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# Outcome associated with use of winged expandable titanium cage following cervical corpectomy: an institutional experience

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## Abstract

**Background** In patients with spinal cord compression behind the cervical vertebra who presented with myelopathy, one of the treatment modalities is anterior cervical corpectomy followed by insertion of graft or implant. Autogenous bone graft has been the choice of implant for corpectomy in the past, but due to donor site complications, it has been majorly replaced with other implants like titanium made expandable and non-expandable cages. Studies on titanium made implants for cervical compressive myelopathy have mostly focused on expandable cages with separate plates. Studies on hybrid cages and winged expandable titanium cages with (WETC) are lacking, especially in patients with poor Nurick grade. Here, we present clinical outcomes and side effects of WETC use following cervical corpectomy in 81 participants from a tertiary care center from Eastern India with 6 months of follow-up.

**Results** We observed a considerable improvement in clinical outcomes which was measured using Nurick grade as mean scores changed from  $4.06 \pm 0.85$  during the pre-operative stage to  $2.85 \pm 1.16$  post-operation ( $P < 0.05$ ). There was also a considerable improvement in the pain status as in the pre-operative stage there were three patients with mild pain, 53 with moderate and 25 with severe pain, but post-operation there were 53 patients with mild pain, only two with moderate pain and none with severe pain ( $P < 0.00001$ ). In these participants, we observed that post-surgical Nurick grade was not associated with age, gender or time since first symptoms but was strongly associated with pre-surgical Nurick grade at  $P < 0.05$ .

**Conclusion** With WETC (in situ plate), we were able to obtain good outcomes with less serious complication in patients with poor Nurick grade. As size of implant is prefixed and can be expanded in WETC, it takes relatively less time to insert, thus leading to shorter operative time. With good endplate preparation and avoiding over expansion of cage, WETC avoids complications.

**Keywords** Cervical corpectomy, Titanium, Expandable cage, In situ plate, Nurick grade, Myelopathy

## Introduction

Patients with different cervical disorders like trauma, infection, degeneration, or tumor may require corpectomy at single or multiple levels along with stabilization using implant. The established and standard graft used after cervical corpectomy has been iliac bone graft or fibular graft also called as tricortical autologous bone (TAB) [1]. TAB along with locking plate has been used by many clinicians. Graft harvesting often leads to pain, at local site it causes hematoma leading to increased morbidity, while at site of insertion it leads to pseudoarthrosis. Graft

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dislodgement has also been reported in many studies [2]. Non-expandable titanium cage (NETC) has been in use at least for 3 decades as an implant and is being used post-corpectomy for different types of pathologies [3]. Proper placement of NETC requires experience and can affect endplate integrity if not performed properly [4]. Expandable titanium cages (ETC) are another type of implants which can be adjusted to the height of bone defect. ETC comes as a single device or with integrated in situ plate. Use of ETC has shown promising results with good clinical outcomes as measured using the Nurick grade scale and has also shown improved radiological outcomes. Some researchers have highlighted increased adjacent level diseases and subsidence using ETC. Most of the studies reported so far have used expandable cage with separate plate. However, studies on winged hybrid cages or winged expandable titanium cages (WETC) with in situ plate are lacking in cervical compressive myelopathy (CCM), especially in patients with poor Nurick grade. In the current study, we describe outcomes and side effects of WETC in CCM patients from a tertiary center from Eastern India having poor Nurick grade.

## Materials and methods

Participants of this study were recruited from a tertiary care center in the city of Ranchi, from the state of Jharkhand located in Eastern India. The participants were recruited over a period of 2 years, which included eighty one consecutive patients of CCM. These patients underwent anterior corpectomy up to two levels with insertion of WETC and were followed up for 6 months post-surgery.

Only those patients who had traumatic subaxial injury with cervical instability or cervical myelopathy due to other causes like infection, degeneration, ossified posterior longitudinal ligament (OPLL) or tumor were included in this study. Patients with posterior involvement requiring a posterior approach or three or more contiguous affected vertebrae were excluded from this study.

Detailed history, examination and investigations were done at admission and at follow-up visits. All complications were assessed in immediate postoperative and at 6 months after surgery. The clinical outcome was evaluated using the Nurick grade scale in pre-surgical and post-surgical period at 6 months (Table 1) [5].

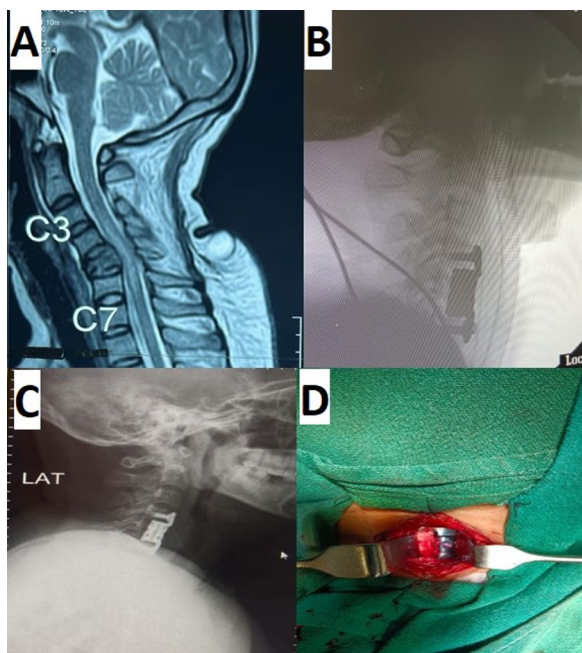
Patients who showed a Nurick grade of zero or one post-operation were considered to be cured. Patients who showed a drop of two levels of Nurick grade were considered to have a good outcome, while a drop of just one level was considered to have fair outcome, but no changes in Nurick grade were considered a poor outcome [5]. All patients underwent pain assessment during pre-operative and postoperative period using the numerical pain rating scale (NPS) [6]. Based on NPS scale, pain was categorized as having no pain (0), mild pain (1,2,3), moderate pain (4,5,6) and severe pain (7,8,9,10) [6]. Imaging-based evaluation, i.e., X-ray (AP, lateral)/CT scan/MRI scan were done routinely before operation, and at follow-up period for assessment of pathology and implant insertion. During operation, cage placement was confirmed using c-arm (image intensifier) shown in Figs. 1 and 2.

All patients underwent right sided anterior cervical incision approach. Discectomy was done above and below the affected vertebral site. Corpectomy was done using rongeur and high-speed drill. Uncal processes bilaterally gave fair assessment of lateral extent. A trench was made in center of body with diameter more than 12 mm. Posterior end of body was under cut for proper decompression of spinal canal. End plates were prepared using curette. Bone graft was obtained from resection site. The posterior longitudinal ligament was generally removed, and dura was exposed except in cases with densely adherent or ossified posterior longitudinal ligament. The titanium expandable cage with in situ plate was inserted, expanded and fixed using self-tapping screws under image intensifier guidance (C-Arm). The cage was filled with the resected bone graft harvested from the corpectomy. During postoperative period, patients were advised to wear Philadelphia collar minimum for a period of 8 weeks.

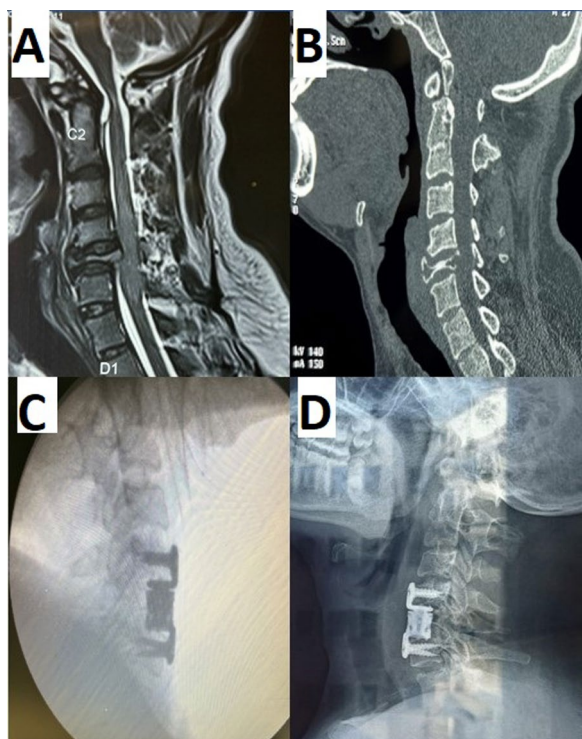
**Table 1** Nurick grades

Grade*	Description of the grade type
0	Signs or symptoms of root involvement but without evidence of spinal cord disease
1	Signs of spinal cord disease but no difficulty in walking
2	Slight difficulty in walking which did not prevent full-time employment
3	Difficulty in walking which prevented full-time employment or the ability to do all housework, but which was not so severe as to require someone else's help to walk
4	Able to walk only with someone else's help or with the aid of a frame
5	Chair bound or bedridden

\*Nurick grade was taken from previous publication by Nurick et al. [5]



**Fig. 1** A. Case of C 5 burst fracture cord changes on T2-weighted MRI, B. intraoperative image after cage insertion, C 6-Month follow-up image. D intraoperative image



**Fig. 2** A. MRI sagittal cut of C 5 fracture. B CT image of C 5 fracture. C Intraoperative image after cage insertion. D. 6-month follow-up image

All patients were guided and mobilized in the presence of physiotherapist. The present work was approved by the institutional ethical committee (ECR/769/INST/JH/2015/RR-18/09), and all patients were enrolled after obtaining written informed consent. There was no cost to the patient for participation in the study or for the implants as they were supplied free of cost under a government sponsored scheme.

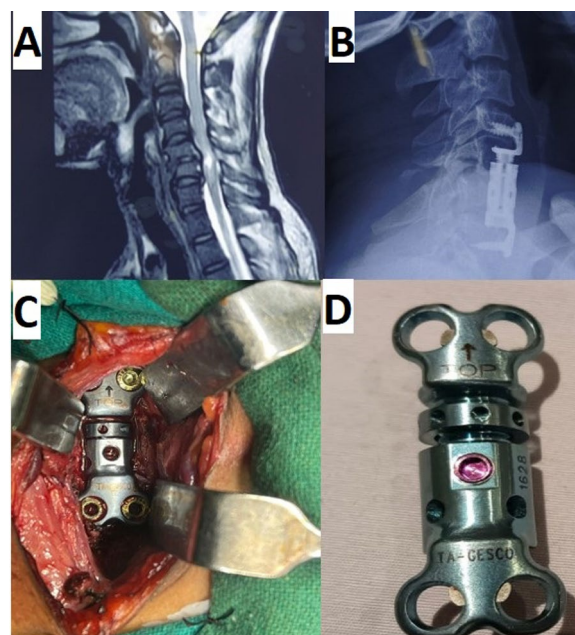
The implant used were of Titanium DAS ultra Gesco health care (integrated/in situ plate) (Fig. 3). The implant used came in four sizes (expansion height) with fixed diameters of 12 mm. The height ranged from 14 to 19 mm, 18 to 27 mm, 26 to 42 and 41 to 64. All implants had integrated plate.

Quantitative traits were expressed as means and standard deviations. Counts of categorical traits were expressed as N and percentages. Correlation analysis was performed using correlation function in R version 3.7 based on Pearson's coefficient. Linear regression was used to check association of pre- and post-surgical Nurick grade with age, gender and time since first symptom. All analyses were performed using R version 3.7 and P value < 0.05 was considered significant.

## Results

### Clinical results

A total of 81 patients (seventy one males and ten females) were included in the study who qualified the inclusion



**Fig. 3** A level C 5,6 cord compression with myelomalacia, B C 5,6 corpectomy with insertion of cage, C intraoperative fixation of cage, D titanium winged cage/cage with in situ plate

and exclusion criteria. All the data related to patients are presented in Tables 2 and 3. The mean age of patients operated was 39.74 years with lower limit being 10 years and upper limit being 70 years. Age categorization numbers are presented in Table 2.

In preoperative period pain as measured by NPS suggested there no patients who were free of pain,

three had mild pain, 53 had moderate pain and 25 had severe pain. In the postoperative period, we observed a significant improvement in pain status as there were 25 patients with no pain, 53 with mild pain, only two with moderate pain and none with severe ( $P < 0.00001$ ) (Table 3).

Patients mostly presented with history of trauma ( $n=47$ ), followed by degenerative disc disease ( $n=32$ ), and infection and ossified posterior longitudinal ligament (OPLL) one each. Among patients with cervical compressive myelopathy (CCM) included patients with multiple level disc disease, thickened posterior longitudinal ligament, osteophytes, subluxation and kyphosis. No kyphosis correction was tried in the current patients. The mean duration of the symptoms was 6.65 months ( $SD = \pm 4.25$  months) and consisted of neck pain patients, radiculopathy, and myelopathy. Most commonly affected level in trauma patients was the fifth cervical level.

Pre-surgical Nurick grade is not associated with age, gender or time since first symptoms (Table 4).

Post-surgical Nurick grade was not associated with age, gender or time since first symptoms but was strongly associated with pre-surgical Nurick grade at  $P < 0.05$ . The association with pre-surgical Nurick grade did not change even after adjusting for age, gender and time since first symptoms ( $P < 0.05$ ) (Table 5).

**Table 2** Patients characteristics

Characteristics	Subtypes	N (%)
Number of patients	Males	71 (87.65)
	Females	10 (12.35)
Age <sup>†</sup>	Patients with age $\leq 40$ years	42 (51.85)
	Patients with age $> 40$ years	39 (48.15)
Etiology	Trauma	47 (58.02)
	Infection	01 (01.23)
	Degenerative disc disease	32 (39.51)
	OPLL	01 (01.23)
	Tumor	00 (00.00)
Corpectomy <sup>‡</sup>	1 Level	79 (97.53)
	2 Level	02 (02.47)
	C3	00 (00.00)
	C4	09 (11.11)
	C5	33 (40.74)
	C6	32 (39.51)
	C7	05 (06.17)
	C5 + C6 (level 1 + level 2)	02 (02.47)
Complication	Postoperative dysphagia	03 (03.70)
	Cerebrospinal fluid leak	03 (03.70)
	Respiratory distress	02 (02.46)
	Implant dislodged/subsidence	00 (00.00)

<sup>†</sup>Mean age of the patients was  $39.74 \pm 15.26$  years

<sup>‡</sup>C-Cervical vertebra body

**Table 4** Association of pre-surgical Nurick grade with age, gender and time since first symptom

Trait	Beta	SE	P-value
Age	-0.00681	0.006319	0.285
Gender	0.3	0.2862	0.298
Time since first symptom (in months)	0.03704	0.0215	0.0889

**Table 3** Patients characteristics (pain and clinical outcome as measured by Nurick grade)

Characteristics	Subtypes	Preoperative status [N (%)]	Postoperative status [N (%)]	P-value
Pain	None	00 (00.00)	26 (32.09)	$p < 0.00001$
	Mild	03 (03.70)	53 (65.43)	
	Moderate	53 (65.43)	02 (02.46)	
	Severe	25 (30.86)	00 (00.00)	
Nurick grade (count)	0	00 (00.00)	02 (02.46)	$p < 0.05$
	1	00 (00.00)	06 (07.40)	
	2	04 (04.90)	22 (27.16)	
	3	14 (17.20)	31 (38.27)	
	4	36 (44.44)	15 (18.51)	
	5	27 (33.33)	08 (09.87)	
Nurick grade (average)	All patients	Mean $\pm$ SD 4.06 $\pm$ 0.85	Mean $\pm$ SD 2.85 $\pm$ 1.16	

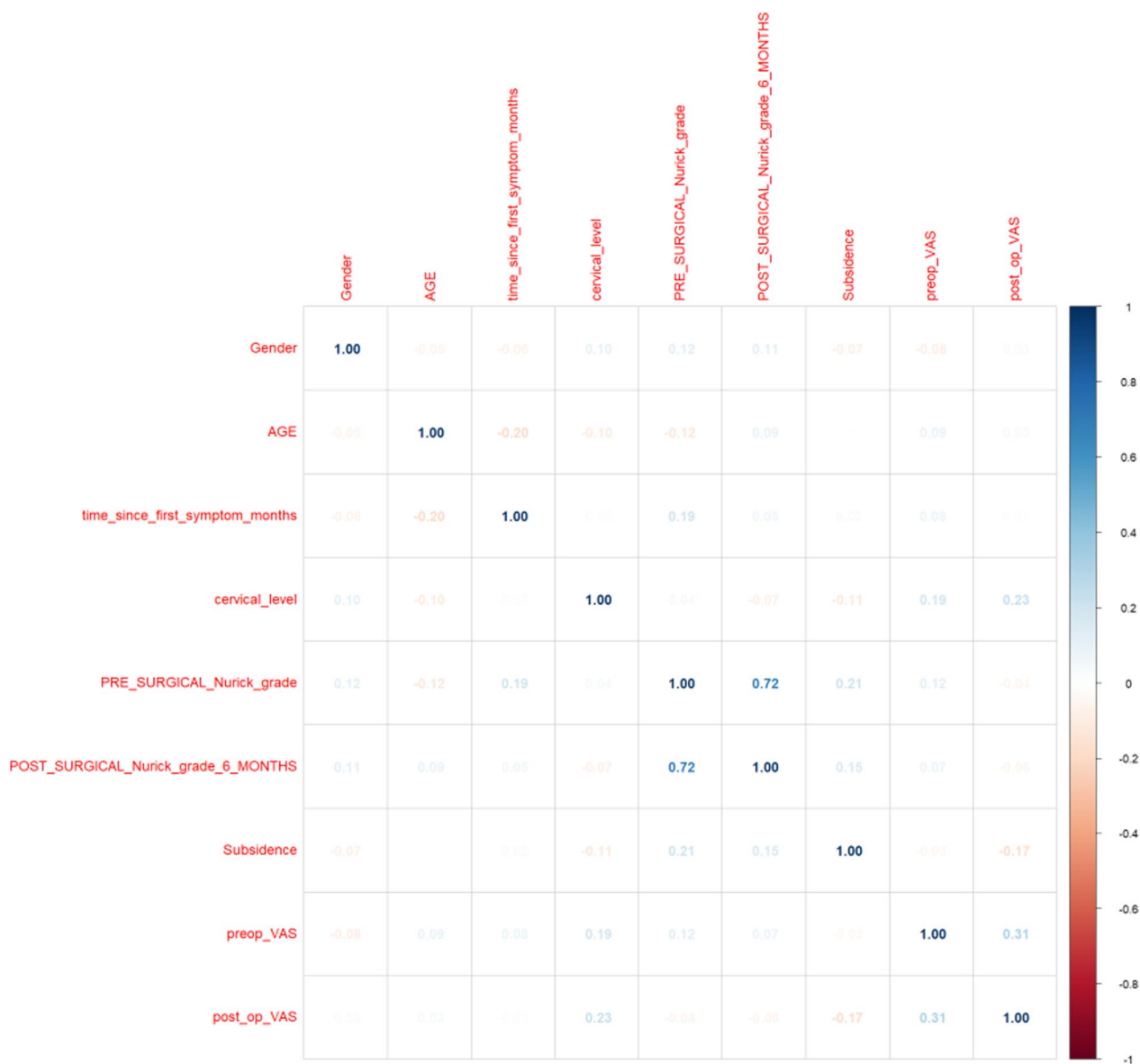
**Table 5** Association of post-surgical Nurick grade with age, gender and time since first symptom and pre-surgical Nurick grade

Trait	Beta	SE	P-value
Pre-surgical Nurick grade	0.9835	0.1078	6.20E-14
Age	0.006856	0.008679	0.432
Gender	0.4	0.3919	0.311
Time since first symptom months	0.0144	0.02999	0.632
Pre-surgical Nurick grade (accounting for age, gender and time since first symptoms)	1.014385	0.11075	8.33E-14

Post-surgical Nurick grade was also strongly correlated with pre-surgical Nurick grade with Pearson’s correlation coefficient of 0.72 (Figs. 4 and 5).

**Complications**

Compared to preoperative image and 6-month follow-up image, no dislodgement or subsidence was noted with this implant. Eight patients presented with complications. Three patients were diagnosed with CSF leak (Table 2), postoperative dysphagia was noted in 3 patients, and two patient developed postoperative respiratory distress. None of the patient presented with infection. There were no mortalities during treatment and 6-month follow-up.



**Fig. 4** Correlation (Pearson’s coefficient) analysis of various traits

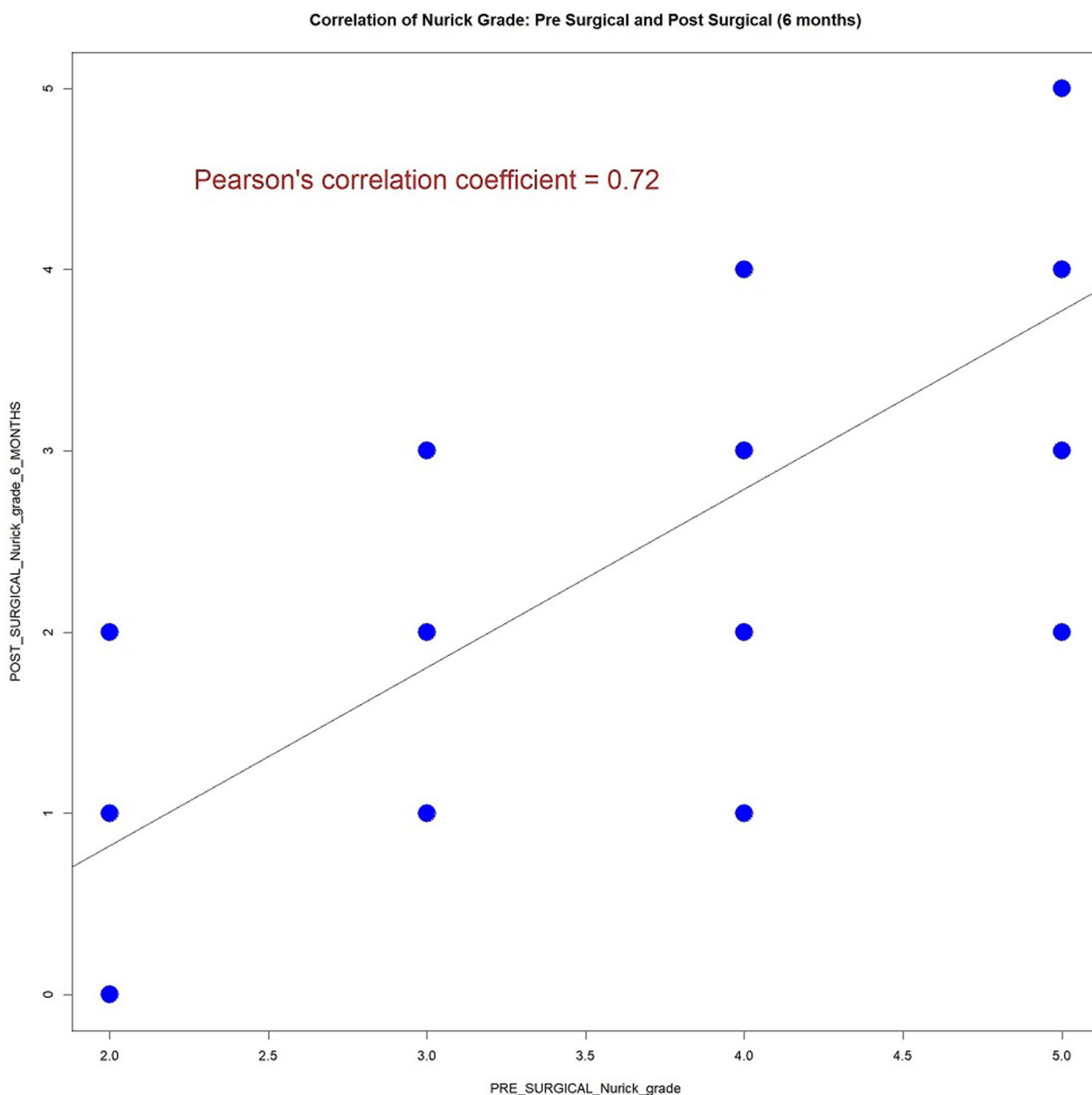


Fig. 5 Correlation plot of pre-surgical with post-surgical Nurick grade

### Discussion

Here, we show that use of WETC in patients of CCM with poor Nurick grade leads to favorable outcomes with little side effects. Majority of the patients operated in our study presented with traumatic spine injury (58%), followed by degenerative disc disease (39.5%). The average age of traumatic spine patient in our study was 36.74 years which was similar to patients in other studies like the one by Tatter et al. [7]. In our study

patients with degenerative spine had an early age of onset with an average age of 45.19 years. In a previous study by Tatter et al. [7], the average age of patients with degenerative spine was 55 years almost a decade later than our patients but, in the study, done by Mesregah et al. [8] the average age was similar to patients in our study. Only one patient in our study presented with OPLL, while another patient presented with Potts spine infection. OPLL is seen more in the Asian population where it has a prevalence of 2–3%. In our study, we had

one patient (1.2%) with OPLL which was similar to the prevalence data of previously published studies [9].

Average duration of presentation of symptomatic patient was 6 months. As our hospital is the only hospital in the province/state of Jharkhand which provides facilities related to neurosurgery, patients often travel from remote areas of state to this facility and take considerable time to come to the center. All patients admitted were examined before and after surgery and 6 months post-surgery. There was a considerable improvement in pain as measured by VAS-neck in postoperative follow-up ( $p=0.001$ ), similar to findings by Tohamy et al. Our results using this in situ plate titanium cage with respect to outcomes and side effects were similar to standalone cages used in the study done by Tohamy et al. [10].

Corpectomy has emerged as an excellent surgical modality for anterior cervical pathology and compression. In our study, 77% patients had poor Nurick grades in the range of 4–5. The initial mean Nurick score prior to administration of WETC was 4.06, and this improved to 2.85 after 6-month follow-up. In a study by Rajashekar et al. [11], the mean Nurick score showed significant change from 4.24 to 2.47 after corpectomy which is in the similar range of improvement as observed in our study. Whereas in a study by Chagas et al. [12] where autologous bone graft was used as implants instead of WETC, the range in improvement of outcomes was lesser as the mean Nurick score improved from 2.97 to 2.10 after corpectomy. Our result related to outcomes were similar to the study done by Zeng et al. [13] where titanium cages with dynamic cervical plate were used as implants. Our result of corpectomy with insertion of WETC plate was similar to previous studies done by Rajashekar V et al. [11] and Chagas et al. [12] Thus, using WETC (in situ plate) in cervical corpectomy showed similar rate of improvement when compared to autologous bone graft or Titanium cage with dynamic cervical plate.

With WETC insertion in patients, operative time can be decreased as seen in our study, where the average time taken for surgery was 120 min which was lesser than previous studies by Zeng et al. (137.4 min) [13] and Tarantino et al. (130 min) [14]. As seen in other forms of spine surgery, longer operative time is often associated with higher incidence of complications [15]. Thus, use of WETC in the current study helped in decreasing operative time and preventing complication.

Complications like donor site morbidities, graft dislodgement and non-fusion and low compression stiffness associated with autologous implant like iliac and fibular graft have led surgeons to use newer titanium implants in cervical spine surgery [16].

In the present study, we observed complications but in a few patients; three patients had dysphagia and CSF

leaks, while two had respiratory distress. Patients with respiratory distress were treated with steroids and put on ventilators and once they recovered were discharged. Patients with postoperative dysphagia were fed using Ryles tube in initial postoperative period and gradually improved with conservative management. Patients with on table CSF leak were treated using postoperative lumbar drainage for 5–7 days and put on acetazolamide. Previously Cabraja et al. had concluded that WETC was an excellent replacement for corpectomy defects. Winged nature of WETC implants have simplified procedure and avoided bone graft site complications and morbidities. Previously it has been implicated that use of WETC as an implant carries higher risk of non-fusion, loss of lordosis correction and height [17]. In a study done by Sasso et al. [16], two level corpectomy with NETC led to 67% failure rate. However, in our study after preparation of end plate using WETC led to easy and fast insertion and fixation and was easier to handle. At 6-month follow-up in our study, no patient showed subsidence or hardware failure. Hardware failure or loss of lordosis as reported previously could be due to inadequate preparation of end plate and overzealous expansion of device. Despite favorable finding related to use of WETC, our study has limitations; the small sample size of the current study has low power; hence, future studies with increased sample size are required to achieve a more appropriate effect size measure. The follow-up period of 6 months in our study can be increased to a year or more to better comprehend the outcomes and side effects post-surgery.

## Conclusion

With use of expandable titanium cage with in situ plate, we were able to obtain good outcome in patients with poor Nurick grade with less serious complication. As size of implants is prefixed in WETC and can be expanded, it takes relatively less time to insert and thus leads to shorter operative time. Over distraction of the implants should be avoided and with better end plate preparations complication rates can be decreased.

## Acknowledgements

Not applicable

## Author contributions

(1) RB,AP,GC have substantial contributions to conception and design, or acquisition, analysis or interpretation of data; (2) AP, RB, GC, GD, CBS were extensively involved with drafting the article and critically revising it for important intellectual content; and (3) AP, RB, GC, GD, CBS have read and approved the final manuscript.

## Funding

No funding was received for this study.

## Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

### Ethics approval and consent to participate

The present work was approved by institutional ethical committee (ECR/769/INST/JH/2015/RR-18/09), and all patients were enrolled after obtaining informed consent.

### Consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

Received: 27 August 2023 Accepted: 1 December 2023

Published online: 11 April 2024

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