Article published online: 2024-08-08

The Emerging Role of Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE) Technique and C-MAC Videolaryngoscope for Difficult Airway Management in a Patient with Klippel–Feil Syndrome: A Case Report

Anjana Kashyap[1] Alia Vidyadhara[1] Vidyadhara Srinivasa[2] Madhava P. Kanhangad[2]

[1] Department of Spine Anaesthesiology, Manipal Hospital, Bangalore, Karnataka, India
[2] Department of Spine Surgery, Manipal Hospital, Bangalore, Karnataka, India

Address for correspondence Alia Vidyadhara, MD, Department of Spine Anaesthesiology, Manipal Hospital, Old Airport Road, Bangalore 560017, Karnataka, India (e-mail: aliadr@gmail.com).

J Neuroanaesthesiol Crit Care 2024;11:196–199.

Abstract

Klippel–Feil syndrome (KFS) is a rare autosomal dominant congenital anomaly characterized by failure in fusion of the cervical vertebrae. There have been no case reports describing the use of a combination of transnasal humidified rapid-insufflation ventilatory exchange (THRIVE) and C-MAC videolaryngoscope in the airway management of an adult patient with KFS. Our patient was a 50-year-old male diagnosed with KFS posted for revision robotic-assisted cervical C2-C4 laminectomy and fusion. He was successfully intubated with the help of THRIVE and C-MAC videolaryngoscope. During induction and intubation, saturation remained above 96%. At the end of surgery, patient was extubated after satisfying all difficult airway extubation criteria. THRIVE and C-MAC videolaryngoscope have been promoted for use in anticipated difficult airway scenarios. We report the first successful usage of THRIVE and C-MAC videolaryngoscope to secure the airway in a patient with KFS.

Keywords
- Klippel–Feil syndrome
- THRIVE
- C-MAC videolaryngoscope

Introduction

Klippel–Feil syndrome (KFS) is a rare autosomal dominant congenital anomaly characterized by failure of segmentation process of cervical vertebrae leading to their nonfusion.[1,2] Awake flexible fiberoptic (FFO) intubation is the gold standard to secure the airway. We report an alternate approach of securing the airway in a KFS patient posted for revision cervical spine surgery with the combined use of transnasal humidified rapid-insufflation ventilatory exchange (THRIVE) and C-MAC videolaryngoscope, thereby avoiding awake intubation.

Case Report

A 50-year-old male patient with KFS with cervical myelopathy had undergone C3-C4 laminectomy, partial C2 decompression with lateral mass fixation. On postoperative day 4, he underwent cervical implant removal due to development of neurological deficits. In view of persistent symptoms, he was planned for revision robotic-assisted C2-C4 laminectomy and fusion at our institute.

While details of previous airway management were unavailable, the discharge summary mentioned elective

article published online
August 8, 2024

DOI https://doi.org/10.1055/s-0044-1787877.
ISSN 2348-0548.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

postoperative mechanical ventilation for 2 days following first surgery.

Airway examination revealed short-webbed neck, low lying posterior hairline, large tongue, and Mallampati score – class 3. Thyromental distance was adequate with a fixed flexion deformity attributed to KFS and aggravated by previous cervical fusion surgery; however, mask ventilation seemed possible. Cervical X-ray (lateral flexion/extension) showed C3-C6 vertebral body fusion, no atlantoaxial joint instability (►**Fig. 1**). Computed tomography sagittal spine confirmed C3-C6 vertebral body fusion, no basilar invagination.

We planned to secure the airway with initiation of THRIVE technique followed by C-MAC videolaryngoscope-assisted intubation after induction of general anesthesia. Written informed consent was taken.

The operation theater was kept ready with all difficult airway equipment. Standard American Society of Anesthesiologists monitors and entropy and neuromuscular transmission monitors (GE HealthCare Technologies, Inc., United States) were used. Intravenous access was secured and balanced crystalloid solution infusion was started. Preoxygenation for 5 minutes was commenced at 20 L per minute (L/min) via Optiflow THRIVE (Fisher and Paykel Healthcare Limited, New Zealand). Premedication included intravenous palonosetron 75 µg and intravenous pantoprazole 40 mg. Gradually, as the patient was induced with intravenous lignocaine 80 mg, fentanyl 125 µg, and sleep dose of intravenous propofol, THRIVE flows were increased to 40 and then 60 L/min. Intravenous rocuronium 1 mg per kg was administered for muscle relaxation. Once the train-of-four (TOF) count of zero was achieved, the C-MAC videolaryngoscope (Karl Storz, Karl Storz SE & Co. KG, Tuttlingen, Germany) was introduced into the oral cavity with the head in neutral position. The Cormack–Lehane grade was 2b. We railroad the endotracheal tube over a bougie to limit neck movements (►**Fig. 2**). Following intubation and confirmation of airway, ventilation was commenced and THRIVE nasal cannula was removed. Throughout the perioperative period oxygen saturation was above 96%. Invasive arterial access, additional intravenous access, and temperature monitoring were initiated postintubation. Maintenance of anesthesia was with total intravenous anesthesia (TIVA) using intravenous propofol (50–150 µg/kg/h) titrated to entropy of 40 to 50 with analgesic intravenous fentanyl (1 µg/kg/h). Mechanical ventilation was with 1:1 mixture of oxygen:air (FiO_2 50%), pressure-controlled ventilation adjusted to an end-tidal carbon dioxide of 30 to 35 mm Hg.

Patient was meticulously positioned prone to avoid any neck movements. At the end of surgery TIVA was titrated and stopped after supination. Residual neuromuscular blockade was reversed once TOF count was more than 2 with intravenous sugammadex 2 mg/kg. Patient was extubated once awake and satisfying the difficult airway extubation criteria.[3] Postoperatively, patient was stable and discharged after 48 hours with no neurological complications.

Discussion

Airway management in KFS patients remains a challenge due to cervical spine instability. FFO intubation requires patient cooperation, anesthesiologist expertise, and bloodless field, and can fail in patients with unstable upper cervical spine pathology, due to displaced or difficult-to-access larynx secondary to spinal deformity.[4,5]

The use of newer airway devices like C-MAC videolaryngoscope as an alternate to FFO has shown to be as effective and safe in securing the airway and in a lesser time period.[6]

While Wong et al demonstrated a greater cervical movement with Lo-Pro GlideScope as compared with flexible bronchoscopy, they also cautioned on the measurable cervical movement with airway maneuvers performed to facilitate Fibreopticbronchoscopy (FOB), especially jaw thrust.[7]

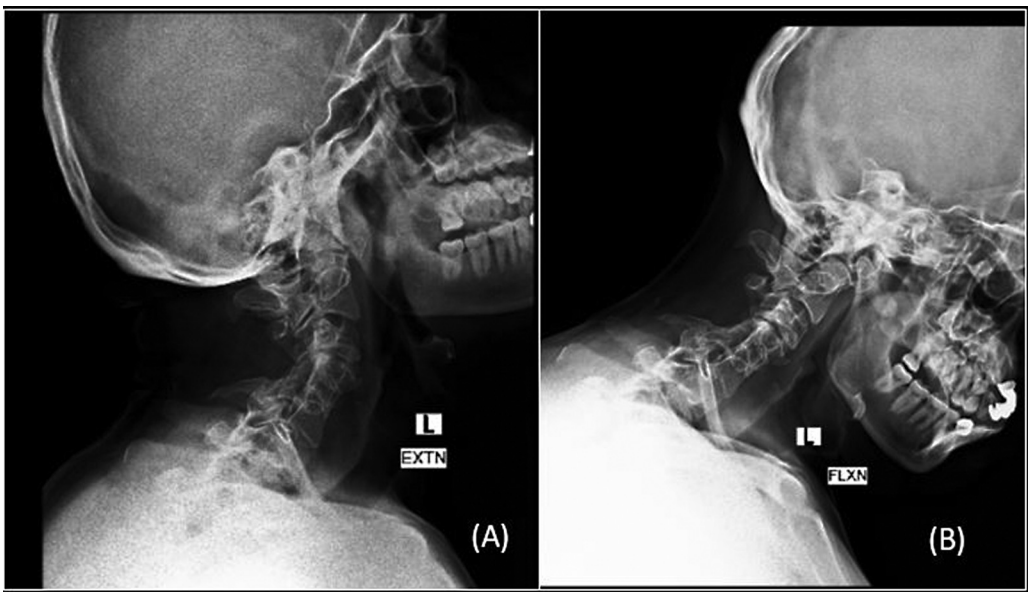

Fig. 1 Lateral (**A**) extension and (**B**) flexion radiographs showing no movement at the cervical block vertebrae.

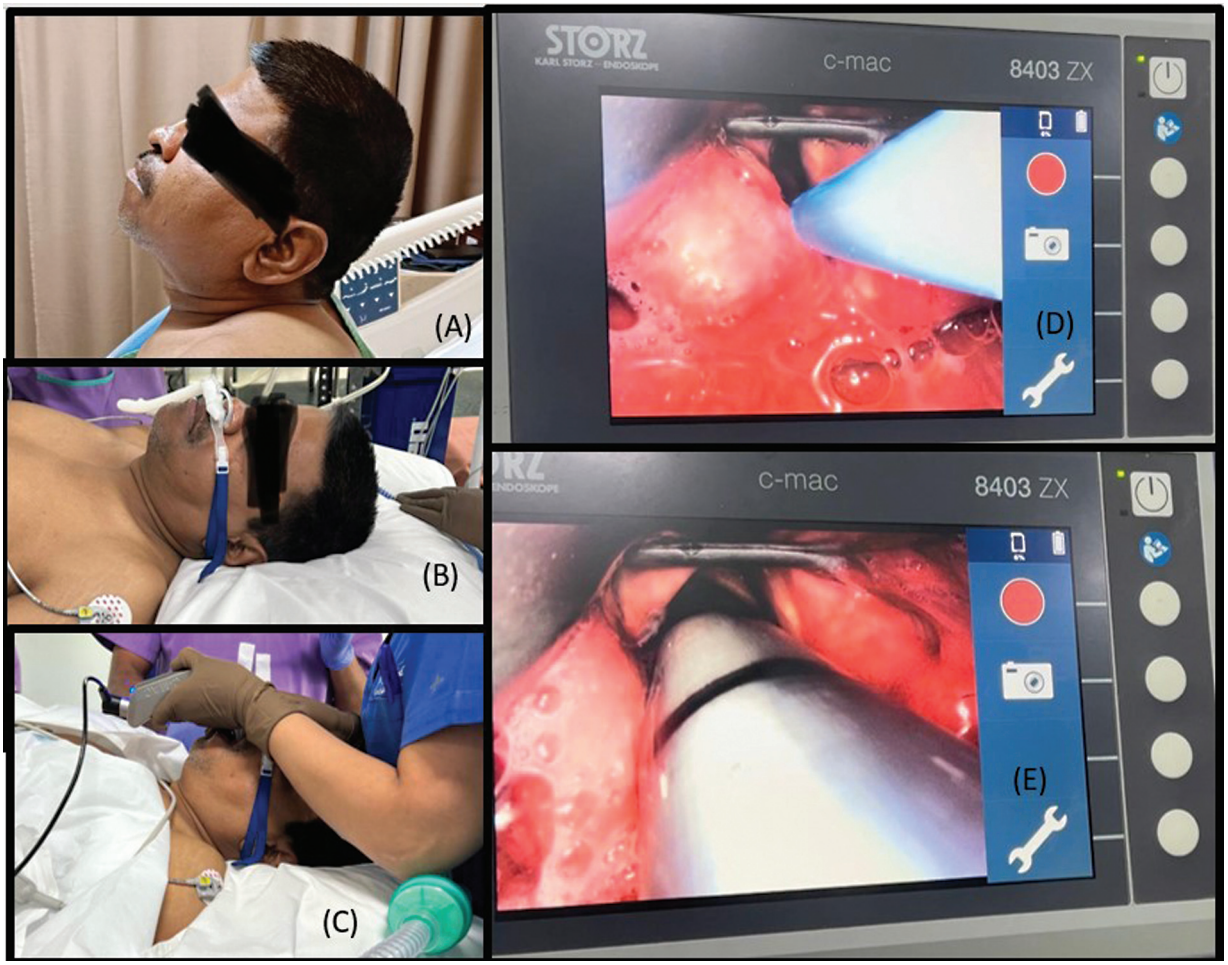

Fig. 2 (**A**) Clinical photos showing limited neck extension. (**B**) High-flow nasal cannula applied prior to induction for transnasal humidified rapid-insufflation ventilatory exchange (THRIVE) (**C**). Use of C-MAC videolaryngoscope with neck in neutral position (**D**). Image of C-MAC monitor showing bougie inserted into the trachea. (**E**) Railroading of the flexometallic endotracheal tube via bougie under vision.

To assuage our patient's apprehension while coming for his third cervical surgery, we decided to secure his difficult airway under general anesthesia. Due to factors like difficult airway, revision surgery, and preexistent cervical instability, care was taken to keep the head in neutral position. The use of THRIVE allowed us the added margin of safety with increase in the safe apnea time to comfortably secure the airway.[8] C-MAC use helped us avoid any airway maneuvers such as tongue pull and jaw thrust that is a prerequisite during awake FFO and can cause significant cervical spine movement as shown in cadaveric studies.[9]

While the combined use of THRIVE and C-MAC videolaryngoscope intubation helped maximize our success, we were prepared with backup options such as plan B (the use of FFO in the event C-MAC laryngoscopy fails) and plan C (the use of a hybrid technique combining both C-MAC and FFO). Neuromuscular blockade with rocuronium allowed a stable airway for instrumentation along with the TOF monitoring, thereby minimizing any airway injury and hemodynamic perturbations. The full reversal dose of sugammadex for rapid reversal of profound neuromuscular block in the event of a "cannot intubate, cannot ventilate" situation was kept ready in the operation theater. The presence of ear, nose, and throat surgeons on call was also sought prior to start of induction.

One must be aware of the complications of THRIVE such as hypercapnia which can lead to cardiovascular complications and respiratory acidosis which has been found to be independent of the flow rate (between 0.25 and 70 L/min).[10]

Lastly, we recommend that there needs to be further studies on use of both modalities in KFS patients as we are unable to draw inferences which can be extrapolated to a larger population from a single case report.

Conclusion

THRIVE when used with CMAC can increase the margin of safety while securing the airway in patients with KFS. We recommend that there needs to be further studies on use of both modalities in KFS patients as we are unable to draw inferences which can be extrapolated to a larger population from a single case report.

Conflict of Interest
None declared.

References

1 Klippel M. Un cas d'absence des vertebres cervicals. Soc Anat Paris Bull Mem. 1912;14:185

2 Kaplan KM, Spivak JM, Bendo JA. Embryology of the spine and associated congenital abnormalities. Spine J 2005;5(05):564–576

3 Parotto M, Cooper RM, Behringer EC. Extubation of the challenging or difficult airway. Curr Anesthesiol Rep 2020;10(04):334–340

4 Wong J, Lee JSE, Wong TGL, Iqbal R, Wong P. Fibreoptic intubation in airway management: a review article. Singapore Med J 2019;60 (03):110–118

5 Karlsen KAH, Gisvold SE, Nordseth T, Fasting S. Incidence, causes, and management of failed awake fibreoptic intubation-a retrospective study of 833 procedures. Acta Anaesthesiol Scand 2023; 67(10):1341–1347

6 Jiang J, Ma DX, Li B, Wu AS, Xue FS. Videolaryngoscopy versus fiberoptic bronchoscope for awake intubation - a systematic review and meta-analysis of randomized controlled trials. Ther Clin Risk Manag 2018;14:1955–1963

7 Wong DM, Prabhu A, Chakraborty S, Tan G, Massicotte EM, Cooper R. Cervical spine motion during flexible bronchoscopy compared with the Lo-Pro GlideScope. Br J Anaesth 2009;102(03):424–430

8 Patel A, Nouraei SA. Transnasal humidified rapid-insufflation ventilatory exchange (THRIVE): a physiological method of increasing apnoea time in patients with difficult airways. Anaesthesia 2015;70(03):323–329

9 Donaldson WF III, Heil BV, Donaldson VP, Silvaggio VJ. The effect of airway maneuvers on the unstable C1-C2 segment. A cadaver study. Spine 1997;22(11):1215–1218

10 Riva T, Greif R, Kaiser H, et al. Carbon dioxide changes during high-flow nasal oxygenation in apneic patients: a single-center randomized controlled noninferiority trial. Anesthesiology 2022; 136(01):82–92