one (4.17%-Grade 2 in sacral) developed during the postoperative period. All the sacral sores healed with regular dressing and postural care by secondary intention without surgical intervention. Two patients (8.34%) had urinary tract infection. No cases had wound infection or dehiscence, or any implant failure. One patient with Frankel's Grade C whom cage was implanted had shown postoperative neurological deficit to Grade A, and immediate computed tomography scan was done, and cage found to have slipped compromising the canal. The cage was removed in an emergency within 6 hours of previous surgery and this patient recovered to Grade B at 2 weeks to finally to Grade A in 6 months'



**Figure 2:** (a-d) Imaging profile of some patients showing the preoperative and postoperative pictures

time. However, there was significant residual kyphosis after cage removal. She is the one with high kyphosis shown in the table [Figure 3].

## DISCUSSION

The battle between the TB and humankind had been centuries old. According to the 2015 WHO data, the

burden of new cases of active TB worldwide is about 10.4 million with 11% living with HIV.<sup>[13]</sup> So on one hand, where science has progressed in leaps and bounds with development of efficient antibiotics antitubercular therapy (ATT), the MRI which can detect early-stage disease and the gene expert (Cartridge Based Nucleic Acid Amplification Test) which can even detect the



**Figure 3:** Demonstrating complication of slipped cage which can be seen in the computed tomography and was retrieved eventually ending with higher kyphosis but full neurological recovery

drug resistance to fight the bug; yet on the side, there has been resurgence of TB in the nonendemic areas due to immunosuppression, atypical presentations such as contiguous multiple levels/noncontiguous skip lesions, and the emergence of drug resistance. The HIV screening becomes mandatory in all TB cases as both HIV and TB accelerate the progress of each other.<sup>[14]</sup> All our cases were seronegative for HIV. Gjergji *et al.* have found that the risk of developing TB is 11–20 times more in HIV affected people than the non-HIV.<sup>[14]</sup> The incidence of extra pulmonary TB among HIV patients is twice as compared to HIV nonreactive patients.<sup>[15]</sup>

ATT chemotherapy forms, the backbone of treatment of tubercular spondylodiscitis which ends with bony interbody fusion in >80% of patients.<sup>[16,17]</sup> The indications for surgery primarily are those with neurological deficit, instability, or severe pain.<sup>[3]</sup> The last century has been the era of anterior approach surgeons and only in its last part, the PAS was introduced as a bailout procedure for sick patients who could not tolerate longer operative time, greater BL, chest/abdominal exposures, and prolonged hospitalization.<sup>[7]</sup> Subsequently, the safety of instrumentation in TB was proved and the PAS started to gain popularity being used in combination with anterior approach. Wang *et al.* used a combined approach of anterior debridement with posterior instrumentation and found it effective to achieve both spinal decompression and kyphosis correction.<sup>[18]</sup> In multiple segments diseases, long anterior instrumentation becomes technically challenging and complex though not impossible. The anterior fixation using single rod is biomechanically less stiff than the posterior double-rod constructs using pedicle screw fixation during dynamic movements.<sup>[19]</sup> The surgeons such as Lee *et al.* and Sahoo *et al.* attempted an all posterior approach in

selective single level early TB disease and found favorable outcomes.<sup>[9,20]</sup> Thus, there is a paradigm shift toward the posterior approach.

Sahoo *et al.* studied single segment early disease and excluded the multiple levels.<sup>[9]</sup> Contiguous involvement of two or more vertebral segments is seen in about 1%–70% of cases.<sup>[18,21]</sup> In the present series, 87.5% patients had multiple VI which is higher than previously reported series. The mean number of vertebrae involved was  $3.29 \pm 0.859$ .<sup>[2-6]</sup> Shen *et al.* have advocated a liberal approach in surgical management of multilevel contiguous lesions.<sup>[22]</sup> Another unique finding was skipping double level affections with TB. The indications for these skip lesions, which are new in our practice, have not been defined. Polley and Dunn found the management of such noncontiguous lesions is same as for typical spinal TB cases with similar end outcomes, but surgical deliberation should be taken in patients having multiple levels with neurological deficiency.<sup>[23]</sup> We included a case of skip double thoracic lesion where combined kyphosis was much high preoperatively and so was the anticipated residual deformity.

Out of the 24 patients, in our series, we did hemilaminectomy/laminectomy in 15 patients, costotransversectomy in three patients (patients with cage fixation), and transpedicular decompression in six patients supplemented with posterior instrumentation depending on the extent of the disease preoperatively. The functional outcome is comparable to earlier studies where selective pedicular and extrapedicular approaches have been done for early stage disease.<sup>[9,20,24]</sup> It is better than Chacko *et al.* where decompression was done without fixation that had poor results.<sup>[25]</sup> The posterior pedicle screw construct gives enough stability to disrupt

the posterior elements during surgery and we have been liberal in laminectomy in our patients. Xu *et al.* studied two groups comparing limited decompression laminar reconstruction group with the laminectomy group and have found better Oswestry disability score in the former.<sup>[26]</sup> However, they urge to limit the indication to monosegmental less kyphotic group and prefer the latter group in multilevel involvement or those with complete paraplegia. Wang *et al.* studied 115 patients with monosegmental disease and concluded that combined anterior with PAS may not be the first choice for treating patients with spinal TB and a single-stage instrumented posterior debridement with bone grafting produces good clinical results.<sup>[18]</sup>

Significant pain relief was reported in all patients as rated by the VAS. The VAS score considerably improved from preoperative mean value of  $6.33 \pm 1.05$ – $1.042 \pm 0.75$  at 3 months of postoperative period. Fixation of the unstable vertebrae (which was due to vertebral loss) reduces the pain and inflammation and surgery *per se* decreases the infection load which in tandem with the ATT is responsible for the improvement. The neurological recovery is also dramatic in our series. Eighteen of twenty four patients were non ambulatory as they belonged to the useless functional motor group (5 patients with Frankel Grade A, 5 Grade B, and 8 Grade C) of which 16 (88.9%) patients became self-ambulatory (to the useful functional group-UF) and other two patients (one patient with Grade B and one patient with Grade C) had improvement but remained in the UL even after 1 year of surgery which was significant. The rest six patients were UF (5 of Grade D and 1 patient with Grade E) and all attained Grade E status at 1-year follow up. Thus, the neurological recovery was 100%, but on an ambulatory scale UF, 16/18 (88.9%) became independent and 2/17 (11.1%) remained wheelchair bound. The reason was a dense neurological loss in one and late presentation in another case. When compared to other studies we had a better neurological recovery.<sup>[9-10]</sup>

Jain in their landmark review paper stated that the development of kyphosis in TB spine is a dictum rather than the exception.<sup>[3]</sup> Earlier studies have shown that conservative treatment increases deformity to an extent of  $15^\circ$  of which 3%–5% land up with a final deformity is  $>60^\circ$ .<sup>[4,8]</sup> The mean vertebral body destruction was 0.616. A lot of studies have not mentioned VBL value. Ours is more when we compared with Sahoo *et al.*,<sup>[9]</sup> who found 0.53 VBL as they included selective early-stage disease in single segment disease. When compared to Lee *et al.*<sup>[20]</sup> group of patients with the multisegment disease who had VI of  $2.24 \pm 0.66$  and fused vertebral

bodies (FV) was  $4.29 \pm 0.92$ ; we had more VI and fixed levels ( $3.29 \pm 0.86$  VI,  $5.50 \pm 1.28$  FV).

The average correction postoperative kyphotic angle in the postoperative period our series was found to be  $9.34^\circ$  (41.66%), which is similar to other posterior approach groups. The final loss of correction at 1 year was  $0.80^\circ$ , which is comparable to Sahoo *et al.*<sup>[9]</sup> and Lee *et al.*<sup>[20]</sup> but better than Kumar *et al.*<sup>[27]</sup> and Ma *et al.*<sup>[28]</sup> who reported a loss of  $4^\circ$ – $5^\circ$ . Thus, we observed that even with higher VBL and kyphotic angle, the correction of kyphosis is substantial and better as compared to another study. However, the loss correction is approach related and comparable to other series.<sup>[9,20]</sup> Jain *et al.* have found the greater correction of kyphosis in lumbar and lumbosacral as compared to thoracolumbar studies.<sup>[29]</sup> This is attributed to more rigid thoracic vertebrae with rib attachments. Segmental spinal fixation, such as the pedicles screw system, allows for additional procedures such as closing wedge osteotomy, interbody fusion using bone graft with or without cages. Overall, the loss of kyphosis is lesser than anterior alone procedure that has been documented in all studies.<sup>[30-32]</sup>

The radiological fusion was observed in 20 patients (83.33%) in this study and 4 patients (16.67%) did not achieve bony fusion. However, the nonfusion patients remained symptom-free and they were able to perform their activities of daily living. Their radiographs showed signs of healing without any signs of instability. Again, the fusion rates in our study was better as compared Sahoo *et al.*<sup>[9]</sup> where the cases were operated early mostly with less involvement end plate.

There are certain limitations in this study. The sample size is small and the follow-up is short. Still, it has a wide clinical variation in regards to distribution in the level of involvement, number of segments, surgical decompressive procedure and fixation methods. The other disadvantages are no similar group to compare with the anterior or combined approach. Hence, a larger prospective controlled trial can be more helpful for validation.

## CONCLUSIONS

The stand-alone posterior approach allows adequate decompression, implant fixation with pedicle screw and rod with/without cage. It is effective in improving clinical, functional and radiological outcome of patients with more advanced disease, in multilevel involvement and also for noncontiguous skip lesions. The PAS can be a “universal approach” to the TB spine.

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## Conflicts of interest

There are no conflicts of interest.

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