SURGICAL RECONSTRUCTION OF THE ANTERIOR COLUMN IN THE MANAGEMENT OF THE TUBERCULOSIS OF THE SPINE (CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL EXPERIENCE: 2012 – 2015)

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ABSTRACT

Background: The anterolateral surgical approach to the tuberculosis of the spine has evolved from the *ab initio* gold standard to the use of titanium mesh cage and anterior instrumentation to construct the anterior column after adequate debridement.
Objective: The aim of the study was to review the outcomes in patients that underwent this procedure between January 2012 and December 2015.
Methods: This was a retrospective review of 60 patients treated. The surgical procedure was standardized irrespective of the HIV status. The measured outcomes include Oswestry Disability Index (ODI) for disability, the Frankel Neurological Grading for neurological deficits and the Cobb angle to measure the kyphosis.
Results: The ODI improved from a mean of 95.4% before surgery to a mean of 8.00% after surgery at the last follow up. Fifty eight patients scored Frankel A or B before surgery, 56 patients achieved Frankel D or E, at the last follow up. The mean kyphosis was 33.9 degrees before surgery, this improved to 23.7 degrees in the immediate post-operative period and a mean of 26.3% at the last follow up.
Conclusions: Anterior column reconstruction using titanium mesh cage and anterior instrumentation is safe and effective for the surgical management of the tuberculosis of the spine. There were good clinical outcomes as determined by the ODI score and the Frankel Grading. The study showed a loss of kyphosis correction that was not associated with negative neurological outcome.

Key words: Tuberculosis, Spine, Anterior column reconstruction, Disability

INTRODUCTION

Tuberculosis (TB) is a recognised major cause of global health problem affecting millions of people every year (1). Together with HIV infection, it remains a leading cause of death throughout the world. In 2015, there were 1.4 million deaths and an estimated 10.4 million new cases. The 2016 global TB report showed that 11% (1.2 million) of all new TB cases are from people living with HIV (1). In 2016, the number of people living with HIV in South Africa was 7.1 million with 18.9% within the age of 15-49 years (2). There is a 1:300 risk that a patient with pulmonary TB will develop skeletal involvement (3). There is an increased risk of skeletal involvement in HIV positive patients (4, 5). TB spine has been reported in 3-5% and 60% of HIV negative and HIV positive patients respectively (4).

The gold standard approach for the surgical treatment of tuberculosis of the spine (TB spine) comprises anterior radical debridement, followed by anterior column reconstruction using a strut graft from the patient's own bone (the iliac crest) (6). Pathology of typical TB of the spine is anterior in its location, thus, a surgical treatment that utilises the anterolateral approach in combination with anti-TB medications is acceptable. The anterolateral approach offers a direct access to the tissue enabling surgical debridement and rapid removal of all the diseased vertebrae, and this often results in large intervertebral defects that necessitate the use of instrumentation and graft to achieve surgical stabilisation of the spine (7).

In comparison to the combined approach, using the anterolateral approach have shown less post-operative complications, shorter hospital stay and less blood loss (8). Some challenges associated with the anterolateral approach includes morbidity related to lung adhesions to parietal pleural in the thoracic region.

The aim of this study was to review functional and neurological outcome measures as well

as spinal angles in patients who underwent anterolateral (transpleural or retroperitoneal) approach, adequate anterior debridement, followed by anterior spinal column reconstruction using the titanium mesh cage and bone graft and/or substitutes as well as an adjuvant anterior interbody fusion (known henceforth as "the surgical procedure").

MATERIALS AND METHODS

This was a retrospective study conducted at the CHBAH orthopaedic spine unit. Adult patients with a surgical history of the anterolateral (transpleural or retroperitoneal) approach, adequate anterior debridement, followed with anterior spinal column reconstruction using the titanium mesh cage and bone graft and/or substitutes as well as an adjuvant anterior interbody fusion (known henceforth as "the surgical procedure"). Patient records between January 2012 and December 2015 were extracted.

Indication for surgery: Low back pain in patients with associated neurological deficit.

Surgical procedure: The surgical approach used was dictated by the level of the lesion. A high trans-thoracic and an anterior retroperitoneal approach was used for lesions in the upper thoracic and lumbar region respectively.

High trans-thoracic approach: A periscapular incision was made and the second or third rib was removed. The scapula was mobilised by isolating and dividing the rhomboids and the trapezius muscles off the lower edge of the scapula. The anterolateral approach to the thoracic spine provides access to thoracic spinal levels 2 to 12 and a left side approach is preferred because the presence of the liver on the right side limits exposure. Also unexpected injury to the aorta which lies on the left side is easier to manage compared to the thinner-walled inferior vena cava on the right. A single-lumen endotracheal intubation was inserted and a left sided thoracotomy was performed in most of the cases. The skin incision was based on the identified rib level which was two levels above the diseased vertebral level. The rib was dissected subperiosteally by cutting the subcutaneous tissue and the muscles overlying it. The rib was removed by cutting it at the costochondral junction and disarticulating it from the transverse process. Due care was taken to prevent injury to the intercostal nerves. The parietal pleural was incised in line with the skin incision and the lungs and other mediastinal structures were retracted using the malleable retractor. The parietal pleural overlying the vertebral bodies was dissected to expose and identify the segmental vessels which are ligated and cauterised. The periosteum was lifted off the vertebral bodies to expose the vertebral bodies and pedicles.

In the thoracolumbar junction, the presence of the diaphragm which originates from the upper lumbar (L) vertebrae and the twelfth rib presents a technical problem for exposure. The incision was therefore centred on the 10th rib to facilitate exposure between T10 and L2. The incision made was curvilinear and can be extended in either a caudal or cephalad direction. The diaphragm was identified and divided at its periphery to avoid postoperative paralysis due to the damage to the phrenic nerve. The diaphragm was incised 2.5cm from its insertion and tagged with sutures to facilitate closure later.

Anterior retroperitoneal approach: This approach facilitates exposure of the L1-L5 region of the spine. The patient was positioned right side down. The incision was made on the left side to avoid the liver and inferior vena cava, as explained above. The skin incision was placed parallel to the 12th rib, in the abdominal region depending on the level of exposure required. The subcutaneous tissue, external oblique, internal oblique, transversus abdominus and the transversalis fascia were all incised in line with the skin incision and care was taken to prevent entering the peritoneal cavity. The peritoneum was reflected anteriorly using blunt dissection to expose the psoas muscle. The structures anterior to the psoas muscles (the sympathetic chain, and the genito-femoral nerve) were identified and protected. The targeted vertebral body was exposed by elevating the psoas muscle from the vertebral bodies. The lumbar segmented vessels were also identified and ligated. The pedicles of the vertebral bodies were identified and the neural foramen was located.

Corpectomy and debridement of the diseased vertebrae: After visualisation and confirmation of the correct level using a localising hypodermic needle as opposed to the gold standard of radical debridement, a thorough (adequate) debridement of diseased vertebrae, together with granulation tissues and abscesses, up to the posterior longitudinal ligament was carried out. The intervertebral disks cephalic and caudal to the resected vertebrae were removed and care was taken not to violate the integrity of the bony

end plates, in preparation for cage implantation. Specimens were taken for histology, microscopy, culture (including TB culture), sensitivity and parasitic and fungal analysis.

The anterior spinal column was reconstructed using a titanium mesh cage (Medtronic or DePuySynthes) in all the patients. The gap left in the spine after debridement was measured with the aid of a laminar spreader and an appropriately-sized titanium mesh cage. The titanium mesh cage from the DepuySynthes is called SynMesh, which an oblong implant that is designed to treat defects in the thoracic and lumbar spine. It has dimensions ranging from 17x22mm, 22x28mm and 26x33mm and heights of 6-88mm. The construct from DePuySynthes uses rods and screws together with the titanium mesh cage to reconstruct the anterior spinal column. Even though, it comes with the end rings, the rings were not utilised in the construct. The anterior instrumentation utilised was either the V2FTM Anterior Fixation Technique or the Rods, called the PolarisTM5.5 Spinal System, both systems are supplied by Zimmer Spine.

The resected rib was morcellised, and in some instances mixed with bone graft substitutes to fill up the cage. When a retroperitoneal approach was used, due to the absence of the rib, the cage was filled with bone graft substitutes. The graft was impacted into the cage and was inserted in the gap. The anterior instrumentation, as described above, was utilised to support and maintain the structural integrity of the graft and increase its stability. An intercostal chest drain was inserted to decompress the pleural cavity and the surgical wounds were closed in layers in the cases in which a thoracotomy was done. The patients were admitted into the High Care Unit for immediate post-operative monitoring for 24-48 hours. Once in the ward, the rehabilitation phase of their treatment commenced and they were given customised thermoplastic Thoraco Lumbo Sacral Orthosis (TLSO) to aid mobilisation.

Follow up: The patients were followed up for 2-3 weeks in the post-operative period for wound care, to monitor compliance with drug treatment and for rehabilitation purposes. Patients were seen 3 months, 6 months and 1 year post surgery and outcomes were measured.

Outcome measures

Oswestry Disability Index (ODI): The ODI is a valid and reliable tool that has been used in several studies to measure functional disability in patients with back dysfunction (9).

Frankel Neurological Grading System: The Frankel neurological grading system is a valid tool to measure neurological function in spinal cord injury (10).

Cobb Angle measurements (Kyphotic angles): The Cobb angle measurement is a reliable method of evaluating spinal joint angles (11).

Sample size: The patients were all operated on by the same set of surgeons, thus providing a uniform approach regarding operative techniques and post-operative management. A cohort of 60 patients with an effect size of 0.8, a 95% confidence interval and a significance level of 0.05 is sufficient to show a significant difference in the pre-operative and post-operative status of the patients. The patients were followed up for a mean period of 21.2 ± 8.4 months (range: 5 – 35 months).

Data analysis: Descriptive statistics of mean, standard deviation and frequency was used to summarise the results. One way ANOVA was used to determine the difference of the outcome measures (Cobb's angle, Frankel neurological grading score and ODI score) prior to surgery and at follow up. The level of significance was set at $p<0.05$.

RESULTS

Demographic characteristics of the patients: A total of 60 patients diagnosed with TB spine underwent anterior column reconstruction between 2012 and 2015 at the Orthopaedic Spinal Unit of Chris Hani Baragwanath Academic Hospital in Soweto, Johannesburg. Of the 60 patients, 27 (45.8%) patients were HIV positive.

The mean age of the patients was 42.58 ± 12.80 years and 68.9% were females as shown in Table 1. Complications were observed in six patients including two deaths unrelated to the procedure; at the last follow up one patient was not contactable. Anterior construction was performed in the thoracic and the thoracolumbar region in 79.7% and 11.9% of the patients respectively.

Clinical and radiological outcome measures: The ODI score pre-operatively was 95.4% ± 6.6%, and post operatively the ODI score was 8.0% ± 12.2%. There was a significant reduction in the ODI score post-operatively (Mean ODIT0 – Mean ODIT1=87.4% ± 12.9%), p value <0.05.

Preoperatively, 58 (96.7%) patients were classified as either A, B or C on the Frankel neurological classification scale. Postoperatively,

Table 1

Demographics of TB spine patients that underwent anterior column reconstruction between 2012 and 2015

	HIV			Total
	Positive (n=27)	Negative (n=17)	Unknown(n=16)	N=60
Age, Mean ± SD years	40.2 ± 10.7	44.2 ± 15.4	45.1 ± 13.3	42.6 ± 12.9
Age range, years	24 - 66	18 – 70	21 – 67	18 – 70
Age category, n (%)				
≤ 30	4 (14.8)	3 (17.6)	3 (18.8)	10 (16.4)
31-45	16 (59.3)	7 (41.2)	6 (37.5)	30 (49.2)
46-64	6 (22.2)	5 (29.4)	6 (37.5)	17 (27.9)
≥65	1 (3.7)	2 (11.8)	1 (6.3)	4 (6.6)
Gender, n (%)				
Male	8 (29.6)	7 (41.2)	4 (25)	19 (31.1)
Female	19 (70.4)	10 (58.8)	12 (75)	42 (68.9)

52 (91.2%) patients were classified as either D or E on the Frankel neurological classification scale as shown in Table 2.

Table 2

Oswestry Disability Index and Frankel neurological classification scores pre and post operatively

	ODI T0	ODI T1	ODIT0-ODIT1	P-value
ODI	95.4% ± 6.6%	8.00% ± 12.2%	87.4% ± 12.9%	<0.05
Frankel neurological classification	NT 0, n (%)	NT 2, n (%)	NT0-NT2	
Frankel A	28 (46.7)	1 (1.7)		<0.05
Frankel B	26 (42.6)	-		
Frankel C	4 (6.6)	4 (6.6)		
Frankel D	1 (1.6)	12 (20.7)		
Frankel E	1 (1.6)	40 (66.7)		
Total, n	60	57		

NT 0 is the neurological scoring before surgery and NT2 is the score at the last follow up.

Figure 1

A graphical illustration of the pre-op and the last follow up Frankel neurological classification

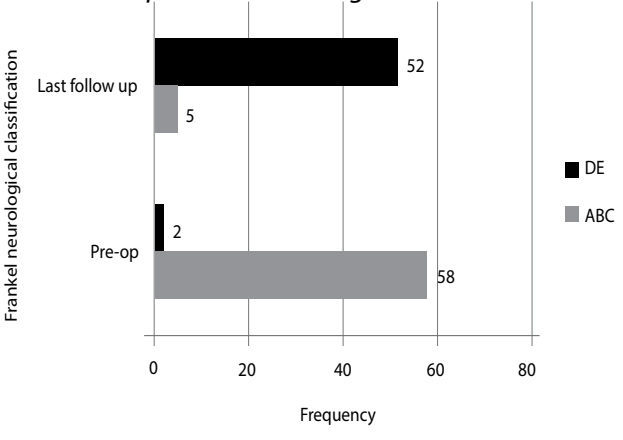

Table 3

Cobbs angle measurement pre and post operatively

	Mean	% change in kyphotic angle	P-value
K0 (Baseline)	33.9 ± 12.4		0.05
K1 (Immediate post-surgery)	23.7 ± 10.3		
K2 (last follow up)	26.3 ± 10.9		
K1-K0	-12.8 ± 10.1	30.1% correction	
K2-K0	- 8.1 ± 9.5	22.5% correction	

As shown in Table 3, these results indicated a 30.1% correction of the kyphosis in the immediate post-operative period and an overall correction of 22.5% over the preoperative kyphosis at the last follow up as shown in Table 3. This reflects a loss of 7.6% in the kyphosis correction for the period between the immediate post-operative and the last follow up.

Table 4

Association between clinical outcome measures and demographics

Outcome measures	Age		Gender		Follow up		RVD	
	rs	p	F	p	rs	P	F	P
ODI								
ODI 1 – ODI 0	0.09	0.51	0.51	0.48	0.31*	0.02	0.74	0.48
Kyphotic angle								
K1 – K0	-0.15	0.26	4.71*	0.03	0.32*	0.02	0.11	0.89
K2 – K0	-0.07	0.62	0.01	0.92	0.13	0.35	0.08	0.92
Frankel classification								
Frankel T0	0.02	0.88	0.57	0.45	0.04	0.75	1.82	0.17
Frankel T1	0.11	0.43	0.59	0.44	0.51**	0.00	1.61	0.21

*denotes P<0.001 and **denotes p<0.05

Spearman correlation (rs) was used to test association between continuous variable (age and follow up) and a one-way ANOVA test was used to test the significant difference between categorical variables (RVD status and gender) and outcome measures (ODI and Frankel Neurological Classification). The results of the association between the follow-up points and the ODI scores showed a significant positive correlation ($r=0.31$, $p<0.05$). Initial follow up post-surgery showed a significant positive correlation with kyphotic angle (K1) ($r=0.32$, $p<0.02$), although at K2, there was no significant association between kyphotic angle and the last follow up ($r=0.13$, $p>0.05$). There is a moderate, positive association between follow-up and the neurological assessment at T1 ($r=0.51$, $p<0.01$) as shown in Table 4. A one-way ANOVA test showed a significant difference between gender and at K1 ($F= 4.71$, $p<0.05$). Age showed no significant correlation with ODI and Frankel neurological scores.

DISCUSSION

In this study, patients were bed-ridden before they underwent surgery (mean ODI score: 95.4% ± 6.6%) and were able to undertake most of their activities of daily living following surgery (mean ODI score at the last follow up: 8.0% ± 12.2%). This demonstrates a mean improvement of 87.4% ± 12.9% in the ODI scoring, and is statistically and clinically significant ($p<0.05$). In degenerative spine, the cut off values for success is a mean change of 20% in the ODI scoring after lumbar disc surgery (12). Using this as a proxy, an improvement of a mean score of 87.4% is an excellent outcome post-surgery.

Before surgical intervention, 58 (96.7%) patients were classified as non-ambulatory according to their Frankel Neurological score. At the last follow up, 53 (91.4%) patients had achieved a neurological score of either D or E, and independent ambulation. This result is comparable to the findings reported by Riemer and Dunn (13) and Govender and Parbhoo (14). In the study by Govender and Parbhoo (14), 77% of the patients had made useful neurological recovery without the use of ambulatory support (Frankel D or E) at one year follow up, while in the Riemer and Dunn (13) study, 70% made useful neurological recovery by achieving independent ambulation without any support at the last follow up.

The post-operative Kyphosis deformity correction achieved in this study compares favourably with that reported in the literature (8). There was a 30.1% correction achieved in the immediate post-operative period and an overall correction of 22.5% at the last follow up reflecting a loss of 7.6% in the kyphosis correction during the period between the immediate post-operative and the last follow up. The loss of kyphosis correction has been reported in several studies and our results falls within the range of loss of kyphosis correction that has been reported (3.5 degrees – 7.2 degrees) (13, 15, 16). There was no association between the loss of correction showed and functional outcome measured. The loss of correction could be due to the associated bony oedema of the adjacent vertebrae from the disease process, and from compression due to the inherent biomechanics of the spine which may lead to collapse because of the rigidity of the anterior instrumentation used. Also, no cage rings were utilised in the reconstruction of the anterior column and this could have reduced the risk of cage subsidence. However, when compared to the neurological grading of the patients, there was no relationship at immediate and last follow up. This is because the stability of the reconstruction provides an enabling environment for the neural elements to recover.

The majority of patients achieved bony fusion, as evidenced by titanium mesh cage incorporation without failure of instrumentation on X-rays and wherever the presence of fusion was in doubt, CT Scans were utilised to confirm fusion as it demonstrated the evidence of cross-trabeculation and titanium mesh cage incorporation.

Complications were reported in six patients. One patient experienced cage dislodgement within the first week following surgery. The cage migrated posteriorly into the spinal canal, resulting in neurological deterioration (from Frankel D to Frankel B). The patient underwent urgent revision surgery and went on to achieve full neurological recovery. Two patients had sepsis. The first patient had a superficial surgical site infection that was treated with antibiotics, local wound care and healing was achieved. The second patient presented one year after the surgery with a deep surgical site infection and a draining sinus. X-rays confirmed fusion and incorporation of the cage in this patient. However, the patient declined further surgery. Thus, this study reveals that the concerns regarding the use of implants in the presence of sepsis is unfounded as evidenced by complete resolution of sepsis in all the patients except for one. It has been documented that mycobacterium does not form biofilms and that titanium does not promote adherence of the biofilms (17).

Two deaths were reported in this study giving it a mortality rate of 3.3%. One death was due to nosocomial infection and surgical wound dehiscence. The patient had an HIV co-infection and had been in the hospital for more than two months with a lung infection. The other death was due to general debilitation due to miliary TB. It was decided that patients would not have an operation done until they were medically and nutritionally optimised (18). The mortality rate was 2.9% in the study where the gold standard procedure was used (6), 15.4% in the study by Govender and Parbhoo (14) and 6.9% in the study by Reimer and Dunn (8). Thus, this study's mortality rate of 3.3% compares well to those reported by other authors.

There was one case of intercostal neuropathic pain. This may have been due to the surgical approach used with the resultant intercostal damage and/or neuroma. The patient was managed with routine pain medication and was subsequently referred to the local pain clinic for further management. Other studies (8, 15, 19) reported minimal and comparable complication rates similar to the one reported in this study. Hence, attention to detail is recommended when using this approach.

The burden of HIV co-infection is clearly demonstrated in this study as 61% (27 out of 44) of tested patients were HIV positive with 70.4% of them being female. The mean age of the HIV positive patients is 40.15 years, and 70.4% are females with an age range of 31-45 years. This age group are the economically active people who are unable to contribute to the economic development of the country due to the disability caused by the disease. Thus the effect of the disease burden is further amplified not only by the cost of treatment but also by the fact that these patients also claim from the Social Security Disability Grants during their treatment period and are economically unproductive.

The main limitation of this study was its retrospective nature. As a result, it was difficult to follow up all the patients. Johannesburg is a cosmopolitan city and the patients are people with ambition and dream, and they are economic migrants. Thus when they become sick, they may go back to their hometowns, to start life afresh upon achieving healing. This usually makes long term follow up difficult. As CHBAH does not have the Picture Archiving and Communication System (PACS), this also adds to the difficulty of tracing the full clinical, laboratory and radiological records of patients. Furthermore, a control group was unavailable as this is usually difficult to establish in spine research. However, since all patients had been operated by the same team of surgeons, a uniform approach regarding operative techniques and post-operative management was maintained.

CONCLUSION

Anterior column reconstruction using titanium mesh cage and anterior instrumentation is safe and effective for the surgical management of TB spine. There was an excellent outcome in terms of the ability of the patients to return to their activities of daily living due to pain relief as measured by the ODI score, neurological recovery as determined by the Frankel Neurological Grading system and kyphosis correction as measured by the Cobb angle.

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