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Height of Tri-Cortical Iliac Crest Graft and Plate Size in Anterior Cervical Decompression and Fusion Surgery in Indian Population

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Abstract:
Aim: *To assess ideal height of tri-cortical iliac crest graft and size of plate in anterior cervical decompression and fusion surgery.*
Materials and methods: *30 patients were included in this study. All of them underwentanterior cervical decompression and fusion surgery for traumatic and other differentdegenerative cervical spine pathologies. Intra-operative size of tri-cortical iliac crest graft and plate were measured using calibrated measuring caliper.*
Result: *In our study, 15 patient undergone anterior cervical discectomy and fusion (ACDF) for discal and retro-discal pathologies, while same number (15) of patient undergone anterior corpectomy and fusion (ACCF) with vertebral and retro-vertebral pathologies. Average height of graft was 7.4 mm (range 6-10 mm); while mean size of cervical plate was 16.9 mm (range 16-20 mm) in patients who had undergone ACDF. Average size of graft was 21.85 mm (range 18-26 mm); while mean plate size was 32 mm (range 26-34 mm) in patient who had undergone single level ACCF.*
Conclusion: *Although our study included less number of patients and large numbers of static and dynamic factors affects final clinical and radiological outcome, graft height of 7.4 (+/-) 1.4 mm and plate size of 16.9(+/-) 1.48 mm is optimum for ACDF; as well as graft height of 21.85 (+/-) 1.65 mm and plate size of 32 (+/-) 3.08 mm is optimal for single level ACCF.*

Keywords: *Cervical, Decompression, Fusion, Height, Graft*

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I. Introduction

Anterior cervical decompression and fixation is the most common surgical procedure done for various cervical spinal pathologies. It includes both anterior cervical discectomy and fusion (ACDF) and anterior cervical corpectomy and fusion (ACCF). More specifically ACDF is usually done for discal and retrodiscal pathologies while ACCF is done for vertebral and retro-vertebral pathologies. Anterior cervical decompression and fusion facilitates proper decompression of spinal cord as well as provides stability and bony union concomitantly. Autogenoustricortical iliac bone graft and cage containing bone substitutes are usually used in the procedure to achieve bony union and stability. Height of graft is very important as small size graft does not restore optimal cervical height and lordosis and have increased extrusion rate and postoperative kyphosis while; larger size graft provide more stability, indirect neuroforaminal decompression and unbulking of ligamentumflavum but simultaneously have increased chances of posterior axial neck pain, graft fracture, endplate failure, non-union and subsidence.

Our purpose of study is to assess ideal height of graft and plate size in anterior cervicaldecompression surgery in Indian population.

II. Material and method

Study patients

This is a retrospective type of study done in spine care unit of VMMC and Safdarjung hospital, a tertiary care center in northern India. In this study, 30 patients (21=male, 9=female) were taken in our study who underwent anterior cervical decompression surgery. Out of 30 patients, (15) had post traumatic fracture of cervical vertebrae and in (13) patients had post traumatic cervical intervertebral disc protrusion while 2 patients had degenerative cervical disc disease.

Average age of presentation was 31.4 years. (Range 15 years to 62years). Most common etiologies leading to traumatic cervical injury was fall from height (24), followed by road traffic accident (2). 1 patient had history of fall of heavy object over Head while 1 had sustained injury during stampede. All patients underwent preoperative stabilization, through general examination, proper neurological examination and radiological evaluation including plain Antero-posterior and lateral view of cervical spine, NCCT and MRI of cervical spine along with screening of whole spine. Crutch field tong skeletal traction was given all post traumatic patients except in patients with contraindication. Out of (15) patient with cervical vertebral fracture, (6) had fracture of C5 vertebra, (4) had fracture of C6 vertebra, (3) had fracture of C7 vertebra, (1) had fracture of C4 and 1 had double level adjacent vertebral fractures of C5 and C6 vertebrae. Out of (15) patient with retrodiscal pathologies, (5) patients had compression over C5-C6, (4) had compression over C4-C5, (3) had compression over C6-C7, (2) had compression over C3-C4 and (1) had compression over C7-T1. Patients with fracture of cervical vertebra or retro-vertebral pathologies underwent anterior cervical corpectomy and fusion (ACCF); while in patient with discal or retrodiscal pathologies, anterior cervical discectomy and fusion (ACDF) were done. All preoperative detail and procedures were recorded and analyzed (Table 1).

Surgical method:

Left sided transverse incision was made along the skin to the target cervical spine segment. After approaching the site of injury, the spinal segment was confirmed by fluoroscopy. Using Caspar pin retractor in the adjacent normal cervical vertebrae, damaged intervertebral disc in case of disc protrusion and cervical vertebral body in case of vertebral fracture were removed.

Proper decompression was done up to posterior longitudinal ligament (PLL) posteriorly and unco-vertebral joint bilaterally. In case of discal pathologies, posterior longitudinal ligament were also removed. The lower endplate of the superior vertebra and the upper endplate of the lower vertebral body were grinded and prepared.

Manual distraction was given to Casper pin distractor in such a manner to achieve normal cervical lordosis, slight neuroforaminal distraction and unbuckling of posterior longitudinal ligament with avoidance of overstretching of spinal cord. Measurement of graft size was done using calibrated measuring caliper so that its end would just touches the grained end plates (Fig 1). Same size of tri-cortical strut bone was removed from the autogenous iliac bone and then prepared as a wedge-shaped strut bone in such a way, that anterior height would be more by 1- 2 mm as compared to posterior (Fig 2). This was followed by insertion of graft in well prepared box shaped cavity with the help of punch and mallet. Thereafter Casper pin distractor was removed and proper positioning of graft was confirmed with the help of fluoroscopy. Thus, efforts were made to restore cervical lordosis and assessing snuggly fitting of graft. After that, measurement for size of anterior cervical plate was done using calibrated measuring caliper so that screws would enter subchondrally in the adjacent cervical endplates (Fig 3). This was followed by application of cervical plate and proper positioning was again confirmed by fluoroscopy. Number 10 suction drain was applied and suturing was done in layers.

Post operatively all patients were mobilized with SOMI brace immobilizer for 6 weeks. After 6 weeks, SOMI brace were removed. Intensive physiotherapy and self-intermittentcatheterization were done in post op and follow up period.

III. Figures and Table

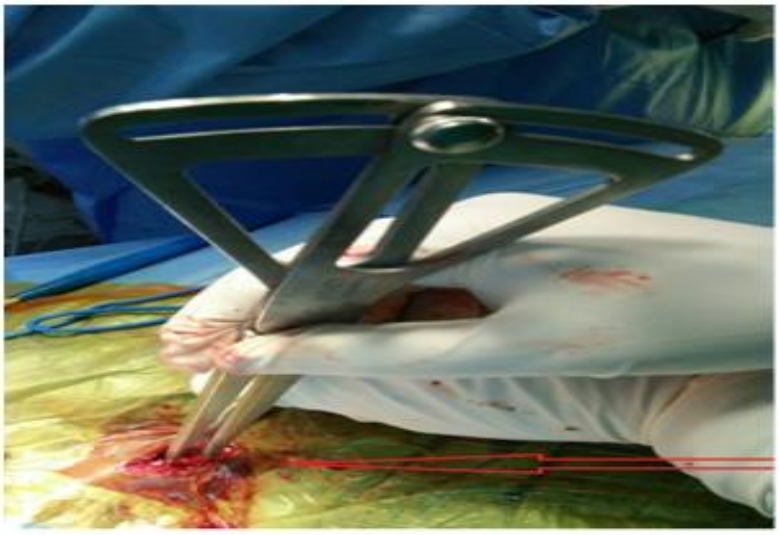

Fig (1) Picture of callibrated caliper during measurement of graft size

Fig (2) Picture of tri-cortical iliac crest graft after graft carpentery

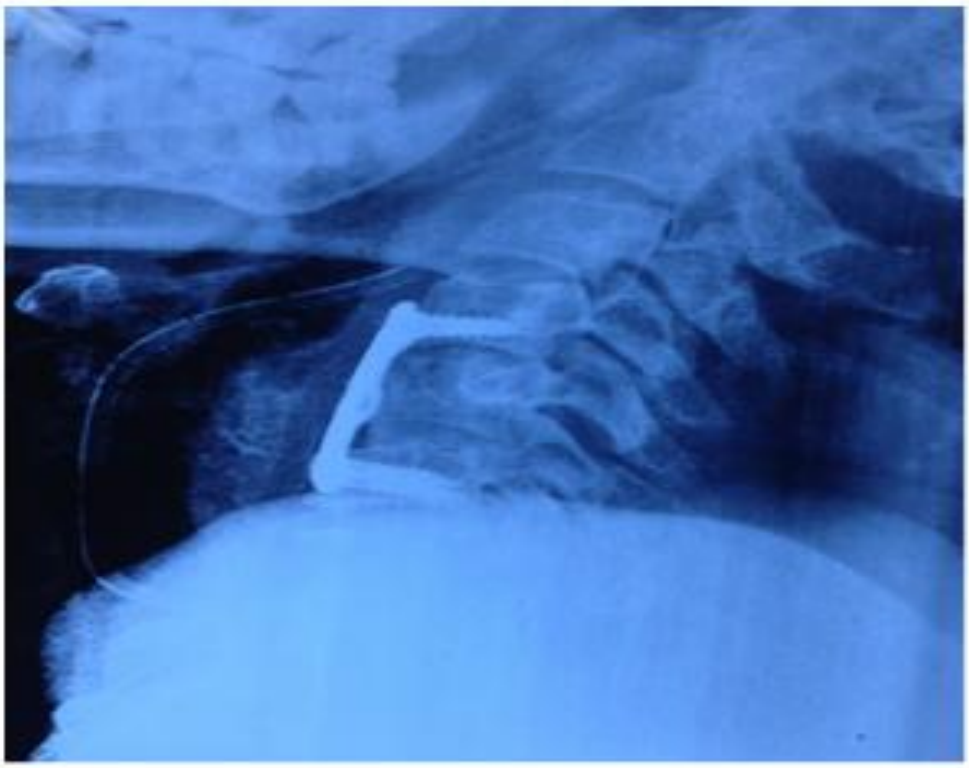

Fig (3) Lateral view of cervical spine showing ideal graft with cervical plate and subchondrally placed screw

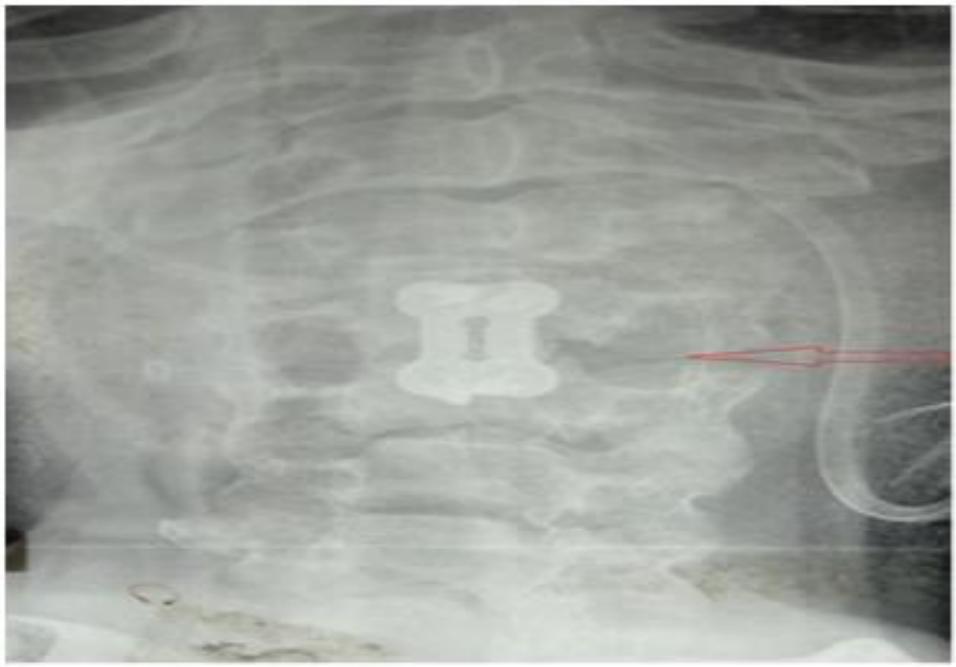

Fig (4) Antero-posterior view of cervical spine showing distracted facet joint due to oversized tri-cortical iliac crest graft (excluded from study)

Fig (5) Lateral view of cervical spine showing distracted facet joint due to oversized tri-cortical iliac crest graft (excluded from study)

S.no.	Age	Gender	Injury	Procedure	Graft size in mm	Plate size in mm	Mode of Injury
1	62	M	PIVD C5-C6	ACDF	6	16	Degenerative
2	45	M	PIVD C3-C4	ACDF	6	16	Fall from Height
3	35	M	PIVD C5-C6	ACDF	7	18	Fall from Height
4	30	M	PIVD C6-C7	ACDF	6	16	Fall from Height
5	30	F	PIVD C4-C5	ACDF	6	16	Fall from Height
6	45	M	PIVD C5-C6	ACDF	8	16	Fall from Height
7	20	M	PIVD C4-C5	ACDF	6	14	Road Traffic Accident
8	50	M	PIVD C6-C7	ACDF	8	18	Fall from Height
9	44	M	PIVD C5-C6	ACDF	8	18	Road Traffic Accident
10	45	M	PIVD C4-C5	ACDF	8	16	Fall from Height
11	52	F	PIVD C6-C7	ACDF	10	18	Degenerative
12	30	M	PIVD C7-T1	ACDF	8	20	Fall from Height
13	34	M	PIVD C3-C4	ACDF	10	18	Fall from Height
14	30	M	PIVD C4-C5	ACDF	8	18	Fall from Height
15	42	M	PIVD C5-C6	ACDF	6	16	Fall from Height
16	20	M	#C5	ACCF	22	30	Fall from Height
17	32	M	#C6	ACCF	26	36	Fall from Height
18	23	M	#C6	ACCF	22	36	Fall from Height
19	32	M	#C5	ACCF	22	36	Fall from Height
20	18	M	#C6	ACCF	20	26	Stampade
21	18	M	#C5,#C6	ACCF (2 LEVEL)	45	54	Fall from Height
22	24	M	#C7	ACCF	22	36	Fall from Height
23	20	M	#C5	ACCF	22	30	Fall from Height
24	26	F	#C4	ACCF	22	30	Fall from Height
25	15	F	#C7	ACCF	22	30	Fall from Height
26	20	F	#C5	ACCF	22	32	Fall from Height
27	20	F	#C5	ACCF	22	34	Fall from Height
28	30	F	#C7	ACCF	18	32	Fall of Heavy object over Head
29	60	M	#C6	ACCF	22	32	Fall from Height
30	35	M	#C5	ACCF	22	30	Fall from Height

Table (1) Preoperative detail and operative procedure done

III. Discussion

Anterior cervical decompression and fusion (ACDF) is the most common procedure done fordifferent cervical pathologies where compression lies anterior to spinal cord- prolapsedintervertebral discs (PID), ossified posterior longitudinal ligament (OPLL), spondylodiscitis andretropulsion of fractured bony fragments. It was first described by Robinson and Smith1. It hasshown excellent results based on long term data, resulting in its current extensive use. Howeverit can also leads to complications ranging from soft tissue swelling to life threateningcomplications like esophageal rupture, tracheal stenosis, sympathetic chain injury andrecurrent laryngeal injury during intra-operatively8. Late complications include graft collapse orextrusion, endplate failure, nonunion, post-operative kyphosis, posterior axial neck pain.However no major complication had occurred intra-operatively in our study. Only 1 patientunderwent tracheostomy after development of respiratory distress on 8th day postoperatively.

The size of graft is very important as it affects clinical outcome. Larger grafts distract theanterior column, thereby indirectly decompressing the neural elements through increasedneuroforaminal height and unbuckling of ligamentumflavum 2(Fig 4 & 5). However, these largegrafts may influence axial load transmission through the cervical spine. Pal and Sherket al3found that 36% of the axial load typically is borne through the vertebral body anteriorly,whereas 32% is borne by each of the posterior pillar. Excessive anterior distraction maydecrease posterior column load transmission, thereby subjecting the anterior graft andvertebral bodies to excessive load4. Thus oversized graft increases the risk of graft fracture orendplate fracture, leading to graft subsidence and non-union.

On the other hand, smaller graft may not optimally restore cervical lordosis. Moreover smallergrafts with loose fitting have slightly higher extrusion risk.5

Historically Robinson and smith recommended use of 10-14 mm graft1. An et al.6 reportedthat the magnitude of compressive force on anterior cervical grafts varied significantly and wasinfluenced by patients size, cervical level, the number of levels fused, alignment of the spineand the exact position of graft. They also determined that for discs with a preoperative heightbetween 3.5-6 mm, the inter-body grafts should be 2 mm larger than the preoperative height.Brower et al.7 reviewed fusion data retrospectively and identified a trend toward non-unionwhen baseline disc height was distracted more than 4 mm. More recent studies haverecommended smaller

grafts 4to 7 mm in size.8,9 In addition to the ideal size of graft, manyothers factors like age, external axial load, integrity of disco-ligamentous complex, neck motion,neck musculature's compressive forces may affect clinical outcome. Furthermore size of graftmay also depend upon human race.

Typically size of grafts are assessed by interference fit at the time of surgery or based onpreoperative radiographic templating. Till date, ideal size of graft remains unknown, particularlyin Indian population. Measurements of preoperative disc height are not useful predictors ofsubsequent graft forces. Intraoperative assessment of distractive forces required to insert agraft may be useful, but compressive force required for tight fitting of graft is much less thanfailure loads of cervical endplate or graft10. Aim of the surgery is to restore optimal cervicallordosis and neuroforaminal distraction without excessively unloading of posterior column.
Patient with fracture of vertebral body underwent ACCF while patients with protrusion of discand with retrodiscal pathologies underwent ACDF. Our purpose is to assess ideal height of graftand cervical plate size in Indian population. Simultaneously it also decreases donor sitemorbidity due to calculated size of graft and avoiding wastage of graft during preparation.

IV. Results

In our study, 15 patients undergone anterior cervical discectomy and fusion (ACDF) for discaland retrodiscal pathologies, while same number (15) of patients undergone anteriorcorpectomy and fusion (ACCF) with vertebral and retrovertebral pathologies. Out of 15patients in which ACDF had been done, graft height was 6 mm in 6 patients, 8 mm in 6 patients,10 mm in 2 patients and 7 mm in 1 patient; while Size of cervical plates was 16 mm in 7patients, 18 mm in 6 patients, 14 mm in 1 patient and 20 mm in 1 patients. Average size of graftis 7.4 mm with standard deviation (SD) of 1.4 mm; while mean size of cervical plate is 16.9 mmwith standard deviation (SD) of 1.48 mm in patients who had undergone ACDF. Graft height of7.4 (+/-) 1.4 mm and plate size of 16.9(+/-) 1.48 mm is optimum for ACDF in 86.66% of Indianpopulation.

Patients who had undergone ACCF surgeries, graft size was 22 in 10 patients and 18mm in 1 ,20mm in1, 22 mm in 1 and 26 mm in 1 patient. Graft size was 45 mm in 1 patient with 2 adjacentlevel vertebral corpectomy ; while plate size was 30 mm in 5 patients, 36 mm in 4 patients, 32mm in 3 patients, 34 mm in 1 patient and 26 mm in 1 patient. Size of cervical plate was 54 mmin patient undergone two level adjacent corpectomy. So patient with double level corpectomyhad been excluded from data analysis to reduce bias. Average size of graft was 21.85 mm withstandard deviation (SD) of 1.65 mm and plate size was 32.14 mm with standard deviation (SD)of 3.08 mm in patient who had undergone anterior cervical corpectomy and fusion (ACCF).

Graft height of 21.85 (+/-) 1.65 mm is optimum for single level corpectomy in 80% of Indianpopulation; while cervical plate size of 32 (+/-) 3 mm is optimum for more than 64% of Indianpopulation.

V. Conclusion

Very few literatures are available regarding size of tri-cortical iliac graft used in anterior cervicaldecompression surgeries but ideal height of graft and cervical plate size remains unknown tilldate particularly in Indian population. Although our study included less number of patients andlarge numbers of static and dynamic factors affects final clinical and radiological outcome, graftsize of 7.4 (+/-) 1.4 mm and plate size of 16.9(+/-) 1.48 mm is optimum for anterior cervicaldiscectomy and fusion (ACDF) as well as graft size of 21.85 (+/-) 1.65 mm and plate size of 32(+/-) 3 mm is optimal for single level anterior cervical corpectomy and fusion (ACCF).

VI. Abbreviation

ACDF- Anterior cervical discectomy and fusion
ACCF- Anterior cervical corpectomy and fusion
OPLL- Ossified posterior longitudinal ligament
PID/PIVD- Prolapsed intervertebral disc
PLL- Posterior longitudinal ligament

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