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ORIGINAL ARTICLE

Titanium Cage Fixation in Thoracic and Thoraco-lumbar Anterior Inter-body Fusion

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ABSTRACT

Objective: *To determine the Cage Fixation for the management of thoracic and Thoraco-lumbar instabilities and inner by inter body fusion.*

Study Design: *Prospective Study.*

Material and Method: *The study was conducted at the department of neurosurgery Lahore general hospital Lahore.*

Results: *Thirty cases were included during period two years. All cases operated for decompression, fusion and instrumentation, cages of titanium mesh were used. Neurological status of the patients assessed before and after operation. Twenty eight (93.3%) cases improved neurologically. Two (6.7%) did not improved.*

There were three infected cases which were treated and improved in the long run.

Conclusion: *By using anterior interbody fusion (AIF) with cage we can mobilize the patient early. Improvement of the neurological status is excellent. Per operative infection rate is very low. Deformity can be corrected with more accuracy.*

Key Words: *Anterior cervical corpectomy, anterior dorsal inter body fusion, anterior, posterior and lateral, computed tommography, magnetic resonance imaging.*

INTRODUCTION

Treatment of spinal disorders has undergone a swift and enduring revolution in the past two decades. An expulsion of new technology, coupled with an improved understanding of the pathologic processes associated with musculoskeletal degeneration, has resulted in plethora of new options for both conservative and operative interventions for patients with spinal disease. Exciting new pharmacological, physical, alternative therapeutic and surgical modalities are now available for the treatment of common back and neck problems. Spinal fusion is now the most common surgical procedure requiring bone autograft and one of the most common procedures requiring the use of allogenic or allograft bone. Although fusion procedures have been performed with regularity for more than half a century the development of modern spinal implants has significantly increased the success rate of successful spinal fusion procedures.

Because freshly harvested auto-graft bone contains both living bone cells and a mineralized extra cellular matrix, it possesses both biologic activity and a structural framework for the intended fusion. In addition the extra cellular matrix of autograft contains bone morphologic proteins as such, autologous graft remains the gold standard for skeletal fusion procedures. A synthetic non-biologic interbody implants would overcome these barriers and can potentially be manufactured to specification with high degree of consistency and availability, ideally it would;

1. Provide a solid structural support with biochemical properties similar to bone.
2. Either promote fusion or allow fusion to occur in its presence.

3. Be biologically compatible.
4. Allow for the radiographic assessment of progress of bone fusion.
5. Have physical properties similar to bone.
6. Be in expensive and relatively easy to manufacture.

Alternative to bone autograft or allograft for inter-body fusion emerged in 1979 from veterinary world. The Bagby cage, a cylindrical stainless steel device. From these humble beginnings, a large variety of structurally unique cages were developed to serve as inter-body fusion devices. In human the first clinical application was in lumbar spine, and similar version was thus developed for use in cervical spine. Except for those device composed of human body, these implants are designed to be filled with osteoinductive and/or osteoconductive substances to promote fusion.

MATERIAL AND METHODS

This was a prospective study; this study was done in department of neurosurgery Lahore general hospital Lahore over a period of two years, from June 2002 to December 2004. Thirty patients in whom anterior dorsal interbody fusion (ADIF) performed using titanium cage filled with bone graft composite were studied. All patients requiring anterior dorsal interbody fusion for unstable or potentially unstable anterior dorsal spine due to;

1. Trauma.
2. Infection.
3. Degenerative spinal disorders.
4. Neoplasia.

Surgical Technique

In each case anterior dorsal interbody fusion using titanium mesh cage filled with autologous bone graft composite was done. The surgical exposure was performed as below

1. For upper thoracic (T_1-T_3), anterior exposure of the highest thoracic segment was achieved through a mid line sternotomy that extends through second intercostals space.
2. Thoracic (T_4-T_{11}) were approached through the chest. The location of the major body destruction or spinal cord compression determined on which side the thoracotomy should be carried out.
3. For thoracolumbar junction (T_{12}-L_2), side on which to perform thoracotomy is determined by the local spinal pathology, when the disease was symmetrical the **left side** was chosen, as the spleen was easier to mobilize than the liver. Moreover aorta is more prone to bear the stress relatively as compare to inferior vena cava.

RESULTS

A total 30 patients with collapsed thoracic vertebrae at the different levels operated between June, 2002 to June, 2004.

Sex Distribution

There were 12 male (40%) and 18 of them were female (60%).

Table 1: *Sex Incidence.*

Sex	Pt. Numbers	Percentage
Male	12	40.0%
Female	18	60.0%
Total	30	100.0%

Age Distribution

The age ranged from 15 years to 48 years.

Ten patients from 15 – 25 years. Nine of them were from 25 -30 years. Seven patients were from 30-40 years, and four patients were from 40-48 years of age.

Table 2: *Age Distribution.*

Age	Pt. Number	Percentage
15-25 Years	10	34.0%
26-30 Years	09	29.7%
31-40 Years	07	23.1%
41-48 Years	04	13.2%
Total	30	100.0%

Area Distribution

Eight patients (26.6%) were from urban areas and 22 patients (73.34%) were from rural area (Fig. 1).

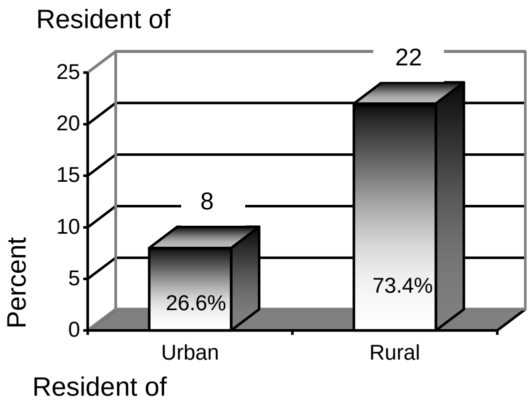

Fig. 1: *Area Distribution.*

Socio-economic

About 90% of the patients belong to poor socio-economic status and other 10 % were from middle and upper class (Fig. 2).

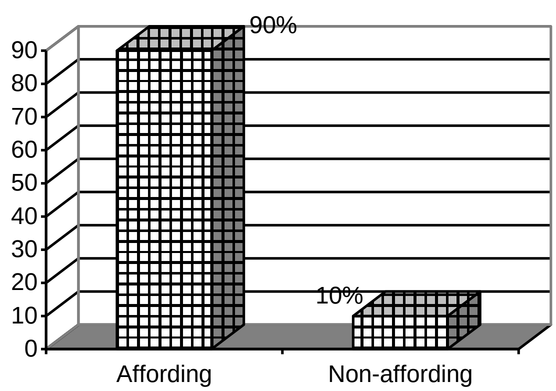

Fig. 2: *Socio-economic status.*

SURGERY AND OUTCOME

All cases were operated for decompression, fusion and instrumentation; cages of titanium mesh were used. One (3.3%) cage displaced, and two (6.66%) of them were loosened, infection occurred in three (10%) cases.

Neurological status improved in 28 (93.3%) cases. Two (6.66%) patients were not improved neurologically (they were found to be associated with trauma). Three infected cases were treated and they improved later on.

Correction of deformity (kyphosis) was performed in 15 cases, eight (53.33) of them improved and the other seven were not improved with only caging but they were operated with an other combined system I.

Table 3: *Out come.*

Neurological Status	Pt. Number	Percentage
Improve	28	93.33
Not Improve	02	06.66

COMPLICATIONS

Accordic to the literature, complications of anterior interbody fusion (AIF) with cage divided in to four groups.

A: Complication of surgical approach;
1. Inadequate exposure.
2. Wrong level.
3. Vascular injury.
4. Direct neural injury.
5. Associated structural injury.
6. Infection.

B: Regional specific complications;
a. Thoracic;
1. Intercostal neuralgia.
2. Dural lacerations.
3. CSF leak with pleural effusion.
4. Lungs injury.
5. Spinal cord injury.
6. Secondary ischemic injury.

b. Lumbar;
1. Lumbar plexopathy.
2. Illiac vessels injury.
3. Injury to sympathetic fibers leading to retrograde ejaculation.
4. Injury to gut.
5. Injury to other structures like kidneys, genital organs etc

C: Graft complications:
1. Fracture.
2. Extrusion.
3. pseudoarthrosis.

D: Instruments complications:
1. Loosening.
2. Breakage.
3. Displacement.
4. Malpositioning.

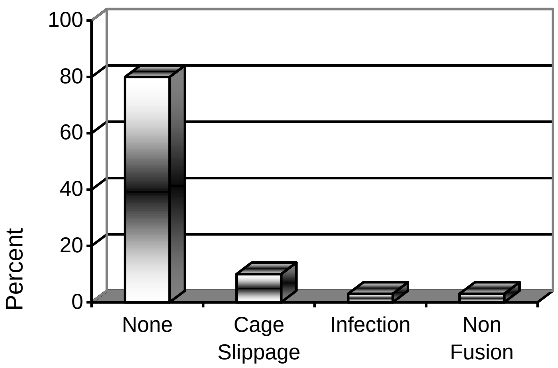

Fig. 3: *Complications.*

FUSION

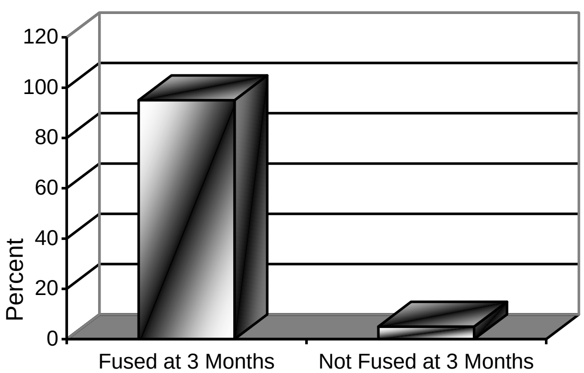

Fig. 4: *Fusion at 3 Months.*

DISCUSSION

In our study of 30 patients Males were 18(60.0%) Female 12 (40.0%) with a male to female ratio of 1.5:1, a male dominancy was noted. The Mean age was 31.1years and Minimum 14.00 years and Maximum 65.00. Chung[1-3] has described similar results in a study of 104 patients, 81 men and 21 women. The mean age of patients was 32.5 years. The most frequent cause of injury was industrial accidents (38.5%). The three vertebrae most commonly fractured, in descending order, were L1, L2 and T12.

In our study Mode of Injury was Fall from Height was the leading cause, in 20 (66.7%) patients, followed by RTA in 5 (16.7%) and Trauma in 5 (16.7%). Most frequent fractured vertebra was L1 in 12 (40.0%) patients and D_{12} in 7 (23.3%) patients, similar to Chong[1].

Leferink, V.J.M[4-6] in a study has given the mean age of the respondents was 40.5 years (range 24-57, SD 10.3), ten patients were male and nine were female. Etiologic factors were traffic accidents (n = 3), accidental fall from height (n = 10) and accidents of sports (horse riding, motor sports and parachute jumping) (n = 6). Fracture levels are merely T_{12} and L_1 Table.

Level	n
T10	1
T11	0
T12	8
L1	8
L2	0
L3	2
L4	0
Total	19

In our study the Pre-operative Frankel grade in majority of the patients was B, in 15 (50.0%) patients, Grade C in 6 (20.0%) patients, Grade D in 5 (16.7%) patients and Grade A in 13.3%.

Pre Operative Alignment was 30 to 50% in 6 (20.0%) patients, 50 to 70% in 11 (36.7%) patients and 70 to 90% in 13 (43.3%) patients. Post Operative Alignment was 100% in 11 (36.7%) patients, More than 95% in 16 (53.3%), More than 90% in 3 (10.0%) patients.

Frankel Grade at 3 Months was B in 3 (10.0%) patients, C in 6 (20.0%), D in 12 (40.0%), and E in 9 (30.0%) patients.

McDonough et al[228] describes 16 patients with neurologic deficit demonstrated at least one Frankel grade improvement on final observation, with 11 (69%) patients demonstrating complete neurologic recovery. Thirty-three patients were treated with anterolateral instrumentation only. Twenty-nine of thirty patients demonstrated radiographic healing. Five were lost to follow-up observation. One patient required subsequent posterior fusion for increasing kyphotic deformity.

Sasso et al[7-9] describes results of stand alone anterior instrumentation and says that, there were no cases of neurologic deterioration, and 30 (91%) patients with incomplete neurologic deficits improved by at least one modified Frankel grade. Mean preoperative segmental kyphosis of 22.7 degrees was improved to an early mean of 7.4 degrees ($P < 0.0001$). At latest follow-up, angulation had increased by an average 2.1

degrees but maintained significant improvement from preoperative measurements. There was one early construct failure due to technical error. Thirty-seven of the remaining patients (95%) went on to apparently stable arthrodesis. Sasso et al[4] concludes that current types of anterior spinal instrumentation and reconstruction techniques can allow some types of unstable three-column thoracolumbar injuries to be treated in an anterior stand-alone fashion. This allows direct anterior decompression of neural elements, improvement in segmental angulation, and acceptable rates of arthrodesis without the need for supplemental posterior instrumentation.

In a recent study by Zeman J et al.[10-14] The authors assessed options for vertebral body replacements They state that, Autologic or homologic bone grafts, a titanium “Harm’s” cage or a polymethylmetacrylate filling reinforced by Kirschner wires, may be used for vertebral body replacements. The cement filling is indicated in oncological patients, the Harm’s cage requires filling with a quantity of bone grafts and, with massive bone grafts, the collection place or the graft availability may be a problem. The telescopic expansion implant is fairly easy to implant, is stable and requires to be filled with a minimum of spongious grafts.[20,21]

They describe their results that the most frequently affected and operated vertebrae included the L1 (4 patients), Th12 (4 patients), Th6 (3 patients). The minimal interval between the procedure and a follow-up was 12 months. No fatal outcome has been recorded. In one patient with a vertebral body metastasis, the disorder has generalized and in a second one, no further metastatic spread has been reported. In one subject, the left-sided L4 root injury was recorded postoperatively, a cauda equina syndrome, diagnosed after the injury, persists in one subject. No signs of deep infection have been recorded. There are no records of the Synex release or displacement. Correction loss (kyphotisation) of up to 2 degrees was recorded in patients with transpedicular stabilization, in Ventrofix patients the loss was up to 5 degrees, except one case, where the loss reached 10 degrees.[41]

One of the commonest indications for the anterior approach surgical stabilization of the spine, is the vertebral body destruction in burst fractures or post-traumatic kyphotizations of the spinal column. Un-healed or poorly healed type A and B (AO classification) pincer vertebral body fractures are other common indications for partial corpectomy and vertebral body replacements. Such fractures can be managed using posterior transpedicular stabilization. However, provided the procedure results in insufficient fracture repositioning, the anterior procedure and the anterior column reconstruction must be performed. A vertebral body can be replaced by a bone graft, a cement filling with Kirschner wiring, a traditional Harm's cage or an expansion implant. The bone graft may be autologic, which involves a disadvantage of the “donor site pain”, or homologic, although a potential for reconstruction is not fully evidenced here.[15-18] Implant migration into the vertebral body has been recorded in the classical titanium Harm's cage with a sharp edge without an additional endplate. Furthermore, it is a rather complicated implantation, requiring an exact implant size, which is considered another disadvantage. The expansion implant may be expanded telescopically in the very place, which is considered its biggest advantage. Furthermore, it need not be filled with bone grafts, but is applied only ventrally or laterally to the cage.[19,20,30,36]

O’Shaughnessy et al[37] in a retrospective clinical study to evaluate the safety and efficacy of using an integrated titanium mesh cage and pedicled rib flap for thoracic spine reconstruction in patients at high risk of pseudarthrosis, describe that a variety of materials are available for interbody thoracic reconstruction; however, the optimal treatment of patients at high risk of pseudarthrosis remains a challenging problem.[38,39] Free or pedicled bone flaps have been shown to be highly effective in terms of promoting fusion and titanium mesh cages provide excellent structural support. Their study consisted of Eleven patients who underwent anterior thoracic corpectomy and spinal reconstruction using an integrated titanium mesh cage and pedicled rib flap were analyzed with a mean follow-up of 37 months (range, 25-55 months). The etiology of spinal disease was infection in 7 (64%) patients and tumor in the remaining 4 (36%) patients. Seven (64%) patients were treated with only an anterior approach while the remaining 4 (36%) patients underwent circumferential spinal reconstruction. Describing the results of their study they state that, all patients demonstrated clinical and radiographic evidence of spinal fusion at the time of follow-up.[32-41] All patients had stable or improved Frankel grades after surgery. There was a mean kyphosis correction of 7 degrees for both the focal and regional thoracic kyphosis. There were three significant postoperative complications: bilateral pleural effusion, gram-negative bacteremia, and transient right lower extremity weakness requiring reoperation and pedicle screw revision. Two patients died after surgery: one from aneurysmal sub-arachnoid hemorrhage and the other from complications of breast cancer. They concluded that, the use of an integrated rib flap and titanium mesh cage construct appears to be a safe and effective means of providing immediate and substantial anterior column support as well as achieving arthrodesis in challenging fusion candidates.[41,28,24]

Dvorak et al[45] in a retrospective cohort study with cross-sectional outcome analysis of patients who underwent anterior column reconstruction with a titanium mesh cage after single-level or multilevel thoracic or lumbar vertebrectomy. Their Objective was to radiographically evaluate the ability of titanium mesh cages to maintain alignment and facilitate osseous fusion after thoracolumbar vertebrectomy. Secondary objectives assessed complications and patient outcome.

The degree of kyphosis and the subsidence of the cage in relation to the vertebral endplates were measured in 43 of 57 (75%) patients available at a minimum of 2 years following titanium mesh cage reconstruction. Health-related quality of life and disability were assessed with various cross-sectional outcome measures[45]. The average kyphosis of 25.4 degrees before surgery was reduced to 7.5 degrees immediately after surgery, and at final follow-up was measured to be 10.4 degrees. Cage subsidence averaged 0.28 and 0.20 cage fenestrations at the cephalad and caudal endplates, respectively. Osseous union (Grade 1 or 2) was identified in 93% of radiographs at the final follow-up.[42,44] Thoracic reconstructions were significantly more likely to require surgical revision because of mechanical failure than thoracolumbar or lumbar reconstructions. They concluded that, the cylindrical mesh titanium cage is a successful adjunct in restoring and maintaining sagittal plane alignment after thoracolumbar vertebrectomy and, in this context, provides an effective method for anterior column reconstruction.[45,46]

Karaeminogullari et al[8] analyzed radiological outcome of titanium mesh cages used for anterior column support following corpectomy in the thoracic and lumbar spine in 34 patients with a minimum three-year follow-up. The aim of the study was to assess the complications and radiological outcomes of patients with structural cages implanted into the anterior column. Titanium mesh cages for the anterior column became popular for anterior column reconstruction following discectomy and corpectomy. Measurements of preoperative and early postoperative local kyphotic angle revealed that a mean correction of 27 degrees (range: 8 to 60) was obtained. While no dislodgement or fracture of titanium mesh cages was observed, there was a mean correction loss of 4 degrees and settling (> 2 mm) was noted in 6 patients. Short posterior and only anterior instrumentation systems were associated with settling. The anatomical location and diagnosis did not affect the development of cage settling. They concluded that Following corpectomy and mesh cage implantation, isolated anterior fixation or short posterior fixation do not provide enough stability, and correction loss and settling can occur.[47,48]

Robertson et al[49] evaluated the radiologic stability of titanium mesh cages (TMCs) when used for single-level corpectomy reconstruction of thoracic and thoracolumbar spine. Thirty-one patients underwent reconstruction for acute fractures (n = 15), posttraumatic deformity reconstruction (n = 10), neoplastic disorders (n = 4), and infection (n = 2). The cages were placed after corpectomy and excision of the adjacent intervertebral discs. Additional stabilization devices included anterior plates alone (n = 18), anterior double screw and rod constructs alone (n = 9), a single anterior rod system (n = 1), posterior stabilization alone (n = 6), and additional posterior stabilization (n = 2). Mean kyphosis correction was from 16 degrees to 5 degrees with 3 degrees of recurrence at 1-year follow-up In patients with greater initial kyphosis (> 20 degrees), mean correction was from 33 degrees to 10 degrees without recurrence (P = 0.004). Distance between adjacent vertebral bodies improved by 13 mm after cage placement, with a mean of 2mm of settling at final follow-up. There was one asymptomatic cage fracture without evidence of other problems.[50,51] Two patients had construct failure after complex three-dimensional deformities were inadequately corrected and the cages had been placed in an angulated position. The authors suggested that TMCs are a sound reconstruction alternative after thoracic and thoracolumbar corpectomy at a single level and may prevent complications associated with the harvest and use of large structural autografts for these reconstructions. Failure to correctly align the spine so the cage can be vertically placed is a contraindication to the use of TMCs.[53-55]

CONCLUSION

1. By using anterior interbody fusion (AIF) with cage we can mobilize the patient early.
2. Improvement of the neurological status is excellent.

3. Per operative infection rate is very low.
4. Deformity can be corrected with more accuracy.

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