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Technical Notes

C2 quad-screws facilitate 4-rod fixation across the cervico-thoracic junction

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ABSTRACT

Background: Cervical spine deformity is a potentially devitalizing problem. Contemporary techniques for repair and reconstruction include fusion using rods of tapered diameter alone, or quadruple-rod constructs in which primary rods are joined to floating accessory rods by connectors. Here, we present how we utilized a quadruple-rod construct to perform five C2 to thoracic spine fusions.

Methods: Our hospital electronic medical record revealed five patients who underwent the four rod C2-thoracic spine fixation. Patients ranged in age from 14-years-old to 78-years-old. The mean operative time was 715.8 min (range 549–987 min), and average estimated blood loss was 878 cc (range 40–1800 cc).

Results: None of the five patients sustained any intraoperative complications, and none demonstrated progressive kyphotic deformity over the average follow-up interval of 8 months.

Conclusion: We successfully treated five patients with degenerative or oncologic cervical pathology requiring fixation across the cervicothoracic junction utilizing a 4-rod C2-cervicothoracic fusion technique.

Keywords: Cervical spine, Cervico-thoracic junction, Posterior instrumentation, Spinal deformity, Spinal tumor

INTRODUCTION

Numerous etiologies contribute to cervical spine deformity.[1,6] High biomechanical strain and anatomic variability between the cervical and thoracic spinal segments pose unique challenges to achieving a posterior fusion construct across the cervicothoracic junction (CTJ).[2,6,8] Quadruple-rod constructs have demonstrated higher correction rates and less correction loss compared to dual-rod constructs across the lumbosacral junction but have not yet been popularized in the cervical spine.[3,8,9]

Here, we present how we successfully utilized a quadruple-rod construct across the CTJ, from C2 to the thoracic spine, in five patients [Table 1]. This supplementary construct maximizes strength of cervical deformity instrumentation.

ILLUSTRATIVE CASES

Case 1

A 78-year-old female presented with neck pain and a chin-on-chest deformity following a prior C3–C6 laminoplasty [Figure 1]. She initially underwent a C3–C7 ACDF as part of a two-stage

Table 1: Patient demographics and clinical data.

Case No.	Age (yrs), sex	Diagnosis	Fusion levels (pedicular, intralaminar)	OR Time (min)	EBL (cc)	Complications	PFS (mos)
1	78, F	Post-laminoplasty CT kyphosis	C2–T11, C2–T3	708	800cc	none	10
2	68, M	CT kyphosis	C2–T4, C2–T2	549	1500cc	none	9
3	14, M	C5 pathologic fracture and cervical cord injury secondary to intraosseous hemangioma	C2–T2, C2–T1	716	250cc	none	8
4	63, M	CT kyphosis	C2–T9, C2–T6	987	1800cc	none	7
5	51, F	Pseudoarthrosis and CT kyphosis	C2–T9, C2–T2	619	40cc	none	6
Mean	54.8	Na	Na	715.8	878	0	8

CT: Cervicothoracic, EBL: Estimated blood loss, OR: Operating room, PFS: Progression-free-survival, yrs: Years, mos: Months, min: Minutes, cc: Cubic centimeters.

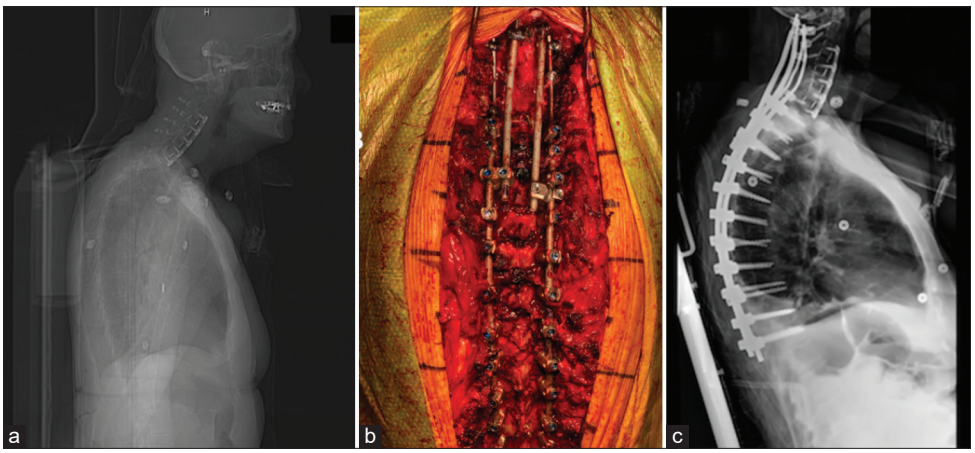

Figure 1: Illustrative case #1. Preoperative lateral X-ray demonstrating severe cervicothoracic junction deformity (a). Posterior instrumentation demonstrating intralaminar fixation of supplementary rods (b). Postoperative lateral X-ray of instrumentation extending across the cervico-thoracic spine (c).

procedure. The second procedure required the placement of bilateral translaminar and pars screws at C2, bilateral C7 lateral mass screws, and bilateral pedicle screws from T1 to T11, plus a dual-headed screw on the left at T3.

A C3–C6 laminectomy and Ponte osteotomies were then performed from T6 to T7 and continued rostrally to C7–T1. Rods were cut to span C2–T11 fixed with set caps. A side connector was placed just distal to the right T3 screw. We compressed all levels at which we performed a Ponte osteotomy. A second set of rods were used to connect the C2 laminar screws to the left dual-headed screw, and right lateral connector at T3 [Figure 1]. Dural sealant was placed to protect the dura from fusion material. We decorticated the remaining bone and packed in allograft to obtain an osseous fusion, and routinely closed. This patient suffered a T12 compression fracture following a mechanical fall 3 months after surgery, without hardware failure or progression of kyphosis.

Case 2

A 14-year-old who presented with quadriparesis underwent a C4–C6 anterior corpectomy using an expandable cage with plate placement from C3 to C7 for tumor.

The patient was then turned prone, bilateral pars and translaminar screws were placed at C2 [Figure 2]. Poor bone quality and tumor invasion allowed only for right C3 and left C4 lateral mass screws. Dual-headed screws were placed in both T1 pedicles, followed by single-headed screws at bilateral T2 and T3 pedicles. Rods were cut to span the C2 pars, subaxial lateral mass, and thoracic pedicle screws and fixed with set caps. We then performed C4–C6 laminectomies for posterior decompression. A second set of rods spanned the C2 laminar screws to the T1 dual-headed screws, which were secured with set caps [Figure 2]. Routine bone decortication, allograft fusion, and closure followed.

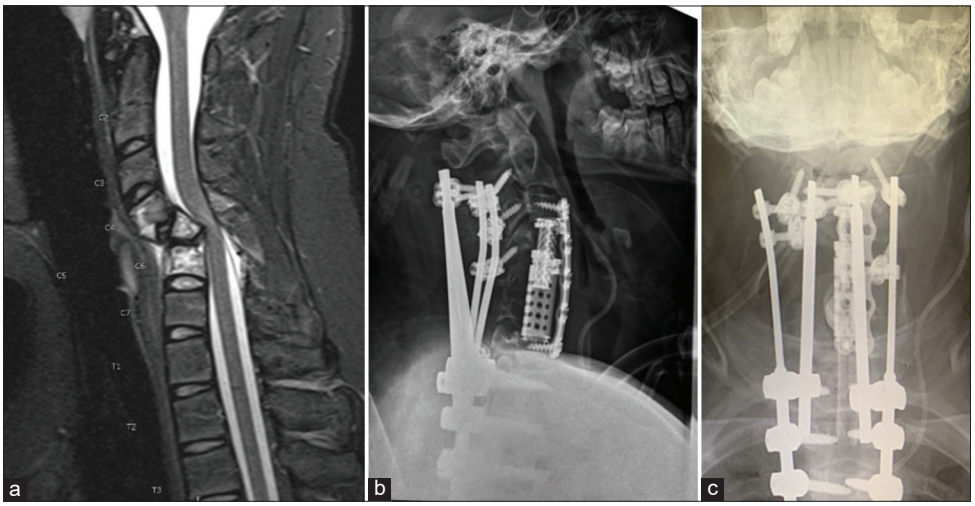

Figure 2: Illustrative case #2 imaging. Preoperative MRI demonstrating C5 fracture and spinal cord compression (a). Postoperative lateral X-ray of stabilizing instrumentation (b). Postoperative AP X-ray of stabilizing instrumentation (c).

RESULTS

Decompressions

Two patients required cervical corpectomies, one required a pedicle subtraction osteotomy, one required a thoracic Ponte osteotomy, and three required decompressive laminectomies.

Fusions

Five patients were treated with a 4-screw anchoring technique at C2 to facilitate quad-rod posterior fusion across the CTJ. Four patients were treated for postoperative cervicothoracic (CT) kyphosis and impaired horizontal gaze, while the fifth had a pathologic fracture and cervical cord injury at C5 due to an aggressive intraosseous hemangioma.

Outcomes

No patient sustained any significant intraoperative complications, and none demonstrated progressive kyphosis over 8 months postoperative months (range 6–10 months).

DISCUSSION

Numerous etiologies contribute to cervical deformity.[1,6] Posterior constructs crossing the CTJ are associated with higher fusion rates and lower reoperation rates in corrective cervical spine procedures.[2] Multi-rod constructs have been shown to increase the rigidity and durability of posterior instrumentation, with longer time to failure and fewer total failures compared to two-rod constructs in the lumbar spine.[4,8,9] To date, quadruple-rod constructs have not been popularized for deformity correction in the cervical spine.

Here, we presented 5 cases utilizing a 4-rod construct to across the CTJ to address different destabilizing cervico-thoracic pathologies. Proximal intralaminar screws allowed for safer placement of additional screw-rod instrumentation at C2 joined to the thoracic spine. The absence of progressive deformity or hardware failure in these five individuals affirms that this construct compares favorably to rates of distal junctional kyphosis as high as 24% and single-rod posterior cervical hardware failure rates of approximately 4%.[4,5,7,8,9] Further, our patients retained their correction at an average follow-up of 8 months, further supporting the mechanical strength of this construct in reconstruction of cervical spine deformities.

CONCLUSION

We successfully treated five patients with cervical deformities warranting posterior fusion constructs utilizing a 4-rod technique for procedures crossing the CTJ.

Declaration of patient consent

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

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Nil.

Conflicts of interest

There are no conflicts of interest.

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