THE TRANSORAL APPROACH TO CLIVUS AND CERVICAL SPINE:
RESURRECTION OF A TECHNIQUE FADING IN TIME

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ABSTRACT

The transoral approach to clivus and upper cervical region is a direct route for treating pathology ventral to the brainstem and upper cervical spinal cord with low morbidity and mortality rates. This approach may be used for congenital atlanto-axial dislocation, fracture dislocation, verteobasilar aneurysms, basilar invagination, compressive rheumatoid pannus and tumours of the craniovertebral junction such as chordomas, chondromas, chondrosarcomas, giant cell tumours and meningiomas at ventral foramen magnum.

KEYWORDS: clivus tumour, basilar invagination, chordoma, atlanto-axial subluxation, basilar aneurysm, schwannoma.

INTRODUCTION

Pathologic lesions of the clivus and upper cervical spine present a challenge to surgical access. This occult niche can harbour neoplastic, inflammatory or degenerative lesions that may cause compression of cervicomедullary junction and craniovertebral instability. The transoral approach to clivus and upper cervical region is a direct route for treating pathology ventral to the brainstem and upper cervical spinal cord with low morbidity and mortality rates. This approach may be used for congenital atlanto-axial dislocation,¹ fracture dislocation,² verteobasilar aneurysms,³ basilar invagination,⁴ verteobasilar aneurysms⁴ and tumours⁵ of the craniovertebral junction such as chordomas, chondromas, chondrosarcomas, giant cell tumours and meningiomas⁶ at ventral foramen magnum.

The transoral approach to ventral rim of foramen magnum and upper cervical spine was suggested by Scoville and Sherman in 1935.⁵ Later, Fang and Ong⁶ (1962) popularized the technique for infection in the area. Haselden and Bryce⁹ published an important case report in Journal of Maxillofacial Surgery on transoral clivectomy for approaching the basilar artery. However, the actual acceptance of the technique came with the publishing of the landmark paper by Alan Crockard in 1985,¹⁰ who described a safe and standard version of the approach for removal of extradural and intradural tumours using microsurgical techniques and watertight closure of dura with the aid of fibrin glue. Subsequently, some modifications of the approach were described for extended inferior exposure using median mandibuloglossostomy (Trotter’s approach)¹¹ or extended superior exposure through transpalatal approach. The most important extension was that reported by Vinod Anand,¹² a head and neck surgeon, who described “Open-door maxillotomy” involving Le Fort I osteotomy of the maxilla and a paramedian sagittal split of the hard palate, providing an “open-book” access to upper clival pathology. For the purpose of avoiding confusion and providing a clear understanding of surgical technique, the standard version of the transoral approach will be discussed in the following text, as described by Paul J Donald (1998).⁴

The decision to employ the anterior surgical route instead of the conventional posterior fossa exploration or cervical laminectomy is contingent with adequate radiological visualization of the area. The availability of computerized tomography, computed myelotomyography and magnetic resonance imaging has provided the surgeon an unprecedented perspective of the area and revealed previously unconsidered aspects of pathology.

SURGICAL TECHNIQUE:¹⁴,⁶,¹⁰,¹¹

PREPARATION

The patient is operated on in the supine position. A C-arm fluoroscope should be put into position before the start of the surgical sterile preparation of the patient. The fluoroscope is not essential in all cases and spot films can be taken instead with a mobile machine during the course of the procedure. Neurophysiologic monitoring of the spinal cord is preferred during the procedure,
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especially when any spinal or atlanto-occipital instability is anticipated.

The head position needs fixation. The head is manipulated into the surgically most advantageous position while the electrical activity of the spinal cord is carefully monitored. The best position is with as much extension as possible. Before surgery, the extent of jaw opening should be assessed, especially in cases of rheumatoid arthritis.

Before surgery, the extent of jaw opening should be assessed, especially in cases of rheumatoid arthritis. Restriction of motion will require median labial mandibuloglossoptomy. A tracheostomy is often done for a number of reasons. A lumbar subarachnoid drain is placed when dural resection is anticipated.

LEGENDS FOR FIGURES

**Fig. 1** – Outline of soft and hard palate incisions.

**Fig. 2** – Outline of incisions on posterior pharyngeal wall.

**Fig. 3** – Dissection of tough soft tissues off the clivus and cervical spine using heavy elevator.

**OPERATIVE PROCEDURE**

The Crockard or Dingman mouth gag is placed to retract the tongue and cheeks and prop open the mouth. Injection of posterior pharyngeal wall, the soft palate and the hard palate is done with 0.5% lidocaine in 1/100,000 or 1/200,000 epinephrine. The initial injection is made in proposed incision line and further infusion is made over the areas of planned soft tissue elevation. A midline incision in the soft palate, splitting the uvula in the midline, is the first step and may be all that is required to provide adequate access to the clivus. If exposure of the sphenoid clivus and floor of sphenoid sinus is needed, an exposure through the hard palate is often required. An incision in the palatal mucosa from the junction of soft to hard palate is made laterally to approximately 3 to 5 mm from the necks of the teeth (Fig. 1). This is carried around the anterior aspect of the hard palate, just posterior to the incisive foramen to the other side and carried down to the level of the first molar tooth on the opposing side. The hard palatal mucoperiosteum is dissected to the junction of the hard and soft palate. The greater palatine neurovascular bundle on the side of greatest exposure is isolated and a ligature slid around it and tied.

The insertions of the soft palatal muscles on the posterior projection of the hard palate are dissected away. On the side of lesser involvement, this is done submucosally if possible to avoid a T-shaped incision that is prone to wound breakdown and subsequent fistulization. The self retaining retractor is inserted, exposing the entire nasopharyngeal and oropharyngeal walls from the posterior nasal septum to the level of C3 and even C4. The posterior pharyngeal wall is clearly seen and a lateral incision is made from the mucosa through the superior constrictor muscle to the alar fascia (Fig. 2). The insertion is made as far lateral in the pharynx as possible, just medial to the posterior pillar of the tonsil and
extends from the nasopharynx to the level of the tip of epiglottis. Care is taken to avoid accidental incision of the ascending pharyngeal artery. The alar fascia is identified as a glistening, white, fibrous layer on the outer aspect of the constrictor muscle, yet anterior to the cervical prevertebral fascia. In the oropharynx, the muscle is clearly and easily identifiable and the alar fascia is obvious. In the nasopharynx, the muscle becomes tendinous and inserts into the pharyngeal tubercle of the clivus. The right angled scissors dissect the muscle layer from the incision to the opposite lateral pharyngeal wall. Hemostasis is ensured with the suction cautery. Once the wound is dry, a parallel incision is created on the opposite side and the same length as its fellow. Hemostasis is established again. The two incisions are connected superiorly, with this superior transverse incision placed in such a fashion that closure near the nasopharynx can be easily achieved at the end of the operation. This incision is usually located just behind the choanae. Sharp dissection connects the free retropharyngeal plane into the nasopharynx to create an inferiorly based posterior pharyngeal flap, as described for the operation by Crumley and Gutin. The flap is dissected inferiorly, folded on itself and temporarily tamped into the hypopharynx. The flap can be secured in this position throughout the remainder of the procedure by placing a suture at each corner of the flap superiorly, running the suture through a small square of lead and stuffing the lead into the hypopharynx.

A drill is now used to remove enough palatal bone to achieve the required exposure of the upper clivus. This exposure may extend as far anteriorly as the cribiform plate, if so desired. The nasal mucoperiosteum of the posterior nasal floor is rather delicate and difficult to preserve. However, the septal mucoperiosteum over the vomer is much tougher once sufficient palatal is removed, the inferior aspect of the nasal septum becomes obvious. It is split on the choanal side right up to the sphenoid rostrum and dissection of the septal mucoperiosteal leaves is carried up this high and the posterior septal bone removed. The Crockard palatal retractor is now inserted.

The midline posterior septal incision becomes continuous with a midline incision through the tough, tendinous tissue over the clivus, the prevertebral fascia and the muscles of upper cervical spine. The heavy elevator is now used to dissect this soft tissue over the clivus and upper two or three cervical vertebrae. The Crockard retractor is reapplied and the soft tissue held in place, exposing the site of proposed bony resection or tumour.

If such exigencies such as a very small oropharynx, severe trismus or severe microgenia and retrognathia are present, or if exposure to the C4 to C6 level is also required, additional exposure may be gained by using the median labial mandibuloglossoptomy originally described by Trotter. A skin incision through the midline of the lip, using a dart in the vermillion descending vertically to the chin button, circling the chin and into the submental area, is created. The mandible is exposed in the midline and a stairstep incision is etched in the symphysis. Drill holes for two parallel plates are placed to secure the bone at the end of the case. Care is taken that the upper-most plate screw holes are below the roots of the incisor teeth, which are generally double the crown length of the tooth. A saw cut begins between the central incisor teeth either with a fine saw blade or with the Midas Rex B5 cutting tool, assiduously avoiding the lamina dura of either tooth. Once the saw cut has bisected the mandible, the anterior floor of the mouth tissue is cut in the midline and the tongue is split down the midline raphe to the hyoid bone. With improved exposure inferiorly, the pharyngeal flap can be dissected to the posteriocoid area, providing the improved access desired. At the end of the resection, the mandible is secured by two plates.

Once the paraspinous tissues have been retracted, drilling of clival and spinal bone may ensue to expose or provide access to tumour or the odontoid. The curved drill of the TAC attachment of the Midas Rex is ideal for this dissection. Coupled with continuous suction irrigation, bone removal is fast, efficient and safe.

**TUMOUR EXCISION**

Most tumours addressed by this approach are chordomas and chondrosarcomas. Some authors have also encountered fibrous dysplasia, non-specific fibrogranulomatous lesions similar to those of Tolosa-Hunt syndrome and metastatic carcinoma.

Often the tumour is present under the peristeum. Additional exposure is gained by progressive resection of bone with the cutting drill. Long dissection instruments developed by Raveh and Paul J Donald are long enough for this task and remove the hand from obscuring the view. In removing a chordoma, great care is exercised to avoid penetrating the dura (Fig. 3). Although every attempt is made to remove the entire tumour, local recurrences are unfortunately common and if intradural, exceedingly difficult to eliminate. Fortunately, the anterior longitudinal ligament provides some barrier to penetration during tumour dissection.

Lateral extension of neoplasm at the skull base towards the hypoglossal canal is a serious impediment to complete excision and a second staged operation such as a lateral approach may be needed for complete tumour removal. Superior surgical resection can be carried into the sphenoid sinus and up to the sella turcica. Surgical stabilization of the spine may be necessary for a few weeks after surgery.

**ODONTECTOMY**

Removal of the dens is done in some cases of fracture, but most commonly for brainstem and upper cervical
cord compression from an arthritic pannus. It is also done for decompression in basilar impression syndrome.

The exposure almost never requires the median labial mandibuloglossoptomy. Removal of palatal bone is minimal or not necessary. Exposure is from the lower clivus to the level of C2. In basilar impression syndrome, cases of other congenital spinal anomalies and even in rheumatoid arthritises, where collapse of the spinal bodies is not uncommon, landmarks are often difficult to define. Identification of the arch of C1 is sometimes problematic and the frequent use of fluoroscope is encouraged to register position.

An exposure similar to that described for tumour is done but usually only a soft palatal split is required without the necessity of removing hard palatal bone. Once identified, the anterior arch of C1 is removed with the drill. In basilar impression, the bony distortion is often so great that the lower clivus must be excised before the odontoid can be reached. The occipital clivus in these cases is often crumblly and weak. The arch of C1 and occipital clivus are removed until the periosteum over the odontoid is reached. The odontoid is grasped with the Crockard forceps and the dens drilled away.

In cases of rheumatoid arthritis, although the dens is often deformed, there is no migration of the spine. The pannus projects against the brainstem. The C1 arch and only a small portion of the clivus need resection. Once the ligament is reached, much inflammatory reaction is present and the pannus becomes obvious, requiring sharp dissection. Excessive vigour in this endeavour may lead to a breach in the transverse ligament and laceration of dura. This must be avoided, if possible because dural leaks here are difficult to repair. Checking depth of dissection with the fluoroscope is very helpful.

**CLOSURE**

Once the resection is finished, any dural disruption is repaired by suturing a fascia graft augmented by fibrin glue. The dead space created by the resection must be obliterated. Surgicel is often placed against the dura and the defect filled with GelFoam. The defect may be filled with cancellous bone from the hip.

The paraspinous muscles and connective tissue are approximated in the midline with absorbable sutures. This closure is not as tidy over the clivus as it is over the cervical spine. The pharyngeal flap is retrieved from the hypopharynx, the lead weight keepers removed and the flap restored to its original position. Lateral sutures are placed with little difficulty, but the uppermost ones in the transverse incision in the nasopharynx are harder to secure. The nasopharyngeal mucosa is more friable than that of the oropharynx, so that the bridging sutures to the mucoperiosteum of the choanal vault may be necessary to anchor the upper portion of the flap.

To avoid fistulization, it is essential to close the soft palate in three layers. The nasopharyngeal side of the palate is closed initially with interrupted absorbable sutures from the posterior nasal septum to the tip of the uvula. The palatal muscle and the oral mucosa are closed with four horizontal mattress sutures in a fashion similar to closure of a cleft palate. More accurate approximation of the oral mucosa is done with fine suture material.

The tough mucoperiosteum of the hard palate is secured with a few interrupted sutures. The anterior most part of the wound is often difficult to close because the tissue is thin and attenuated and the angle makes suturing mechanically difficult. Because the bony resection is designed to come short of the mucosal incision, sufficient overlap of mucoperiosteum prevents fistula formation.

Closure of the median labial mandibuloglossoptomy is relatively simple. The deep tongue musculature is approximated with 3-0 absorbable sutures and the mucosal surface with 4-0 sutures. The mandibular split is repaired with low-profile titanium plates and screws. Skin and mucosal closure are meticulous to avoid deforming scars. It is essential to accurately approximate the white role of the lower lip because this is the keystone to good aesthetic repair. Interrupted sutures in the skin produce a much better scar than a running closure.

The tracheostomy is maintained after surgery until the pharyngeal and palatal wounds have healed. No pharyngeal diversion is necessary and nasogastric tube feeding is avoided. Oral alimentation can often resume in about 5 days. If complications preclude oral feedings, then a nasogastric tube is placed, taking great care to avoid disruption of the palatal and pharyngeal wounds. If necessary, fiberoptic control can be used.

In most cases, the atlanto-occipital junction is unstable and later upper cervical fixation through a posterior approach will be necessary. In the intervening period, the patient’s spine is stabilized with halo-type fixation.

**CONFLICT OF INTERESTS**

The authors declare that there is no conflict of interests that could influence this work.

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