

Anesthetic Management of a Potential Difficult Airway in a Patient with Renal Osteodystrophy and Secondary Hyperparathyroidism: A Case Report

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Case Report

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Abstract

Background

Renal osteodystrophy associated with long-term kidney disease and secondary hyperparathyroidism may result in skeletal deformities that potentially complicate airway management. Conventional bedside airway assessment may not fully identify airway-related risks in patients with marked skeletal abnormalities. We report the anesthetic management of a patient with long-term maintenance hemodialysis, secondary hyperparathyroidism, and severe skeletal deformity who was considered to have a potential difficult airway despite relatively reassuring conventional airway findings.

Case presentation

A 45-year-old man with a 25-year history of chronic kidney disease and maintenance hemodialysis was admitted for parathyroidectomy because of long-standing secondary hyperparathyroidism. Preoperative examination revealed marked thoracic kyphosis, skeletal deformities, and abnormal trunk posture. Although the patient had a Mallampati class II airway, approximately three-finger-breadth mouth opening, and relatively preserved neck extension, cervicothoracic computed tomography demonstrated severe kyphosis and abnormal spinal alignment. Three-dimensional airway reconstruction further demonstrated altered spatial relationships between the cervicothoracic skeletal structures and the airway axis. Considering the potential limitations of airway positioning and manipulation, an awake fiberoptic intubation strategy was selected. After adequate preoxygenation, mild sedation was achieved with midazolam and sufentanil while spontaneous ventilation was maintained. Topical airway anesthesia was performed using lidocaine spray and cricothyroid membrane puncture. Successful tracheal intubation was achieved under flexible bronchoscopic guidance before induction of general anesthesia. Multiple rescue strategies, including supraglottic airway devices, retrograde intubation equipment, and emergency front-of-neck airway access, were prepared in advance. General anesthesia and subsequent extubation were uneventful. Postoperative monitoring showed a transient decrease in serum calcium without clinical manifestations of hypocalcemia.

Conclusions

In patients with long-term dialysis and secondary hyperparathyroidism, marked skeletal deformities may indicate potential airway management challenges even when conventional airway assessment appears reassuring. Comprehensive evaluation of skeletal anatomy, body alignment, airway positioning, and rescue options may help identify occult airway risk. Awake fiberoptic intubation with preservation of spontaneous ventilation may provide a controlled approach when difficult airway management is anticipated. Postoperative calcium monitoring is also important after parathyroidectomy in patients with long-standing secondary hyperparathyroidism.

Background

Renal osteodystrophy encompasses a spectrum of skeletal abnormalities associated with chronic kidney disease-mineral and bone disorder and may develop as a consequence of longstanding disturbances in mineral metabolism and parathyroid hormone regulation. Persistent secondary hyperparathyroidism (SHPT), particularly in patients receiving long-term dialysis, can lead to increased bone turnover and abnormal skeletal remodeling. These changes may involve the axial skeleton and other skeletal structures and can result in substantial deformity in patients with advanced disease [1, 2].

Airway management in patients with marked skeletal deformities can be challenging. Abnormal spinal alignment, restricted mobility, and difficulty achieving an appropriate head and neck position may interfere with airway alignment and tracheal intubation. However, conventional bedside airway assessment tools, such as the Mallampati classification and mouth opening, primarily assess specific aspects of the upper airway and may not adequately reflect challenges related to whole-body alignment or cervicothoracic skeletal abnormalities.

Awake tracheal intubation may be considered when difficult airway management is anticipated because it allows airway control while spontaneous ventilation is maintained. Appropriate preparation, oxygenation, topical airway anesthesia, carefully titrated sedation, and confirmation of tracheal tube placement before induction are important components of this strategy.

We report the perioperative anesthetic management of a patient with long-term maintenance hemodialysis, SHPT, renal osteodystrophy, and marked skeletal deformities who was considered to have a potential difficult airway despite relatively reassuring conventional airway assessment. The case highlights the importance of integrating systemic disease, skeletal anatomy, body alignment, and airway rescue planning when assessing airway risk.

Case presentation

A 45-year-old man, 150 cm in height and weighing 47 kg, was admitted for further evaluation and surgical treatment of SHPT. More than 10 years previously, elevated parathyroid hormone (PTH) levels had been identified, and the patient had received long-term treatment with calcitriol. He had a 25-year history of chronic kidney disease and had progressed to end-stage kidney disease requiring regular maintenance hemodialysis three times per week. Because of persistent SHPT and progressive renal osteodystrophy, he was admitted for parathyroidectomy.

The patient had no known history of cardiovascular, cerebrovascular, pulmonary, or neuromuscular disease. He denied smoking and alcohol consumption and had no previous history of surgery.

On admission, he was conscious and in a relatively stable general condition. His temperature was 36.8°C, heart rate 70 beats/min, blood pressure 138/78 mmHg, and respiratory rate 22 breaths/min. Physical examination revealed short stature, marked thoracic kyphosis, skeletal deformities, and abnormal trunk posture (Figs. 1 and 2).

Preoperative electrocardiography showed sinus rhythm, high left ventricular voltage, abnormal Q waves in leads III and aVF, and mild ST-segment elevation. Transthoracic echocardiography revealed no significant structural cardiac abnormalities. Left ventricular ejection fraction was preserved, with grade I left ventricular diastolic dysfunction and normal right ventricular function.

Laboratory examination showed an elevated serum total calcium concentration of 2.57 mmol/L and a PTH level of 416 pg/mL. Other laboratory findings were considered acceptable for surgery. The patient underwent maintenance hemodialysis one day before surgery to optimize volume status and correct potential metabolic abnormalities.

Preoperative airway assessment

Conventional airway assessment revealed a mouth opening of approximately three finger breadths, a Mallampati class II airway, and relatively preserved head and neck extension. No obvious predictors of difficult intubation were identified using conventional bedside airway assessment.

However, the patient had a long history of dialysis-associated SHPT accompanied by marked thoracic kyphosis, skeletal deformities, and abnormal trunk alignment. These findings raised concern that positioning of the head, neck, and upper airway might be difficult despite the relatively reassuring conventional airway examination.

Preoperative cervicothoracic computed tomography (CT) demonstrated severe thoracic kyphosis and abnormal spinal alignment (Fig. 3). Three-dimensional airway reconstruction further demonstrated altered spatial relationships between the cervicothoracic skeletal structures and the airway axis (Fig. 4).

Although these imaging findings did not establish a difficult airway by themselves, they suggested that conventional airway assessment might underestimate the potential difficulty associated with airway positioning and manipulation. After multidisciplinary assessment, the patient was therefore considered to have a potential difficult airway.

The airway management plan and possible risks were explained to the patient and his family, and written informed consent was obtained.

Airway management strategy

Considering the anticipated difficulty with airway positioning and the potential consequences of airway failure after induction, awake fiberoptic intubation with preservation of spontaneous ventilation was selected as the primary airway strategy.

A flexible bronchoscope was prepared as the primary intubation device. Reinforced endotracheal tubes with internal diameters of 6.0, 6.5, 7.0, and 7.5 mm were prepared to allow selection according to the patient's airway anatomy and procedural requirements.

Supraglottic airway devices, including size 3 and size 4 laryngeal masks, together with nasopharyngeal and oropharyngeal airways, were prepared as rescue ventilation devices. Because failure of awake fiberoptic intubation was considered possible, equipment for retrograde tracheal intubation was also prepared, including a commercially available retrograde intubation set, an 18-gauge puncture needle, a 0.038-inch × 110-cm guidewire with J-tip and straight-tip configurations, and a Rapi-Fit adapter. Equipment for emergency front-of-neck airway access was also immediately available.

This stepwise preparation was intended to ensure that oxygenation and airway control could be maintained if the primary intubation strategy failed.

Anesthetic management

After arrival in the operating room, standard monitoring was initiated, including electrocardiography, noninvasive blood pressure, pulse oximetry, and bispectral index monitoring. An arterial catheter was inserted under local anesthesia for continuous blood pressure monitoring.

The patient was placed in a comfortable supine position, with the head and neck maintained in a neutral position. Excessive extension or flexion was avoided because of the patient's skeletal deformity.

Adequate preoxygenation was performed using a face mask with 100% oxygen at a flow rate of 6 L/min. Before induction of general anesthesia, arterial blood gas analysis showed a pH of 7.37, PaCO₂ of 40.9 mmHg, PaO₂ of 189 mmHg, lactate of 0.6 mmol/L, serum potassium of 4.2 mmol/L, and ionized calcium of 1.23 mmol/L.

Awake fiberoptic intubation was then performed while spontaneous ventilation was maintained. Mild sedation and analgesia were provided with intravenous midazolam 1 mg and sufentanil 5 µg. After adequate sedation had been achieved, topical airway anesthesia was administered using 50 mg lidocaine by spray to anesthetize the oropharyngeal mucosa. Subsequently, the cricothyroid membrane was punctured, and 50 mg lidocaine was injected to provide additional anesthesia of the subglottic airway and tracheal mucosa.

After adequate airway anesthesia was confirmed, an oral flexible bronchoscope was introduced. The vocal cords were visualized, and the reinforced endotracheal tube was advanced into the trachea under direct bronchoscopic guidance. Correct tracheal tube placement was confirmed before induction of general anesthesia.

Following confirmation of a secure airway, general anesthesia was induced with intravenous etomidate 10 mg, sufentanil 10 µg, and cisatracurium 10 mg.

General anesthesia was maintained with continuous infusions of propofol at 4–8 mg/kg/h and remifentanil at 0.15–0.20 µg/kg/min. Additional cisatracurium 2 mg was administered intermittently according to surgical stimulation and neuromuscular blockade requirements.

Throughout the operation, hemodynamic parameters remained stable without significant fluctuations in blood pressure or heart rate. The surgical procedure lasted approximately 1 h, and estimated blood loss was 10 mL.

At the end of surgery, arterial blood gas analysis showed a pH of 7.38, PaCO₂ of 43.9 mmHg, PaO₂ of 283 mmHg, lactate of 0.8 mmol/L, serum potassium of 4.8 mmol/L, and ionized calcium of 1.23 mmol/L.

Propofol and remifentanyl infusions were discontinued at the end of surgery. The patient gradually regained consciousness and demonstrated adequate spontaneous ventilation. After confirming adequate oxygenation, stable hemodynamics, recovery of consciousness, and satisfactory spontaneous respiratory function, the endotracheal tube was removed under close monitoring.

The patient was transferred to the post-anesthesia care unit (PACU) and observed for 30 min. During this period, spontaneous respiration remained stable, and no airway obstruction, laryngospasm, or hypoxemia occurred. He was subsequently transferred to the general ward.

Postoperative calcium and PTH monitoring

Because of the patient's long-standing SHPT and the potential for postoperative calcium disturbances following parathyroidectomy, serum calcium and PTH levels were monitored after surgery.

On postoperative day (POD) 1, serum calcium was 2.36 mmol/L and PTH was 274 pg/mL. On POD 3, serum calcium was 2.30 mmol/L and PTH was 198 pg/mL. On POD 5, serum calcium was 2.32 mmol/L and PTH was 180 pg/mL. On POD 7, serum calcium was 2.34 mmol/L and PTH was 165 pg/mL.

Compared with the preoperative concentration of 2.57 mmol/L, serum calcium decreased after surgery and reached a nadir of 2.30 mmol/L on POD 3, followed by gradual recovery. PTH decreased continuously throughout the postoperative observation period.

The patient did not develop clinical manifestations suggestive of hypocalcemia, including perioral numbness, extremity paresthesia, muscle spasms, or other neuromuscular symptoms. His postoperative recovery was uneventful, and he was discharged on POD 7.

Discussion

The main anesthetic challenge in this case was not an obvious difficult airway identified by conventional bedside assessment, but the recognition of a potential airway difficulty associated with extensive skeletal deformity and abnormal body alignment.

The patient had a 25-year history of maintenance hemodialysis and more than 10 years of SHPT, accompanied by marked thoracic kyphosis and skeletal deformities. Long-term disturbances in mineral metabolism and persistent elevation of PTH can cause abnormal bone turnover and skeletal remodeling,

contributing to renal osteodystrophy and structural deformities [1, 2]. In advanced disease, these abnormalities may involve the spine and thoracic skeleton and can substantially alter body configuration.

From an airway management perspective, marked skeletal deformity may be clinically relevant even when conventional airway parameters appear normal. The Mallampati classification, mouth opening, and neck mobility provide useful information but represent only selected components of the airway examination. They may not adequately capture difficulties caused by abnormal spinal alignment, altered head and neck positioning, or changes in the spatial relationship between the airway and surrounding skeletal structures.

This distinction was particularly important in the present patient. His Mallampati class II airway, approximately three-finger-breadth mouth opening, and relatively preserved neck extension did not suggest an obviously difficult intubation. Nevertheless, physical examination demonstrated pronounced thoracic kyphosis and abnormal trunk posture. CT further demonstrated severe cervicothoracic skeletal deformity, while three-dimensional reconstruction provided additional visualization of the altered relationship between the skeletal structures and airway axis. These findings increased concern that the patient might not tolerate conventional positioning or airway manipulation after induction of anesthesia.

Therefore, airway assessment in patients with renal osteodystrophy should not rely exclusively on conventional bedside parameters. Instead, the overall assessment should integrate the underlying disease, skeletal deformity, cervical mobility, ability to achieve an appropriate airway position, anticipated surgical requirements, and the feasibility of rescue ventilation and intubation.

The 2022 American Society of Anesthesiologists Practice Guidelines emphasize that difficult airway assessment should incorporate patient-specific anatomical and physiological characteristics as well as the planned procedure rather than relying on a single airway predictor [4]. This principle was particularly relevant to the present patient because his potential airway risk was primarily related to abnormal skeletal anatomy and positioning rather than an obviously abnormal oropharyngeal examination.

Rationale for awake fiberoptic intubation

The decision to perform awake fiberoptic intubation was based on the possibility that airway management could become more difficult after induction of general anesthesia. In a patient with potential difficulty in airway positioning or manipulation, loss of spontaneous ventilation before establishment of a secure airway may reduce the margin of safety.

Awake tracheal intubation allows airway control while spontaneous ventilation is maintained and provides an opportunity to confirm successful tracheal tube placement before general anesthesia is induced. Current difficult airway guidance emphasizes adequate oxygenation, effective topical airway anesthesia, carefully titrated sedation, continuous assessment, and confirmation of tube placement before induction of general anesthesia in appropriate patients [5].

In the present case, the patient received only low-dose midazolam and sufentanil. Sedation was intentionally limited to avoid excessive respiratory depression and loss of airway patency. Topical airway anesthesia was achieved using a combination of oropharyngeal lidocaine spray and cricothyroid membrane puncture with lidocaine injection. The bronchoscope was then advanced while spontaneous breathing was maintained, and the tracheal tube was positioned before induction of general anesthesia.

This sequence was clinically important. Rather than relying on successful mask ventilation or intubation after induction, a secure tracheal airway was established first, thereby reducing the potential consequences of unexpected airway difficulty.

Importance of a comprehensive rescue plan

Preparation for difficult airway management should not end with selection of the primary intubation technique. A structured rescue plan is essential because awake fiberoptic intubation can also fail because of inadequate topical anesthesia, patient intolerance, airway secretions, bleeding, anatomical distortion, or technical limitations.

In this case, different endotracheal tube sizes, supraglottic airway devices, nasopharyngeal and oropharyngeal airways, retrograde intubation equipment, and emergency front-of-neck airway equipment were prepared before airway management began.

The purpose of this preparation was not to imply that all rescue techniques would necessarily be required, but to ensure that a predefined escalation pathway was available if the primary technique failed. Such preparation is particularly relevant when a patient's skeletal deformity may make subsequent positioning and airway rescue more difficult.

The case therefore illustrates an important principle: in patients considered to have a potential difficult airway, airway planning should include not only the first intubation technique but also strategies for oxygenation, alternative intubation, emergency airway access, and subsequent extubation.

Extubation as a separate stage of airway management

Extubation deserves particular attention in patients with anticipated difficult airway management. Successful intubation does not eliminate the possibility that reintubation may be difficult if postoperative airway compromise occurs.

The ASA difficult airway guideline recommends developing an extubation strategy in patients at increased risk of airway difficulty and considering the possibility that airway re-establishment may be required [4]. In patients undergoing neck surgery, postoperative bleeding, hematoma, and local tissue edema may further compromise the airway [6].

This consideration was relevant to the present patient because his marked skeletal deformity could potentially make emergency airway re-establishment more challenging. Accordingly, extubation was

performed only after recovery of consciousness and adequate spontaneous ventilation, with stable oxygenation and circulation. The patient was then closely observed in the PACU for 30 min.

Although no postoperative airway complication occurred, the uneventful extubation should not be interpreted as evidence that the patient had no airway risk. Rather, it reflects the importance of considering extubation as an independent stage of difficult airway management and ensuring that appropriate monitoring and rescue capability are available.

Perioperative management of SHPT and calcium homeostasis

In addition to airway management, the patient's long-standing SHPT and renal osteodystrophy required attention to perioperative mineral metabolism. Persistent PTH elevation in patients with chronic kidney disease can promote high bone turnover and abnormal bone remodeling [1, 2]. The patient's long duration of dialysis, prolonged SHPT, and skeletal deformities were consistent with substantial chronic disturbances in bone metabolism.

Management of SHPT in patients receiving long-term dialysis requires consideration of PTH together with calcium, phosphate, and vitamin D metabolism [7]. Following parathyroidectomy, a rapid reduction in PTH may alter the balance between bone mineral uptake and circulating calcium concentrations. In patients with severe longstanding SHPT, increased skeletal uptake of minerals may contribute to postoperative hypocalcemia and, in severe cases, hungry bone syndrome (HBS) [8].

Therefore, postoperative calcium assessment should not rely solely on the postoperative PTH concentration. Serial calcium measurements and assessment of symptoms potentially related to hypocalcemia are clinically important, particularly during the first several postoperative days.

In the present case, PTH decreased from 416 pg/mL before surgery to 274, 198, 180, and 165 pg/mL on POD 1, 3, 5, and 7, respectively. Serum total calcium decreased from 2.57 mmol/L preoperatively to 2.30 mmol/L on POD 3 and subsequently increased to 2.34 mmol/L by POD 7. Importantly, the patient did not develop clinical manifestations of hypocalcemia.

These findings suggest that postoperative calcium homeostasis remained clinically stable in this patient. Nevertheless, the transient postoperative decrease in serum calcium illustrates why continued postoperative monitoring is warranted, particularly because clinically significant hypocalcemia may develop several days after parathyroidectomy in patients with longstanding SHPT.

The present case also illustrates that perioperative management of such patients requires an integrated approach. Airway assessment and preparation are particularly important because skeletal deformity may be clinically significant even when conventional airway examination appears reassuring. At the same time, the underlying mineral and bone disorder should be considered because it may influence both the patient's skeletal anatomy and postoperative metabolic course.

Conclusions

Patients with long-term maintenance hemodialysis and secondary hyperparathyroidism may develop renal osteodystrophy-associated skeletal deformities that complicate airway positioning and manipulation. Conventional airway assessment may appear reassuring despite the presence of potential airway risk. A comprehensive assessment incorporating skeletal deformity, body alignment, cervical mobility, imaging findings, and the feasibility of rescue airway strategies may therefore be valuable.

In the present patient, awake fiberoptic intubation with preservation of spontaneous ventilation provided a controlled approach to airway management, and extensive preparation for alternative and emergency airway techniques further increased the safety margin. Careful extubation planning and postoperative observation were also important because re-establishing the airway could potentially be difficult if postoperative complications occurred. In addition, serial postoperative calcium monitoring is warranted after parathyroidectomy in patients with long-standing SHPT because of the risk of delayed hypocalcemia.

Abbreviations

BIS	
Bispectral index	
CT	
computed tomography	
HBS	
hungry bone syndrome	
PTH	
parathyroid hormone	
POD	
postoperative day	
SHPT	
secondary hyperparathyroidism.	

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

MG contributed to the clinical management, data collection, and drafting of the manuscript. NC and XW contributed to the clinical management and manuscript revision. CW contributed to the conception of the report, clinical management, and critical revision of the manuscript. All authors read and approved the final manuscript.

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Figures



Figure 1

External appearance and abnormal posture of the patient. Marked thoracic kyphosis and abnormal trunk posture were observed on preoperative physical examination



Figure 2

Skeletal deformity associated with long-term renal osteodystrophy. The patient demonstrated marked skeletal deformity and abnormal body alignment



Figure 3

Preoperative cervicothoracic computed tomography. Computed tomography demonstrated severe thoracic kyphosis and abnormal spinal alignment.

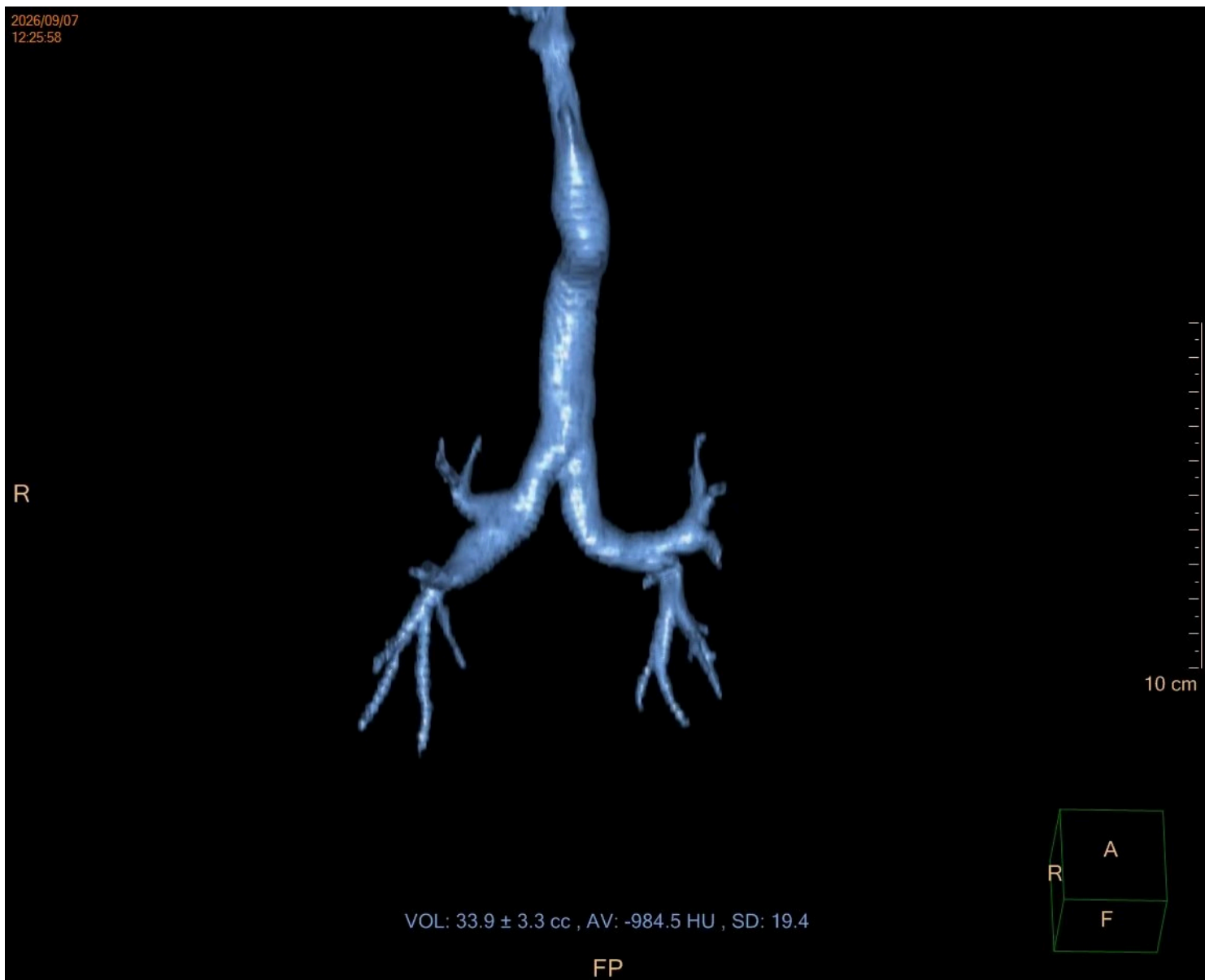


Figure 4

Three-dimensional reconstruction of the airway and cervicothoracic skeletal structures. Three-dimensional reconstruction demonstrated altered spatial relationships between the cervicothoracic skeletal structures and the airway axis.