Chapter 106 – Transnasal and Transoral Approaches to the Cervical Spine

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The superior aspects of the cervical spine (C1 and C2) are not easily reached from a transcervical route and have traditionally been accessed through a transoral/transpalatal approach. Innovations in recent years include the introduction of endoscopes for assistance with the transoral approach and the development of a completely endoscopic transnasal approach. Although not widely used yet, we believe that the transnasal approach has distinct advantages that will make it the preferred technique. The otolaryngologist does not typically perform cervical spine surgery in isolation but cooperates with other specialties (neurosurgery, orthopedic surgery) to provide access to the upper cervical spine. With the transnasal endoscopic approach, the otolaryngologist maintains an endoscopic view for the neurosurgeon after the initial exposure is achieved.

Resection of the odontoid process is sometimes necessary for the treatment of basilar invagination with brain stem compression. This may be the result of rheumatoid degeneration with pannus formation or traumatic fracture and dislocation of the odontoid. With the advent of transnasal endoscopic approaches to the ventral skull base, resection of the odontoid may also be performed to provide access to tumors of the foramen magnum and adjacent areas.

ANATOMY

The transoral and transnasal approaches to C1 and C2 are midline approaches. C1 and C2 articulate with the skull at the inferior edge of the clivus (foramen magnum). The dens or odontoid process is covered anteriorly by the arch of C1. The vertebral bodies are covered by the paraspinal muscles anteriorly (longus colli and longus capitis). The body of C2 is typically at the level of the soft palate. The posterior pharyngeal wall covers the bodies of C3 and C4. Laterally, the vertebral artery is exposed between C1 and C2, where it exits the vertebral canal and loops superficially. The parapharyngeal segment of the internal carotid artery is situated laterally and is not in the surgical field, but an ectatic artery may occasionally deviate medially into the retropharyngeal region.

The palatal mucosa receives its blood supply from the greater palatine vessels, which exit the greater palatine foramina medial to the second molars. The arteries course anteriorly to supply the mucosa over the hard palate. Passavant's ridge is a muscular ridge that is physiologically but not anatomically distinct and provides contact with the soft palate during nasopharyngeal closure.

The clivus is the anterior portion of the occipital bone and extends from the floor of the sphenoid sinus to the foramen magnum. The bone of the clivus thins as it approaches the foramen. Laterally, the clivus is bounded by the medial pterygoid plates and the base of the pterygoids. The pterygoid canal and vidian artery lead to the second genu of the petrous carotid artery, which is situated superolaterally. The lateral limit of the surgical field is the eustachian tube.

PATIENT SELECTION

Indications for surgery on C1 and C2 include infectious, inflammatory, traumatic, and neoplastic conditions. Infectious problems are rare but could include a localized retropharyngeal abscess, which is best accessed directly, and osteomyelitis. Traumatic injuries of C1 and C2 that compress the spinal cord cannot be repaired directly but may require decompression of displaced bone fragments. Stabilization of the spine with posterior fusion is usually necessary.

The most common indication for surgical ap-proaches to C1 and C2 is rheumatoid degeneration of the ligaments with resultant destruction of the odontoid and creation of an inflammatory pannus (Fig. 106-1). Symptoms are a consequence of cervical instability, as well as basilar invagination and compression of the brain stem.

Figure 106-1 Basilar invagination with brain stem compression secondary to rheumatoid pannus *(arrow)*.

Resection of the lower clivus and odontoid provides a surgical corridor to tumors at the foramen magnum (Fig. 106-2). These tumors are a heterogeneous group consisting of chondrosarcomas, meningiomas, chordomas, and other types. This approach may be combined with other modules of the expanded endonasal approach to the ventral skull base to obtain optimal exposure.[1]

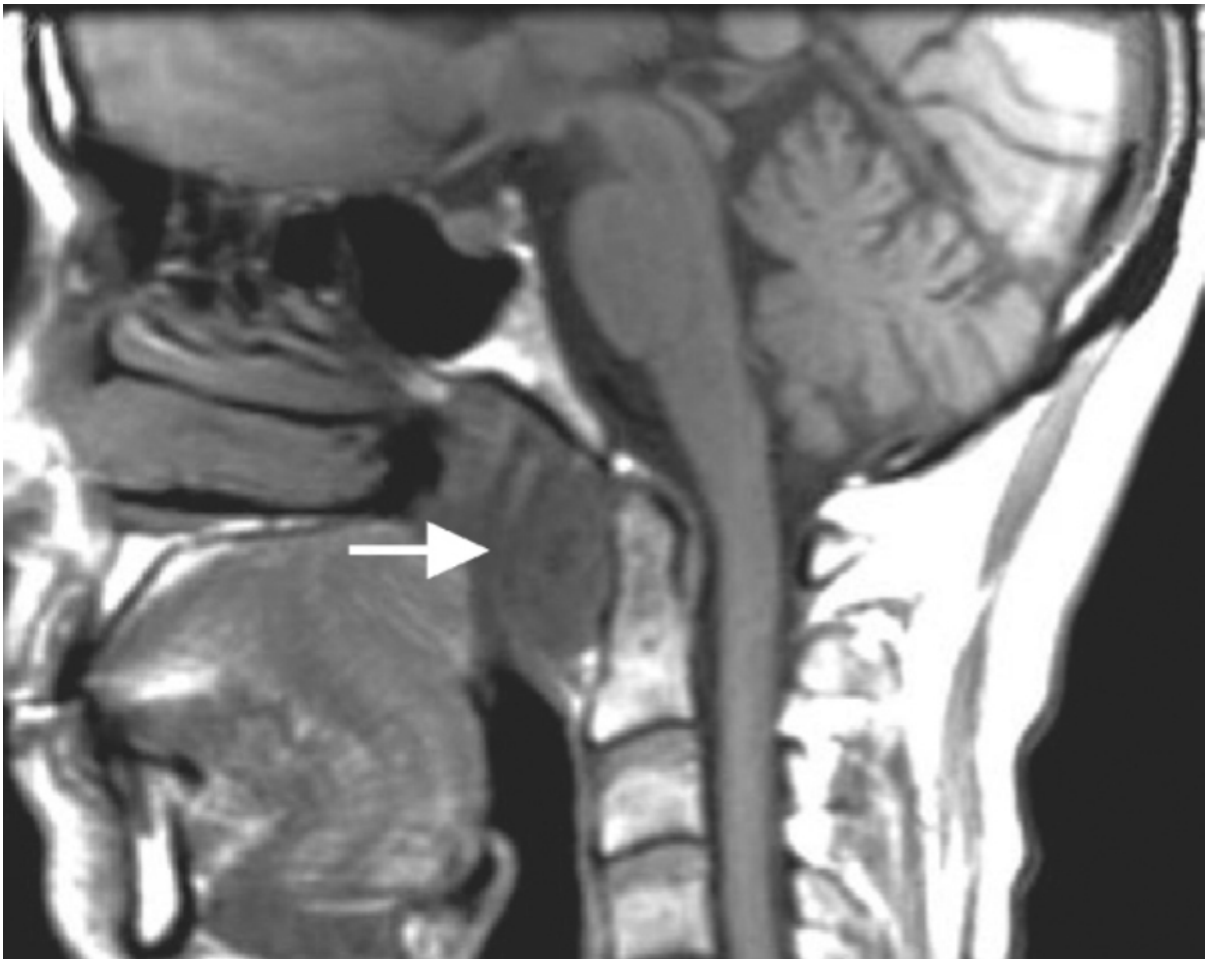

Figure 106-2 Neoplasms at the level of the foramen magnum *(arrow)* are most commonly chordomas, chondrosarcomas, or meningiomas.

PREOPERATIVE EVALUATION

Patients with basilar invagination are typically elderly patients and often have severe pharyngeal dysfunction at the time of surgery. A complete neurologic examination with assessment of evidence of long-tract compression should be performed. The larynx is examined to evaluate laryngeal function, swallowing, and risk of aspiration.

Computed tomography (CT) is best suited to assess changes in bone anatomy, the relationship of C1 to the lower clivus, and the position of the odontoid. Magnetic resonance imaging (MRI) is superior for visualization of the pannus and the amount of brain stem compression. If an intraoperative navigational system is used, a CT angiogram is obtained preoperatively for image guidance. It is necessary to modify the standard scanning protocol to include the upper cervical spine to the C3 level.

Consultation with an anesthesiologist should be obtained for evaluation of the airway and consideration of airway options. Increased difficulty of intubation because of cervical instability may be encountered. There is also a risk of accidental extubation with repositioning of the patient for posterior cervical fusion if performed during the same operative setting.

PREOPERATIVE PLANNING

After endotracheal intubation and induction of general anesthesia, the patient undergoes baseline somatosensory evoked potential (SSEP) monitoring before positioning. Brain stem evoked responses to monitor brain stem function may also be indicated. Cervical instability during repositioning requires continued monitoring, especially with movement of the patient. The patient is then placed in Mayfield pins in a neutral position, and postpositioning SSEPs are used to confirm the safety of the positioning. Image guidance registration, including the cervicomedullary junction, is undertaken.

Adequate preparation of the nares or pharynx is carried out, and the patient is given a third-generation cephalosporin for perioperative antibiotic prophylaxis. Topical antibiotics may also be used in this situation because the entire dissection is usually extradural.

SURGICAL APPROACHES

Although the transoral/transpalatal approach is still the standard of care at most institutions, we prefer the transnasal route for decompression of the brain stem. The transnasal route is limited inferiorly and can reliably reach only the body of C2. If more inferior resection is needed, a transnasal route can be combined with a transoral route. A transoral route is contraindicated in patients with severe trismus and is difficult in patients with a full set of restored teeth.

Transoral/Transpalatal Approach

Surgery may be performed with nasal or oral endotracheal intubation. If the patient is nasally intubated, the tube can be displaced to one side in the pharynx. Alternatively, an oral RAE tube can be held between the retractor and the tongue. Various retractors (Dingman, Crockard) are available and allow self-retained retraction of the mandible and tongue, as well as the lateral oral commissure (Fig. 106-3). One of the biggest challenges is finding a proper fit of the tongue blade so that the base of tongue does not bulge into the field. During lengthy cases, the retractor should be released for several minutes intermittently to prevent excessive tongue pressure and the potential for ischemic necrosis or edema.

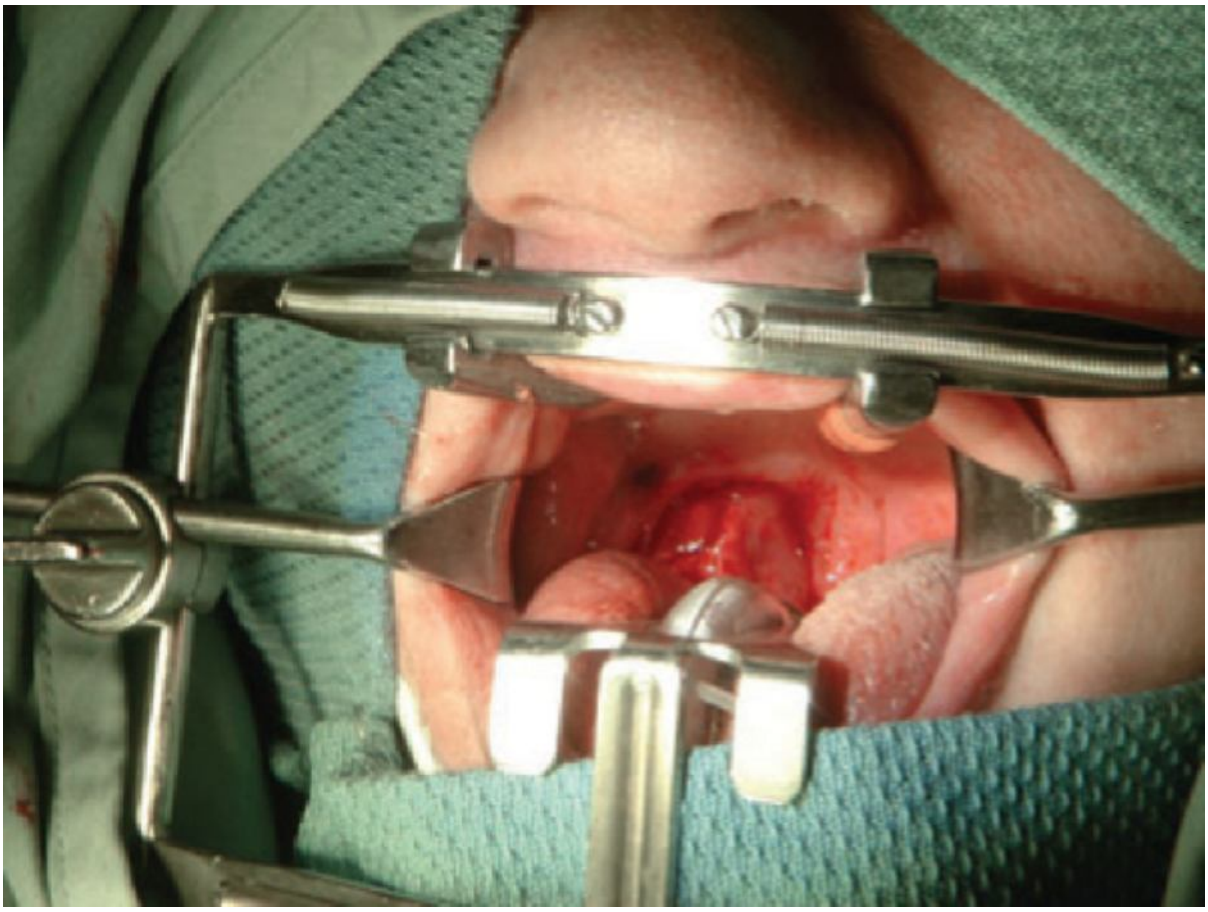

Figure 106-3 A Dingman retractor distracts the mandible and maxilla and displaces the endotracheal tube, tongue, and cheeks.

If the superior extent of the resection is the odontoid, incision of the palate is not necessary. A red rubber catheter is passed transnasally and sutured to the soft palate adjacent to the uvula. It is then retracted to pull the soft palate into the nasopharynx and secured to the drapes. If the exposure needs to extend to the rostrum of the sphenoid, incision of the palate is generally necessary. A paramedian incision is made adjacent to the uvula and curves in a lazy “S” fashion behind the maxillary alveolus so that the majority of the palatal flap is based on one greater palatine artery. The mucoperiosteal flaps are elevated laterally to the edge of the greater palatine foramen with preservation of the blood supply. The posterior edge of the hard palate may be resected to provide additional exposure superiorly.

Electrocautery is used to make a vertical midline incision in the posterior pharyngeal wall from the level of C3 to the nasopharynx. The incision continues through the soft tissues in the midline between the longus capitis and longus colli muscles. The paraspinal muscles are elevated from the vertebral bodies and ring of C1. Excessive lateral dissection is avoided because ofthe risk of injuring the vertebral artery. A self-retaining retractor is placed

and the bone work is then performed with a drill and Kerrison rongeurs. Visualization is enhanced with use of the operating microscope or even endoscopes.

After completion of the decompression, the pharyngeal incision is closed in two layers: a deep layer of interrupted 3-0 polyglycolic acid suture and a superficial layer of 3-0 polyglycolic acid suture placed with a vertical mattress technique. Obtaining watertight closure can be difficult at the superior and inferior limits of the incision. If a palatal incision has been made, the soft palate incision is closed in two layers: a deep intramuscular layer of interrupted 4-0 polyglycolic acid suture and a superficial layer of interrupted 4-0 polyglycolic acid suture. The mucoperiosteal flap over the hard palate is thin and closed in a single layer with a vertical mattress technique. A paraffin nasal splint can be molded to the contour of the hard palate and secured with sutures around the teeth. This protects the palatal mucosa during mastication.

Transnasal Approach

The technique has been described elsewhere[2,3] and is performed by a surgical team consisting of an otolaryngologist and neurosurgeon operating simultaneously. The first step is bilateral sphenoidotomy with resection of the posterior attachment of the nasal septum to the rostrum of the sphenoid (see Video 106-1).

The mucosa of the posterior nasopharynx is then cauterized and elevated to expose the underlying paraspinal muscles (longus capitis and longus colli). The soft tissues and muscles are then resected to expose the underlying pharyngobasilar fascia (see Video 106-2). Resection of

this dense fascia is facilitated by using a drill with a 3-mm coarse diamond bit to remove the cortical bone of the clivus starting at the sphenoidotomy and progressing inferiorly (see Video 106-3). The limits of exposure

include the eustachian tubes laterally, the floor of the sphenoid sinus superiorly, and the level of the soft palate inferiorly.

An image guidance system is used to identify the level of the ring of C1, and the bone is then exposed (Fig. 106-4). The lower edge of the clivus is thinned with a drill and resected with a Kerrison rongeur. The central portion of C1 is then removed with the drill and the defect is widened laterally with a bone rongeur (Fig. 106-5) (see Video 106-4). The location of the underlying

dens is confirmed with image guidance and the central portion of the dens is drilled (see Video 106-5).

When only a shell of outer cortical bone remains, the base of the dens is detached from the body of C2. Blunt and sharp dissection of the attachments of the dens to the surrounding pannus allows mobilization and removal of the remaining bone (Fig. 106-6) (see Video 106-6).

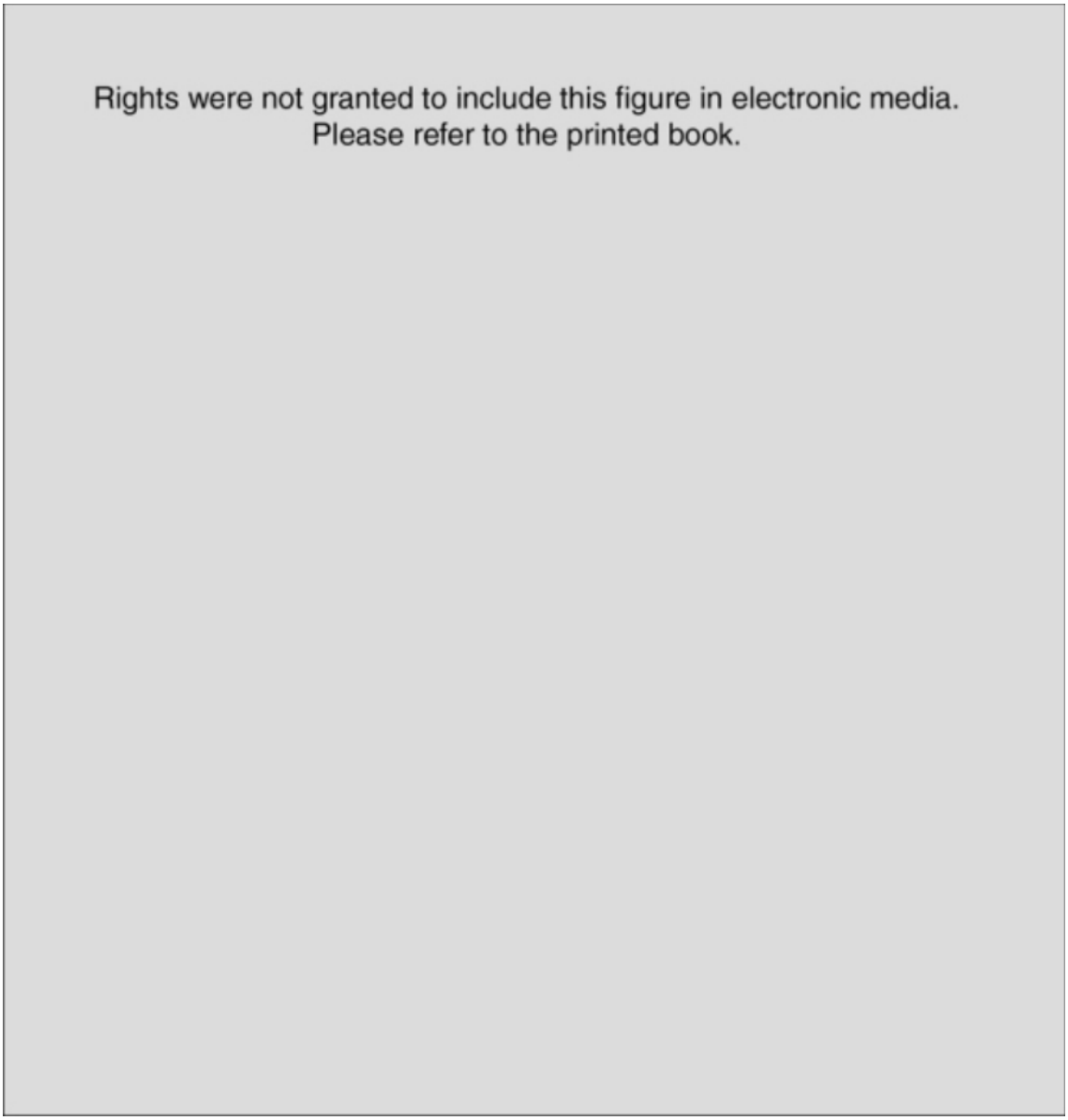

Figure 106-4 The nasopharyngeal soft tissues are resected to expose the lower clivus and ring of C1. OC, occipital condyle; SPA, sphenopalatine artery; Vid, vidian artery.
(Reprinted with permission from Kassam AB, Snyderman C, Gardner P, et al: The expanded endonasal approach: A fully endoscopic transnasal approach and resection of the odontoid process: Technical case report. Neurosurgery 57[1 Suppl]:E213, discussion E213, 2005.)

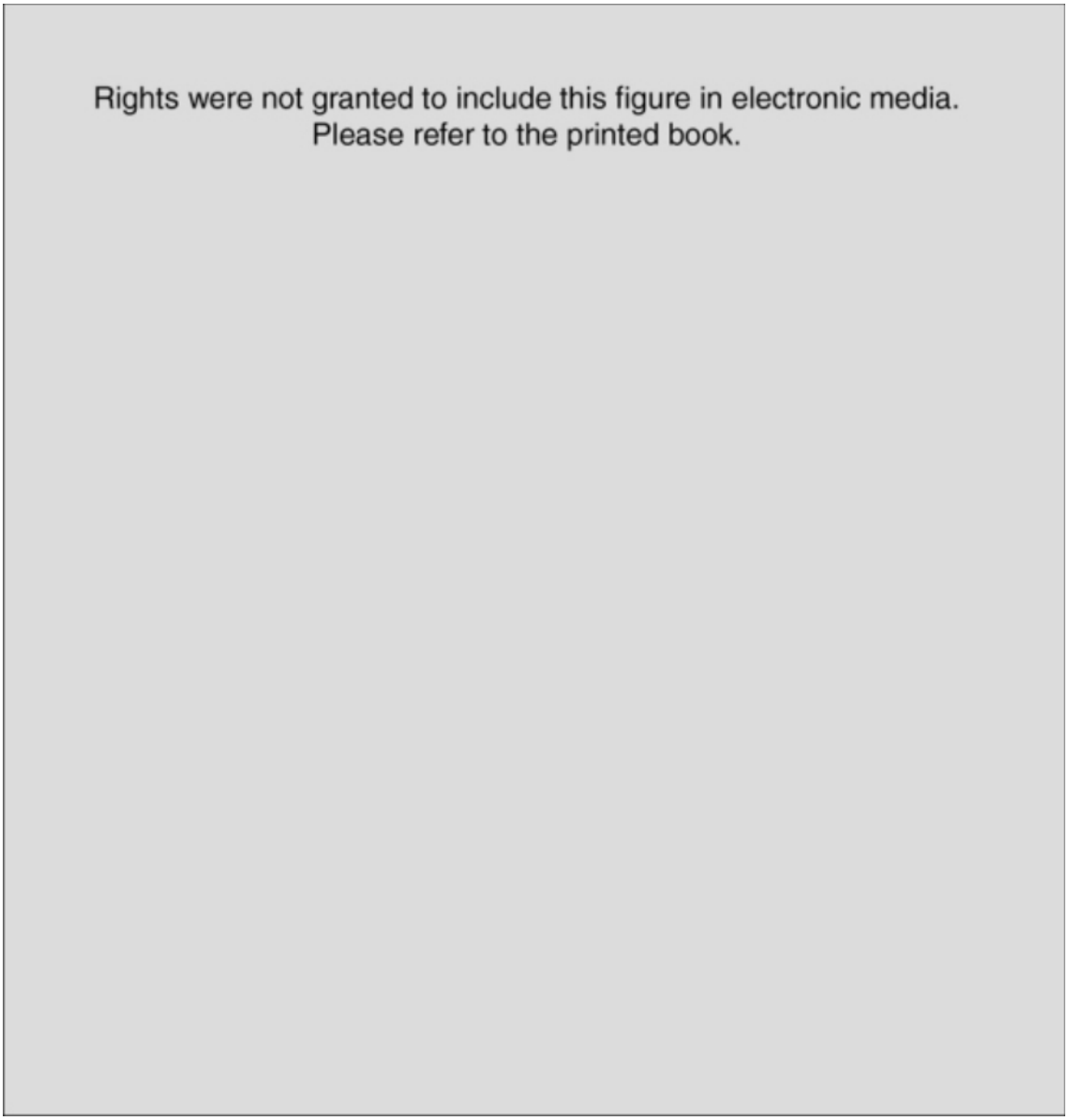

Figure 106-5 The central ring of C1 is removed with a drill and the gap is widened with a Kerrison rongeur. FM, foramen magnum; OC, occipital condyle, Od, odontoid.

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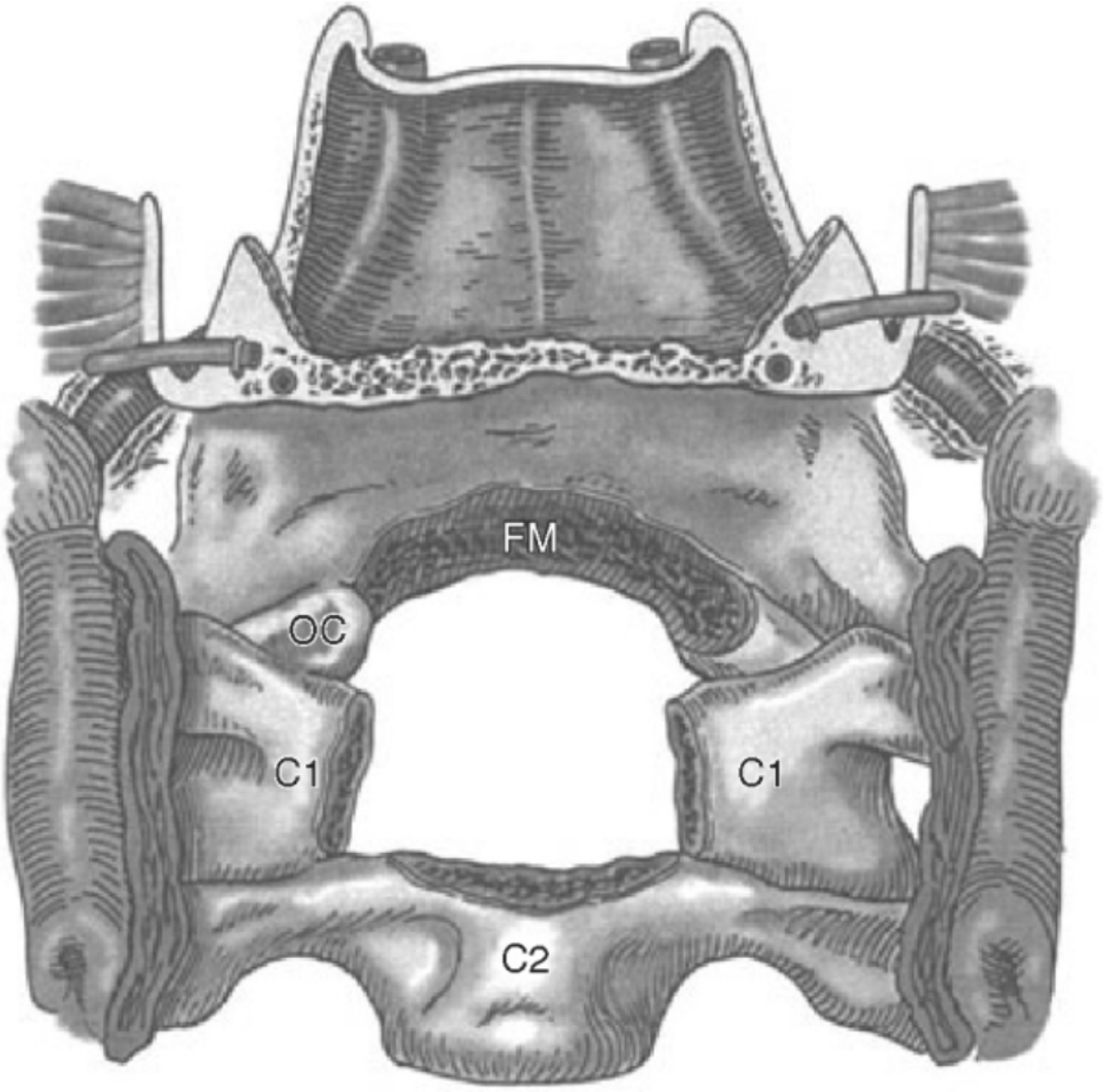

Figure 106-6 The odontoid is removed with a drill and dissection of the ligamentous attachments. FM, foramen magnum; OC, occipital condyle.
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Although resection of the pannus may not be necessary, we prefer to partially resect the pannus with an ultrasonic aspirator until pulsations transmitted from the brain stem are observed (see Video 106-7). No reconstruction is necessary if the dura has not been violated. The defect is covered with fibrin glue (see Video 106-8).

Because of inherent instability of the craniovertebral junction in these patients, posterior fusion of the cervical spine to the occiput is usually performed during the same operative event.

POSTOPERATIVE MANAGEMENT

These patients are at increased risk for aspiration postoperatively, and reintubation can be difficult because of posterior neck fusion. Consideration should be given to leaving the patient intubated postoperatively until a safe airway can be ensured, or a temporary tracheostomy should be performed. With the transnasal approach, we have found tracheostomy to be necessary only in patients with significant preoperative pharyngeal dysfunction.

Patients may start a full liquid diet and progress to a soft diet as soon as they are able to swallow without aspiration. Formal evaluation with a modified barium swallow may be helpful in determining swallowing capability. With the transnasal approach, patients can resume an oral diet immediately. Return of swallowing function is often delayed for several days with a transoral route.

If used, nasal septal or palatal splints are removed 1 week postoperatively.

COMPLICATIONS

The transoral/transpalatal approach to the upper cervical spine and foramen magnum provides limited exposure, especially in patients with impaired jaw opening or enlarged oropharyngeal tissues. Although C2 and C3 can be exposed with retraction of the soft palate, exposure plus removal of bone of C1 and the lower clivus are difficult, even with a palatal incision. Resection of the posterior edge of the hard palate provides additional exposure but increases the risk for a palatal fistula postoperatively. Other potential risks include dental injury, edema or necrosis of the tongue, upper airway obstruction secondary to edema, dysphagia, pain with swallowing, nasal regurgitation/hypernasal speech as a result of palatal incompetence, retropharyngeal hematoma or abscess, and temporomandibular joint syndrome secondary to excessive opening of the jaw. Because of concerns about the airway postoperatively, patients may remain intubated or require a tracheostomy. The angle of approach to the tip of the odontoid is less than 90 degrees and may hinder visualization with a microscope and increase the difficulty of dissection. Although the introduction of endoscopes through the oral cavity has the potential of decreasing the extent of exposure and improving visualization, it does not solve all these issues.

Palatal dysfunction is a significant problem with transoral/transpalatal procedures. Palatal incisions result in some degree of retraction, and partial dehiscence of the closure can create a gap at the palatal edge. Additionally, resection of vertebral bone and retropharyngeal soft tissues increases the distance between the palate and the posterior pharyngeal wall and prevents good contact during nasopharyngeal closure. This results in hypernasal speech and nasal reflux of liquids. There is less risk of palatal dysfunction with a transnasal approach. Because the posterior pharyngeal defect is above the level of the contact point for the soft palate and posterior pharyngeal wall (Passavant's ridge), there is no risk of hypernasal speech or nasal regurgitation.

Closure of the pharyngeal incision is difficult after a transoral approach, and ongoing contamination of the wound by saliva with heavy bacterial flora can occur. In contrast, the defect created by a transnasal approach is above the level of the soft palate and should not be exposed to the same degree of bacterial contamination. The wound is protected with a layer of fibrin glue at the end of the procedure.

The extracranial parapharyngeal segment of the internal carotid artery is lateral to the fossa of Rosenmüller and deep to the eustachian tube. On occasion, a tortuous internal carotid artery may course medially in the retropharyngeal area. This a relative contraindication to a transoral approach but would not preclude a transnasal approach.

Far lateral dissection at the level of C1 and C2 may injure the vertebral artery and should be performed only under image guidance.

If a cerebrospinal fluid (CSF) leak should occur with a transoral approach, obtaining a watertight closure can be difficult, depending on the length and accessibility of the superior extent of the incision. With the transnasal approach, there is a greater risk of a dural opening and CSF leak if dissection is performed in the region of the occipital condyle superolaterally. A CSF leak in this area can be effectively sealed with a fat graft or septal mucosal flap.

SUMMARY

The transnasal endoscopic approach to the odontoid is direct and provides access to the lower clivus, C1, and body of C2. Visualization with the endoscope is superior to that with the microscope and facilitates more complete removal of pannus if indicated. The only limitation is the ability to dissect below the body of C2 because of the level of the hard palate. Avoidance of pharyngeal and palatal incisions circumvents the potential airway and swallowing morbidity associated with the transoral approach. Because the surgical opening is above the level of the soft palate, palatal dysfunction is avoided and there is no need to close the mucosal defect. No infections have been observed. There is also minimal pain, and patients are able to resume an oral diet immediately if there were no swallowing problems preoperatively. A more rapid return to normal function and avoidance of operative morbidity should result in shorter hospitalization with decreased cost of care.

PEARLS

- A palatal incision can usually be avoided by retraction of the soft palate into the nasopharynx with a catheter sutured to the base of the uvula.

- With a transnasal route, resection of the posterior nasal septum to the nasal floor is necessary to provide adequate lateral access.
- Resection of the nasopharyngeal mucosa and underlying muscle and fascia improves exposure of C1 and C2.
- Removal of a thickened pannus should be performed until transmitted pulsations are evident; complete removal risks a CSF leak.
- The inferior extent of the transnasal approach is limited by the posterior edge of the hard palate.

PITFALLS

- Patients with preoperative pharyngeal dysfunction are at increased risk for airway problems and should have a tracheostomy performed at the same time.
- Patients with cervical instability should undergo neurophysiologic monitoring during positioning and throughout surgery to avoid neural injury.
- Excessive pressure from an oral retractor can result in ischemic necrosis of the tongue.
- Loss of retropharyngeal soft tissue and bone increases the risk for postoperative palatal insufficiency.
- Retropharyngeal dissection lateral to the eustachian tube should be avoided because of the risk of injury to the internal carotid artery.