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Comparative Analysis of Interbody Cages versus Tricortical Graft in Isolated Traumatic Cervical Spine Injury Patients

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Abstract: ***Introduction: Cervical spine injuries are becoming very common which can result in significant and long - term disabilities. There are many different techniques and modalities of fixation which is used in anterior cervical discectomy and interbody fusion in traumatic cervical spine injury. Each procedures have their own merits and demerits. Such variety of techniques reflects a lack of consensus method to be performed to get the uniformity in the outcome. Aims and objectives: Prospective study was done to analyse safety and efficacy of tricortical autograft (Group A) and cylindrical titanium cage filled with cancellous bone (Group B) in procedure of ACDF for single level cervical discectomy in traumatic cervical spine injury patients. Materials and methods: Twenty four patients with traumatic cervical spine injury with single level disc protrusion selected for the study. Computer generated randomization done and twelve patients were operated with tricorticate iliac crest graft (Group A) while twelve patients were operated with stand alone titanium cages filled with cancellous bone from January 2020 to January 2022. Odoms criteria, Sequential radiographs and visual pain analogue score obtained to assess the clinicoradiological outcome. Results: Functional assessment done by Odoms System shows in each group about 84 % of the patients satisfied with outcome. In both the groups no obvious statistical difference found which is assessed by visual analogue score. Fusion was present in 92 % of patients in tricortical graft group and 84 in Cage group after the 6 month of follow up. In tricorticate group Graft collapse was seen in 1 patient while in titanium cage group 1 patient shows anterior extrusion of cage which required revision surgery. Conclusion: Use of tricortical bone and the titanium cage both shows adequate stability and reliable functional outcome in traumatic cervical spine injury. Titanium cage for the cervical fusion constitute an efficient alternative to tricortical autograft.***

Keywords: Anterior Cervical Discectomy and Fusion, Cervical spine injury, Tricortical iliac graft, Titanium cage, Neurosurgery

1. Introduction

In today's world of racing against time, pace is the world and this pace is one of the causes of dreaded condition that is fast becoming a bane on modern human life and that is trauma. Traumabears the greater cost of human suffering related to spine injuries in form of impaired ambulation and other neurological dysfunctions. In cervical spine injury patients Anterior Cervical Discectomy and Fusion (ACDF) is an established and proven surgical procedure for definitive management with predictably good results [1, 2]. This procedure works doubly by decompressing spinal cord and increasing neuroforaminal size and volume by anterior interbody distraction in cervical spine and correcting any listhesis or the change in alignment of the vertebral column [3, 4]. Intervertebral fusion can be facilitated by using autograft (Iliac crest, fibula), allograft or bone graft substitutes. Cervical spine can be further stabilised by use of anterior cervical plate, standalone cage or combination of both to maintain curvature and decrease pseudoarthrosis. Standalone graft shows complications such as graft subsidence, dislodgement, non - union and donor site morbidities. Similarly Using titanium cage alone after ACD shows complication such as dislodgement, subsidence but Intervertebral cages have been postulated to avoid some of these difficulties due to their self - fixing construct, ability to contain graft or graft substitute in it. In this prospective study, we evaluated two different fusion and fixation methods: autologous tricortical iliac crest bone graft and standalone threaded titanium cage stuffed with cancellous bone cylinders harvested using minimally invasive methods.

Aim: This Study was conducted in tertiary care Government institute to analyse safety and efficacy of tricortical autograft with cylindrical titanium cage filled with cancellous bone in procedure of ACDF for single level cervical spine injury patients.

2. Materials and Methods

Study was carried out in tertiary carecentre, Government Medical College and hospital from January 2020 to January2022.24 patients with cervical spine injury with single level disc protrusion were included in study. Detailed assessment of neurological status and co - morbidities, radiological confirmation of diagnosis was done with plain radiographs of cervical spine, CT cervical spine and magnetic resonance imaging. Patients were planned for anterior cervical discectomy and fusion after achievement of hemodynamic stability. Computer generated randomisation done to assign mode of fusion.12 patients were operated with Tricortical Iliac Crest autograft (Group A) while 12 patients were operated with non - coated threaded titanium cage stuffed with cancellous bone harvested using minimally invasive measures (Group B) for fusion after discectomy. The following patients with isolated cervical spine injury

having single level disc protrusion age >15 years, hemodynamically stable, Grade 1 listhesis or no listhesisand without any obvious body fractures are included in the study. Pediatric age group patients, patient in Spinal shock, more than Grade 2 listhesis and hemodynamically unstable patients were excluded from the study. The clinical and demographic profiles were comparable in both groups are as follows:

Table 1: Clinical and Demographic Profiles

	Group A	Group B
Number Of patients	12	12
Male/Female	8/4	9/3
Mean Age	42.6	46.51
Involved Level		
C3 - C4	1	1
C4 - C5	2	3
C5 - C6	5	4
C6 - C7	4	4

Surgical Approach: Patients included in the study were operated by the same surgeon in same operation theatre at KGMCH. Patients were operated in supine position with partially extended position of neck by placing a small bolster under scapular blades. Position of skin incision determined with the help of C arm. Transverse skin incision was taken from midline till medial border of the sternocleidomastoid muscle at the appropriate level of vertebral pathology. Fascial sheath and platysma were incised in the line of skin incision to reach deep cervical fascia. Sternocleidomastoid muscle was retracted laterally and strap muscles (sternohyoid and sternothyroid) were retracted medially. Carotid pulsations were localized with digital palpation and dissection plane was developed between medial edge of carotid sheath and the midline structures by blunt dissection of pretracheal fascia on the medial side of carotid sheath. Carotid sheath with its enclosed structures and sternocleidomastoid were retracted laterally. Plane was developed deep to pretracheal fascia. Prevertebral fascia including anterior longitudinal ligament were divided, and Longus colli muscle was reflected subperiosteally from anterior aspect of vertebral body. After exposing the site of involved vertebrae, level of disc to be operated was confirmed. Stab knife was used to cut anterior longitudinal ligament and annulus fibrosis. All possible disc material was removed. Partial curetting of end plate were done. This prevents post operative graft collapse or cage subsidence. Cages (Fig 2) can sit through end plates to subchondral bone by their threads. Cage size was determined by preoperative templating, intraoperative evaluation using a trial cage and fluoroscopic guidance.

Figure 1: Tricortical iliac graft

Figure 2: Titanium Cage

Figure 3: Graft harvesting Technique

Cage was filled with cylinder of cancellous bone harvested from iliac crest with minimal invasion using a specially made graft harvesting sleeve. After a small stab incision over widest palpable portion of iliac crest, a sleeve with cutting edges at end and trocar (Fig 3) was secured at iliac crest. After removal of trocar, with rotatory movements in direction of iliac blade, sleeves carve out a cylinder of cancellous bone between two tables of ilium. In the patients with tricortical iliac graft (Fig 1) incision of about 5 - 6 cm made posterior to ASIS along subcutaneous border of iliac crest. Desired size of tricortical graft harvested after cutting both the tables of iliac bonewith an osteotome. Stability of graft or cervical cage was checked intraoperatively under vision. Wound was closed in layers. Patient's neck was immobilised with hard cervical collar post - operatively. The patients were followed up at regular intervals and examined for relief of pain, neurological status, radiological examination to know the position of grafts its incorporation, position of implant and any complication. Patient adviced to use cervical collar for at least 3 months, active and passive motion exercises of extremities were started. On follow - up other than neurological reassessment, radiographs of cervical spine in lateral projection were done to assess for union activity. All patients followed up range from 9 months to 3 years.

Radiological and Clinical Evaluation

Odom's Criteria was used for the evaluation of results Evaluation of results [7, 8]. Patients also evaluated by Visual pain analogue (VPA) scale [8], lateral projection radiographs of cervical spine to see fusion and overall satisfaction of patient with treatment. Odom et al., classified functional results as excellent, good, fair, or poor based on union activity between vertebral bodies, radicular symptoms and neurological recovery. Neurological involvement was assessed for motor, sensory, autonomic functions and peripheral reflexes. Motor power was graded based on MRC

(Medical Research Council) criteria. Osseous trabeculae bridging the disc space on lateral radiograph shows the fusion was solid. In cases of threaded titanium cervical cage fusion was considered solid, when on lateral flexion and extension radiograph, the difference of distance between tips of spinous processes at fusion levels was less than 2 mm [8, 9]. Patients with persistent symptoms or deteriorating symptoms were planned for further evaluation by magnetic resonance imaging. Patients showing good postoperative functional outcome and radiographic fusion were excluded for postoperative MRI.

Excellent	• Solid fusion on radiograph. • No neck or arm pain. • Normal finding on neurological examination.
Good	• Solid fusion on radiograph. • No neck or arm pain. • Neurological improvement with mild residual problem.
Fair	• Solid fusion on radiograph. • Persistent neck or arm pain, • Post operative myelogram or magnetic resonance imaging reveals no additional neurological compression.
Poor	• Continued symptomatic nonunion • Neurological worsening • Need for a reoperation.

Figure 4: Odom's criteria

VPA Score was measured using Visual pain analogue scale. Patient is asked to indicate perceived pain intensity along a 10 cm horizontal line. A score of 0 cm indicate absence of pain & 10 cm as worst pain even experienced by the patient.

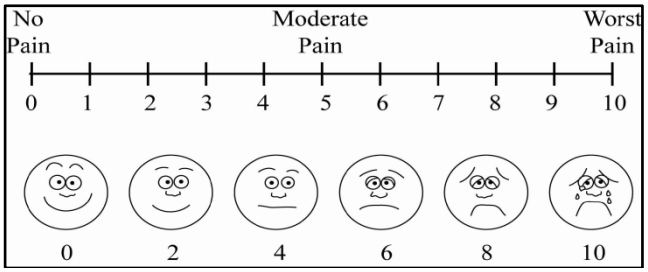

Figure 5: Visual Pain Analogue Scoring

Results

1) Radiological Fusion: Fusion was achieved in all patients in both groups except for one patient in Group A, with duration for fusion ranging from 3 - 7 months in both groups with mean duration in tricortical graft group 4.7 months (4 - 6 months) and cage group 4.2 months (3 - 7 months). One patient of tricortical graft group presented with kyphosis associated with partial graft extrusion and graft collapse. But presence of graft collapse and segmental kyphosis was not associated with adverse clinical outcome. (Fig 6 and 7)

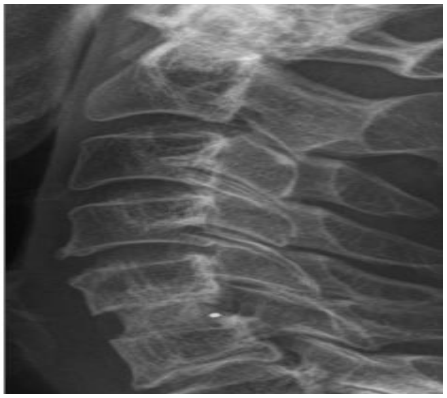

Figure 6: Ilaic graft at C5 - C6 discectomy

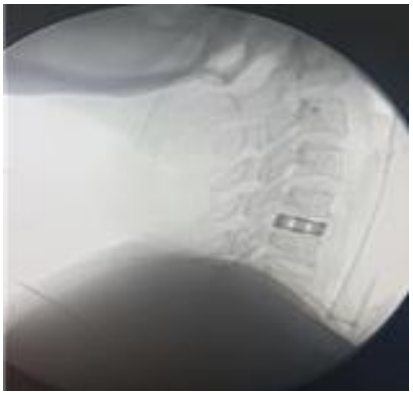

Figure 7: Titanium Cage at C5 - C6 level

2) Odom's criteria (Fig 4) In 84% patients of ACDF with tricortical graft group was having excellent to good result while cage group shows excellent to good results in about 92% of patients. Two patients in Graft group had poor results due to persistent radiculopathy and neck pain while Similar complaints are seen in one patient in cage group.
3) VPA Score There is significant improvement in VPA score in all patients except one in each group after

ACDF in both groups at last follow - up. Mean preoperative VPA score in tricortical graft was 6 (range 3 - 8) which decreased significantly to new mean level of 3 (range 1 - 9). Similarly, in cage group mean preoperative score was 6 (range 3 - 9) which reduced to a new level of 2 (range 1 - 9). (Fig 5)

4) Neurological improvement: Neurological deficit was present preoperatively in 8 among tricortical graft group and 9 in cage group. There was improvement in neurological status in all patients within 6 months after surgery. Motor deficit was first to improve followed by sensory deficit.
5) Complications and Patient satisfaction: Any intraoperative complication was encountered in any patients. No patient neurologically deteriorated in post - procedure neurological assessment. Dysphagia was noted after surgery in 2 patients (one in tricortical graft group and one in cage group), which was transient to settle within a week in all patients. In immediate postoperative period, appropriate positioning of cage and graft was confirmed by lateral cervical radiograph. Partial graft extrusion and graft collapse was present in one patient in tricortical group. Three instances of donor site morbidity were present in group A one having superficial stitch infection and two having chronic operative site pain. Patient satisfaction as reported by patients at the end of follow up was 84% in each group.

Table 2: Clinical and Radiological Assessment

	Group A	Group B
Radiological fusion		
Patients	12	12
Non Union	1	0
Duration	4 - 6 months	3 - 7 months
VPA score	Mean 3 (range 1 - 8)	Mean 2 (range 1 - 9)
Odom's Rating	Excellent 6	7
	Good 4	4
	Fair 0	0
	Poor 2	1

3. Discussion

Anterior cervical discectomy and fusion is established modality for treatment of degenerative conditions of cervical spine with radiculopathy as well as in the traumatic disc disease [1, 4, 5]. Different modifications and methods have evolved in clinical practice without establishing superiority of one over other. One such aspect of procedure with multiple methods in practice is modality to facilitate fusion [5, 8, 9]. Fusion provides stability to the spinal column after anterior cervical discectomy. Use of tricortical graft or Biomechanical disc spacers like cage restores the height of the disc space by relieving buckling of posterior longitudinal ligament and ligamentum flavum and corrects any translation or rotionalchangesin the vertebral bodies if present. It relieves cord compression and restores volume of the neural foramen thereby decompressing nerve root by the principle of ligamentotaxis. A fusion diminishes neural irritation by limiting motion and by allowing resorption of osteophytes partially [8 - 10]. Conventionally, tricortical autograft is considered gold standard for fusion which provides osteogenic, osteoinduction and osteoconduction properties to graft along with mechanical strength owing to cortical struts in it. Such autografts producesconcerns like graft collapse, graft extrusion and donor site complications. Graft has poor self - fixing characteristics and it can extrude, collapse or fail to heal resulting in symptomatic pseudoarthrosis [5, 10, 11]. Harvesting of iliac crest graft by minimaly invasive methods aims to minimise various complications of graft harvesting, while giving benefits of autograt and saves surgical time by avoiding complex en - block harvesting of tricortical graft fills cage very well due to cancellous nature. Allograft eliminates donor site morbidity but having chances of disease transfer like HIV or hepatitis, though very rare [12]. Derived from lumbar spine experience, a titanium cervical cage is proposed as an alternative method for cervical spine fixation and fusion simultaneously providing strength of cortical strut and osteogenic potential with minimal morbidities [12]. Different types of Biomechanical spacers made of materials like Polyetheretherketone (PEEK), Methymethacrylate, Hydroxyappetite ceramics and Implant made of carbon fiber, titanium, tantalum etc are there in use. Threaded titanium cagesprovides immediate stability, minimising donor site morbidity, easier implantation technique having less operative time and less chances of cage related complication [11, 14 - 18]. Cage subsidence is most common complication associated with standalone cages with varied incidence rate by various investigators [16 - 19]. Barsa et al., reported 19 of 144 inserted cages (13.2%) subsided in his series [19], while Bartels et al., noticed an incidence of 29.2% in series of 69 patients [20]. In our patients, we reported one incident of cage subsidence without any neurogical deterioration but results are of follow up of few years only. In our study Clinical outcome is independent to incidence of cage subsidence and does not correlate with it. Moon et at., Bartels et al., and Gereck et al., found no correlation between poor functional outcome and cage functional outcome. subsidence which seems to be independent of functional outcome [18 - 21]. One patient in our series had graft subsidence, but hadgood functional outcome. In our series, persistent pain in one patient in each group was evaluated with MRI and adjacent disc disease was incriminated as cause of pain and poor satisfaction at the end of treatment. There are many studies regarding the various cage materials and have been studied in comparative studies. Titanium cage and PEEK cages have been compared with respect to physical properties, functional outcome and incidence of complications. Modulus of elasticity is higher for titanium cages, but not translate into higher incidence of complications with use of titanium cages as compared to other cage designs. Cabraja et al., did not found any statistical difference between two materials of cage with respect to cage subsidence, fusion rates and lordosis maintenance [22]. Thom et al., found cage as safe modality for fusion as compared to tricortical autograft with better functional outcome in cage group with a less concern fordonor site morbidity [23]. In our study also, although functional outcome of both groups is comparable with similar complication profile, Graft site morbidity occurred in three patients in tricortical graft group. Every study has some drawbacks, so has our study. An investigator blinded study with larger number of study subjects as well as longer period of follow up will establish true clinical superiority of one technique over other. Cancellous graft required in cage group is small in volume and can be easily harvested using

trochar - sleave instruments giving small cylinders of pure cancellous bone, which can be easily stuffed in titanium cage. It does not inflict donor site morbidity associated with harvesting and dissection of large tricortical graft.

4. Conclusion

Using titanium cage filled with cancellous graft is a less invasive, simple procedure for anterior cervical discectomy and fusion. It reliably alleviates neurological Symptoms caused by cervical spine injury by attaining decompression and adequate interbody fusion. Itconclude that titanium cages after cervical discectomy constitute a safe and equally efficient alternative to iliac crest autograft by providing adequate stability and good functional outcome. Minimally invasive harvesting of cancellous graft saves surgical time and various complications associated with other methods.

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