



Original Article

## Clinicoradiological outcomes of Goel and Harms fixation for atlantoaxial instability: An institutional experience

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### ABSTRACT

**Background:** Few studies have reported on the long-term outcomes of Goel and Harms C1-C2 fusions in the Asian population.

**Methods:** This was a retrospective analysis of 53 patients undergoing Goel and Harms fixation (2010–2018). Clinical outcomes were assessed utilizing the neck disability index (NDI), Japanese Orthopedic Association (JOA) score, and visual analog scale (VAS). Outcomes were then correlated with fusion rates (using dynamic X-rays), atlanto-dens interval (ADI), and space available for cord (SAC) data.

**Results:** The study's 53 patients averaged 49.98 years of age and included 42 males and 11 females. The mean preoperative versus postoperative scores on multiple outcome measures showed NDI  $31.62 \pm 11.05$  versus  $8.68 \pm 3.76$  post, mean JOA score (e.g., in 41 patients with myelopathy) improved from  $13.20 \pm 3.96$  to  $15.2 \pm 2.17$ , and the mean VAS decreased from  $4.85 \pm 1.03$  to  $1.02 \pm 0.87$  and showed restoration of the ADI ( $1.96 \pm 0.35$  mm) and SAC ( $20.42 \pm 0.35$  mm). A 98.13% rate of C1-C2 fusion was achieved at 12 postoperative months.

**Conclusion:** Goel and Harms technique for C1-C2 fusion resulted in both good clinical and radiological outcomes.

**Keywords:** Atlantoaxial, Cervical spine, Goel's technique, Harms, Instability

### INTRODUCTION

There are various techniques available for atlantoaxial (A-A) arthrodesis.<sup>[5]</sup> In 2001, Harms and Melcher first reported 37 patients undergoing posterior C1-C2 stabilization utilizing lateral mass screws.<sup>[4]</sup> Goel *et al.* subsequently documented the efficacy of an A-A plate/screw fusion technique.<sup>[3]</sup> Here, we report our experience in the Asian subcontinent for A-A fusion utilizing the Goel and Harms combined techniques.

### MATERIALS AND METHODS

We performed a retrospective analysis of clinical and radiological data for 57 patients who underwent Goel and Harms C1-C2 fusions for various pathologies (2010–2018) [Figure 1

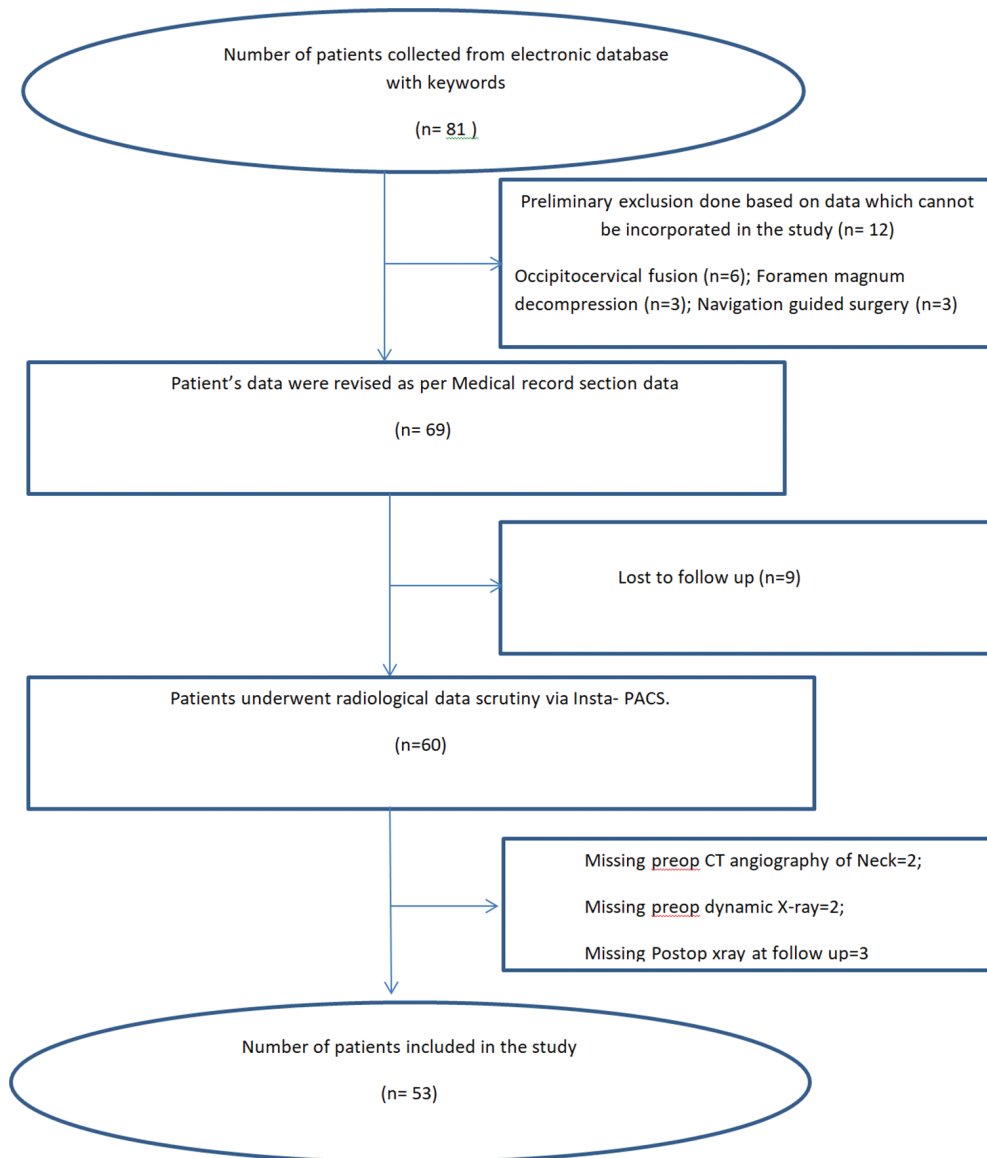
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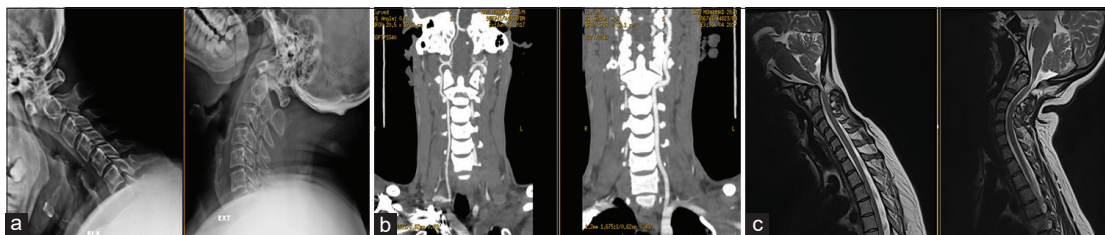
and Table 1]. Patients underwent preoperative cervical X-rays, computed tomography angiography (CTA) of the neck, a cervical MRI, and postoperative X-rays (at 3 months, 6 months, and 1 year) [Figures 2 and 3]. Clinical outcomes were assessed at 3 months, 6 months, and 1 year postoperatively using the Japanese orthopedic Association (JOA) score, visual analog scale (VAS), and neck disability index (NDI) scores. Surgical outcomes assessments included length of hospital stay, operative time, blood loss, and intraoperative or postoperative complications. Radiological parameters included fusion, implant failure and, preoperative and postoperative atlanto-dens interval (ADI), and space available for cord (SAC). Fusion was confirmed by the presence of bony trabecular bridging between C1-C2 and/or no abnormal movement on dynamic X-rays.

**Table 1:** A table showing the demographics of patients included in the study.

Sex distribution	
Male	42
Female	11
Mean age	49.98±21.82 years
Etiology of instability	
C1-C2 osteoarthritis	3
Rheumatoid arthritis	12
Os odontoideum	6
Potts spine C1-C2	5
Traumatic without odontoid fracture	9
Odontoid Type II fracture	15
Congenital C1-C2 instability	1
Downs syndrome	2



**Figure 1:** Flowchart depicting inclusion and exclusion of the patient.



**Figure 2:** Preoperative dynamic X-ray (a), CT-angiography of neck (b), and dynamic MRI (c) and for assessment of C1-C2 instability.

### Surgical protocol followed in our institute

Dynamic X-rays were used to assess the instability of C1-C2. The diameter of the C2 pedicle was assessed on preoperative CT scan and the CTA documented whether or not there was a high riding vertebral artery. C2 pedicle/pars screws and C1 lateral mass screws were used for fixation, and rods were connected to the screws. Clinical outcomes and dynamic X-rays were performed at 3<sup>rd</sup> months, 6<sup>th</sup> months, and then yearly.

### Follow-up duration

The mean follow-up duration was  $48.90 \pm 24.78$  months (12–96 months).

## RESULTS

### Clinical findings

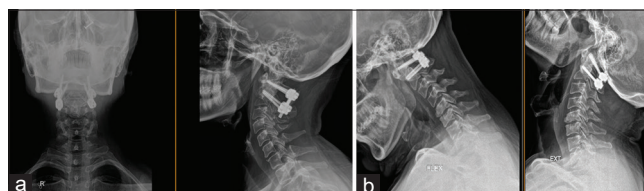
For 53 patients undergoing various surgical procedures, 43 patients had signs of myelopathy. The mean operative time was  $175.09 \pm 58.21$  min, the average blood loss was  $143.02 \pm 91.38$  ml, and the average length of stay was  $10.85 \pm 10.61$  days [Table 2].

### Outcome scores

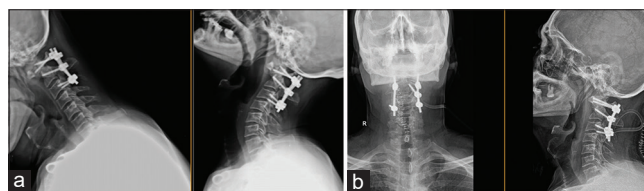
Postoperatively, the improvement was seen on the JOA, VAS, and NDI scores, while radiological improvement was noted (e.g., X-rays and/or MR) on the ADI and SAC measures [Table 2]. Symptomatic adjacent segment degeneration was not seen in any patient. Notably, 43 of 53 patients neurologically improved at 3 months postoperatively.

### Complications

There were six complications; a patient with Os-odontoidum deteriorated postoperatively from AIS-E to AIS-C but improved to AIS-D 3 months later, two sustained intraoperative or postoperative CSF leaks, two patients had to undergo revision surgery [Figure 4], and there was one death (cardiac arrest) due to heart failure 12 days postoperatively [Table 2].



**Figure 3:** Assessment of postoperative X-ray at 3 months: AP and lateral view (a) and dynamic X-ray to look for stability (b).



**Figure 4:** Preoperative dynamic X-ray (a) and immediate postoperative X-ray (b) of the patient who had implant failure with extrusion of left C1 screw.

## DISCUSSION

Gallie, Brooks, and Jenkins used bone grafts for C1-C2 fusion with sublaminar wires to provide A-A stability.<sup>[1,2]</sup> Magerl introduced transarticular screw fixation to directly support the C1-C2 facet joints, abolishing the use of postoperative support. Later, Harms and Melcher recommended posterior screw fixation of the lateral mass of C1 and pedicles of C2 with C1-C2 rod stabilization.<sup>[4]</sup> The Goel and Harms technique proved excellent fusion (e.g., based on biomechanical studies) and reduced the risk of vertebral artery injury. Isik *et al.* (2018) showed in 28 patients, there were no poorly placed screws, and they observed significant postoperative clinical improvement (e.g., JOA and VAS scores).<sup>[6]</sup> Zheng *et al.*, in 2016, also reported significant recovery and a 97.7% fusion rate, a finding (97% fusion rate in 60 patients using Goel/Harms technique) also echoed by Rajinda *et al.*<sup>[7,8]</sup> Here, we also found acceptable long-term results utilizing the Goel/Harms technique without any evidence of radiological or clinical deterioration an average of 48.9 months postoperatively. Here, we documented a 98.13% fusion rate utilizing the Goel and Harms technique.

**Table 2:** A table describing the surgical, clinical, and radiological outcomes of patients.

Surgical parameters					
Mean hospital stay (days)					10.85±10.61
Mean OT time (min)					175.09±58.21
Mean blood loss (ml)					143.02±91.38
Implants used in the study					
Medtronic vertex*					n=28
Globus Ellipse*					n=9
Depuy Synthes*					n=5
GSM sky*					n=5
Jayon*					n=6
<b>Clinical outcomes</b>	<b>Preoperative</b>	<b>3 months</b>	<b>6 months</b>	<b>1 year</b>	<b>Final follow</b>
Mean VAS	4.85±1.03	3.77±0.75	3.09±0.74	1.98±0.66	1.02±0.87
Mean NDI	31.62±11.05	25.81±8.33	13.66±6.09	9.36±3.63	8.68± 3.76
Mean JOA	13.20±3.96	13.80±3.11	14.00±2.83	14.4±2.41	15.2±2.17
Perioperative/postoperative complications					
Neurological deterioration					n=1
Incidental durotomy					n=1
Postoperative mortality					n=1
Screw failure					n=1
Postoperative CSF leak					n=1
Revision surgery*					n=2
*Two patients had revision procedures: (1) Patient with Potts spine C1-C2 operated 5 years back and presented with neck pain with failure of left C1 screw. (2) Patient with Potts spine C1-C2 operated elsewhere and presented with neck pain with implant failure					
<b>Radiological outcome</b>					
<b>Fusion rate at 1-year follow-up</b>			<b>98.13%</b>		
	<b>Preoperative</b>			<b>3 months</b>	
ADI (mm)	6.45±1.68			1.96±0.35	
SAC (mm)	11.52±0.80			20.42±0.35	

## CONCLUSION

The Goel and Harms technique was a safe and effective technique for treating A-A (C1-C2) instability in the Asian population.

## Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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