Spine SRS Focus Issue

Anterior Approach to Cervical Spine

Kenneth M. C. Cheung, MBBS, MD, FRCS, FHKCOS, FHKAM (Orth), K. C. Mak, FRCS (Ed), FHKAM (Orth), and Keith D. K. Luk, MCh (Ortho), FRCSE, FRCSG, FRACS, FHKAM (Ortho)

Study Design. Review of surgical technique.

Objective. To provide accounts of the authors' preferred methods for performing anterior cervical surgery with personal tips and pearls. **Summary of Background Data.** Many have described the various anterior surgical approaches to the cervical spine, and in this review, we hope to describe our preferences, highlighted with some tips and pearls.

Methods. Various accounts of the transoral, the anterolateral (Smith-Robinson), and the split manubrium approaches were reviewed and used as the basis of the review. Additional notes with regard to the authors' preferences were noted to provide further guidance. The descriptions were delineated from the most cephalad to the most caudal. **Results.** The transoral, the anterolateral (Smith-Robinson), and the manubriotomy approaches were described. Each account starts with the basic preoperative considerations, then describes the incision and the main anatomical landmarks, and finally concludes with closure and main complications to monitor for. A brief description of the main pathologies that each approaches to the cervical spine are direct and algorate solutions to motion and the cervical spine are

direct and elegant solutions to pathologies arising from the anterior column. They supplement the more commonly used posterior approaches, which provide stronger multilevel fixation, and thus provide an essential tool in the armamentarium of spine surgeons.

Key words: anterior cervical decompression, anterolateral approach, manubriotomy, transoral approach. **Spine 2012;37:E297–E302**

he anterior approach to the cervical spine is an extremely practical and elegant approach to dealing with pathologies that arise primarily from the anterior spinal column. Well-known surgeons have described their approach to the anterior cervical spine in previous publications,^{1–3} and in this article we hope to provide some notes on our preferred approach and

DOI: 10.1097/BRS.0b013e318239ccd8

Spine

some tips and pearls along the way. The approaches to the anterior cervical spine may be divided into 3 for convenience of description. They are the transoral, the anterolateral cervical, and the split manubrium approaches. The well-established transoral approach affords a reasonably wide runway to C1 and C2. And, the more recently proposed split manubrium approach allows access to the lowermost cervical and upper thoracic levels, down to T4, without having excess morbidity from damaging the sternum caudally.⁴

Differing pathologies require different methods to address them, and the anterior approaches complement that of the posterior to allow the surgeon to attain the treatment objectives without compromise. We hope that readers could gain a utilitarian understanding of managing diseases ranging from the craniocervical junction to the cervicothoracic junction and could start making good use of them to help suitable patients. Our description of the methods will be from cephalad to caudal.

TRANSORAL APPROACH Preoperative Considerations

The transoral approach affords a direct working portal to the anterior aspects of C0 to C3 (Figure 1). And, despite having to cut through a number of layers, including mucosa, fascia, and the median raphe of the prevertebral muscles, the cut is relatively thin and avascular.¹

The approach is dictated by the trajectory through the oral opening, and this in turn is determined by neck extension and interdental distance. The latter is recommended to be at least 25 mm to allow a reasonable working portal.⁵ Temporomandibular joint stiffness may reduce the interdental distance, whereas subaxial cervical kyphosis and basilar invagination may alter the trajectory as well.⁶ A Mayfield retractor with 2- to 3-kg traction and a roll under the scapulae is helpful in ensuring hyperextension of the cervical spine and stabilizing the head and neck. One of the most useful preoperative assessments is the lateral radiograph taken with the neck in hyperextension. It also allows screening for any neurologic complaints with that position.

Prophylactic antibiotic coverage is with broad-spectrum coverage for both gram-positive and gram-negative organisms.⁷ Preoperative culture swabs are taken in case of an infection requiring specific antibiotic therapy.

Airway Protection and Incision

Airway protection is especially important for this procedure. Orotracheal intubation is our preferred approach. Alternatives include nasotracheal intubation or tracheostomy. The latter

From the Department of Orthopaedics and Traumatology, The University of Hong Kong, Pokfulam, Hong Kong SAR, China.

Acknowledgment date: February 7, 2011. Acceptance date: September 26, 2011.

The manuscript submitted does not contain information about medical device(s)/drug(s).

No funds were received in support of this work. No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

Address correspondence and reprint requests to Kenneth M. C. Cheung, MBBS, MD, FRCS, FHKCOS, FHKAM (Orth), Department of Orthopaedics & Traumatology, Queen Mary Hospital, 102 Pokfulam Road, Hong Kong, SAR, China; E-mail: ken-cheung@hku.hk



Figure 1. Lateral view of the transoral approach. With the neck in hyperextension and mouth opened wide, the approach generally reaches C0 to C3. A specialized retractor (R) with blades depresses the tongue (T) and elevates the soft palate. Sometimes an additional soft tube through the nasal passage (NP) is used to further retract the soft palate.

is indicated in those who require ventilation for a prolonged period after the surgery.8 Specialized retractors, for example, Davis-Crow or Spetzler-Sonntag transoral retractors, are used to maintain the width of the exposure. A self-retaining malleable retractor may be used to elevate the soft palate. An alternative for soft palate retraction is to suture a tubing to the uvula and pull through the nasal passage. If this is not adequate, then the soft palate may be split in the midline and repaired en masse later. And if a more cephalad trajectory is required, the posterior portion of the hard palate may be removed and stabilized with miniplates afterward.7 Alternatively, a midline posterior split of the hard palate with infracture into the nasopharynx and removal of the vomer may be used.9 Care should be taken not to cause excessive compression on the tongue or lips. And, finally, a throat pack is used to prevent debris from falling into the airway, and the patient is placed in a Trendelenburg position to reduce the chance of aspiration.¹⁰

Before making the incision, a lateral x-ray is suggested to confirm the final alignment and position of the palate, the mandible, and the spine. The key landmark to palpate and identify is the anterior tubercle of C1 (Figure 2), which is the most prominent point and normally should lie in the midline. This prominence is particularly evident in those with atlantoaxial dislocation.¹ A patient with C1–C2 rotatory subluxation may have the lateral mass rotated toward the midline and, thus, lead to disastrous violation of the vertebral artery.⁶

The incision should be directly down to bone,¹ with an attempt to preserve the pharyngomucosal flap for subsequent closure.⁸ With the center of the incision about 1 cm caudal to the anterior tubercle, a 3- to 5-cm longitudinal cut is made.¹ Subperiosteal dissection is performed as far laterally as the



Figure 2. Specialized oropharyngeal retractor is used to maintain access. The important landmark to identify is the anterior tubercle of C1 (AT), which lies directly under and near the insertion of the anterior longitudinal ligament. The tectorial membrane (TM) is cephalad, and the longus colli muscles (LC) flank the anterior longitudinal ligament.

lateral margin of the lateral masses, therefore also raising the anterior longitudinal ligament and longus colli muscles.¹ Closure should be done in layers with anterior longitudinal ligament and longus colli muscles in the deeper layers, and the overlying layer of fascia and mucosa sutured as 1 layer.⁶

Resections

Lateral lying structures include the vertebral arteries, eustachian tubes, and hypoglossal nerves. Bony removal of the anterior arch of C1 should not extend more than 15 mm from the midline to avoid injuring the adjacent structures.^{7,8} Safety margins lie within 11 mm from the midline at the foramen magnum, 24 mm at the atlas, and 14 mm at the lower border of the axis.⁷

Resection of the dens is performed in stages with initial thinning of the cortex using a high-speed burr, and final removal by burr, or a 1-mm Kerrison ronguer, or an angled curette (Figure 3). However, final resection of the dens cortical shell should be performed after removal of the alar and apical ligaments to ensure tension in the ligaments for ease of resection. Great care is needed for removal of the dens cortical shell because there may be adhesions to the dura for inflammatory entities. Finally, the transverse ligaments should be preserved to ensure lateral stability of C1 on C2.⁶ And, because the transoral procedure often results in destabilization, a posterior fusion is necessary. We prefer immediate posterior stabilization and, therefore, use the Jackson table. Sometimes, however, it is only with the postoperative flexion-extension radiographs that the instability is noted.



Figure 3. Resection of the dens (D) usually requires burring thin the anterior portion and finally resecting the cortical shell by Kerrison ronguer or an angled curette. The transverse ligament (TL) lies immediately posterior, and great care is needed to preserve this to maximize lateral stability.

Postoperative Care and Complications

The endotracheal tube may be retained for 24 hours in view of the risk for tongue swelling, although local application of steroid cream may help reduce this postoperative swelling. A nasogastric tube is inserted to continue drainage of the gastric contents and prevent reflux; it is kept for 5 to 7 days, after which clear fluids may be allowed and regular diet resumed by around day 14. To prevent wound infection, antibiotics are usually continued for 3 days after the operation.

Postoperative wound breakdown or infection is of primary concern. Wound inspection, especially for the cephalad portion, often requires the use of an endoscope through the nasal passage. Early wound dehiscence is usually due to poor reapposition.⁶ But retropharyngeal abscesses usually develop later, after 5 to 7 days, and require surgical drainage.

The other main complication of the transoral procedure is cerebrospinal fluid leakage.⁶ If there is suspicion of a dural tear, checking for cerebrospinal fluid leakage by way of the Valsalva maneuver may be necessary. Dural tear may be reapproximated or repaired using a fascial graft. Fibrin glue is often used for additional security. In case of an established cerebrospinal fluid fistula, insert a lumbar drain and give antibiotic coverage for the duration that the drain is *in situ*.

The transoral approach is a very useful and direct approach to pathologies located in the upper anterior cervical spine (C0–C3), although it may entail extra caution by way of the structures lying lateral to the vertebral column and, possibly, closely adherent dura mater posteriorly.

ANTEROLATERAL (SMITH-ROBINSON) APPROACH

This is probably the most widely used approach to the cervical spine that was first described by Robinson and Smith¹¹ and later modified by Southwick and Robinson³ to access C3 down to T1. Thus, this account is not meant to be exhaustive but includes some personal preferences and tips for the readers' consideration.

Preoperative Considerations

The patient is placed in the supine position with the head slightly rotated to the left, and with a rolled towel or equivalent placed transversely under the scapulae to allow the neck to extend slightly. With this position, the chin-chest distance is increased, allowing a larger working area and also opening up the intervertebral disc spaces anteriorly, facilitating discectomies. If iliac crest bone graft is needed, we place another roll under the iliac wing on the side of graft harvest to facilitate surgical exposure. Contrary to descriptions in the literature,¹² our preference is to approach the spine from the right side from C3 to C6, whereas, for the cervicothoracic junction, we approach from the left side to avoid the need to expose and protect the recurrent laryngeal nerve.¹³ This preference is based on the authors' being right-handed, and thus an approach from the right side, favoring the right hand, is preferred. Of course, other considerations such as a local injury or infection or prior surgery, for example, radical neck dissection, may preclude choosing the desired side of approach. Intraoperative traction by the use of Garner-Wells tongs or Mayfield clamps is rarely used or needed except in cases where some deformity correction is needed. Usually, the neck and head are stabilized by a well-padded head cushion.

Skin Incision and Dissection

A transverse incision along the skin crease of some 3 to 5 cm in length is adequate for the exposure of 2 to 3 disc levels, whereas an extensile longitudinal incision parallel and anterior to the sternocleidomastoid muscle is used for more extensive exposures (Figure 4).¹³ The level of incision can be determined by using surface landmarks but, more commonly, with preincision radiologic screening and skin marking, as this allows a more accurate determination of levels and, therefore, the size of the incision needed. The incision should be at



Figure 4. Anterolateral (Smith-Robinson) approaches using 2 different skin incisions. The transverse skin incision (T) is for up to 2-level surgeries, whereas the longitudinal skin incision (L) is used for more extensive surgeries.

Spine

the midpoint of the level of surgery or just cephalad because retraction caudally is easier.¹⁴ The approach utilizes internervous planes between the sternocleidomastoid and the longus colli muscles (Figure 5).

Once past the skin, the platysma may be split in the same direction as the skin incision. Blunt dissection is used all the way to the vertebral body. Care is taken during the dissection to identify and either coagulate or ligate all bleeding vessels to ensure a clear operative field. Care is taken to ensure an adequate longitudinal and lateral release to allow clear visualization and adequate mobilization and protection of the trachea and esophagus together with the recurrent laryngeal nerve. The common carotid artery and internal jugular vein are routinely identified and protected by gentle lateral retraction.

Care should be taken when retracting the esophagus, as intraoperative perforation and postoperative fistula are known as rare complications. The middle thyroid veins may be ligated without adverse sequelae, but caution is advised when approaching more cephalad (*i.e.*, up to C3), where there is the superior thyroid artery.¹³ The superior laryngeal nerve often is near the superior thyroid artery, and damage to this nerve will paralyze the ipsilateral vocal cord. The omohyoid may be encountered when approaching the lower cervical area and should therefore be transected. The authors' preference for single-level surgeries would be to preserve and retract it. Care is taken to extensively push the esophagus off the prevertebral fascia using blunt dissection, as this facilitates exposure and reduces the risk of damage to the esophagus.

It is important to identify both sides of the longus colli muscles, as this provides an excellent visual guide to the midline. The sympathetic trunk converges as it goes caudal, whereas the longus colli muscle diverges. They intersect around the level of C6 near the anterior border of the longus colli, and care should be taken to avoid injuring it.¹⁵

Level Confirmation Should Always Be Carried Out Using Intraoperative Imaging

Once levels are confirmed, further mobilization would involve retraction of the longus colli muscles and coagulation of the segmental vessels at the levels concerned. For a single-level discectomy, the authors' preference is to transversely cut part



Figure 5. The Smith-Robinson approach utilizes the internervous plane between the sternocleidomastoid and the deeper longus colli muscles. Our preferred approach for the midcervical levels is through a right-sided incision, and the longus colli muscles (LC) are retracted to their corresponding sides, whereas the trachea (Tr) and esophagus (Es) are retracted to the left.

of the longus colli fibers to facilitate lateral exposure without the need to extensively elevate the muscle to allow adequate lateral retraction.

Decompression

The techniques of decompression may vary among surgeons but it usually starts with a discectomy and resection of anterior osteophytes at the involved level. Some points are worthy of note. First, width of decompression is judged adequate when both uncovertebral joints can be seen. This is usually around 15 mm in width. The only caveat to dissecting till the joint of Luschka is when preoperative computed tomography shows an aberrantly medial vertebral artery in the midbody of the vertebral body, which may be just medial (average 0.14 mm to be precise) to the uncovertebral joint.¹⁶ Second, the authors prefer to routinely remove the posterior annulus and posterior longitudinal ligament to expose the dura. This is to ensure that all disc fragments including possibly sequestrated fragments are removed. The greatest worry is violation of the vertebral arteries just lateral to the uncovertebral joints.

The midcervical anterolateral approach is the workhorse of anterior cervical surgical approaches. It represents a relatively atraumatic dissection to the midcervical elements with minimal blood loss and can be used to tackle the majority of anterior spinal pathologies.

MANUBRIOTOMY APPROACH

Depending on the position of the manubrial notch, the majority of cervical pathologies can be accessed through the Southwick-Robinson approach. However, in cases when the notch is high or when the pathologies extend into the upper thoracic spine, then a more extensile approach may be necessary. An easy way to tell would be to take a lateral view of the upper thoracic/lower cervical spine and then extend a horizontal line from the upper border of the manubrial notch to the spine. Where the line crosses, the spine would indicate the lower limit of a cervical exposure without splitting the manubrium. Usually, this can be as low as T2, but it may vary between individuals.

A number of different approaches to the cervicothoracic junctions have been described.^{17–19} The authors' preference is to use a split manubrium approach, described by Luk *et al*,⁴ for its relative ease of exposure. Such an approach would allow further extension of the exposure to T4 while avoiding the morbidity of a full sternal split or clavicular osteotomies.

Preoperative Considerations

The split manubrial approach has been described as either an L-shaped split, in which the exposure width is approximately 4 cm, or a bilateral split as an inverted T, which affords an 8-cm width of manubrial retraction. This approach can be combined with a Southwick-Robinson approach to allow for an extensile exposure from C3 down to T4. As with any anterior cervical procedure, good neck extension is essential. A towel roll is placed under the scapulae to extend the neck and pull the shoulders back.

E300 www.spinejournal.com

Skin Incision and Dissection

For a detailed description of the approach, the readers are referred to the original description by Luk et al.⁴ The incision starts from the manubrial notch, and the caudal end needs to be only 3 cm caudad to the manubriosternal angle (Figure 6). The cephalad arm may be extended as required to facilitate midcervical spine exposure. A 2-cm-wide skin flap is raised from the manubriosternum bilaterally, and with finger dissection, the posterior manubrial surface is freed. In younger patients, the thymus may be encountered. The internal thoracic artery (previously known as the internal mammary) is encountered and ligated around the second intercostal space, which is where the transverse limb of the osteotomy should exit. A unilateral transverse cut, or bilateral cut, can be made with an oscillating saw to achieve the width of exposure required (Figure 7). A retractor can then be placed vertically to maintain exposure to the anterior mediastinum, and finger dissection can be used to mobilize the retrosternal soft tissue.

In the U-shaped pocket, the common carotid artery will border on the left, whereas the brachiocephalic artery and vein will border on the right. The floor is formed by the trachea and esophagus and can be retracted left to expose the spine. Identification of the right recurrent laryngeal nerve is imperative at this stage. It loops under the right subclavian artery, a branch of the brachiocephalic trunk, and ascends near the trough formed by the trachea and esophagus on their right side.

With the above dissection, C7–T4 could be approached comfortably. However, to approach T5, it may be necessary to dissect along the lateral border of the ascending aorta until the upper border of the heart. The left brachiocephalic vein may have to be retracted distally and even ligated to ensure adequate exposure.



Figure 7. The longitudinal osteotomy is made over the midline of the manubrium with the transverse limb cutting across the second intercostal space. Therefore, an L-shaped or inverted T-shaped cut is created depending on the width of the approach required.



Figure 6. The manubriotomy skin incision is a longitudinal incision that extends from the manubrial notch (MN) to 3-cm caudad to the sternal angle. The incision may be extended cephalad anterior to the sternocleidomastoid (SCM) if more proximal levels require operating. The medial end of the right clavicle (C) is shown.



Figure 8. This schematic diagram illustrates the positions of the main vessels relative to the third thoracic vertebra (T3). On the right side, the third thoracic vertebra is flanked by the right brachiocephalic vein (RBv) and artery (A). The left brachiocephalic vein (LBv) crosses caudal and anterior to the third thoracic vertebra while the left common carotid (LCC) flanks the left. The esophagus and trachea are not shown here because it is retracted to the left under the retractor (TE).

This approach is relatively demanding, and it is recommended that a cardiothoracic surgeon should be involved, at least in the initial experience. A number of important structures need to be identified and protected, and these are summarized below and in Figure 8:

- 1. Left: common carotid artery
- 2. Right: right brachiocephalic (innominate) artery and vein
- 3. Caudad: left brachiocephalic vein
- 4. "Floor": trachea and esophagus
- 5. Right recurrent laryngeal nerve—ascends between the trachea and esophagus
- 6. Thoracic duct—if approaching from left side of the esophagus

The manubriotomy, whether unilateral or bilateral, is a versatile and extensile approach to the cervicothoracic junction that allows exposure down to T4 with relative ease, and extension to the midcervical spine simply by way of the conventional Southwick-Robinson approach. For exposures beyond T4–T5, a full sternotomy approach is recommended.⁴

SUMMARY

The authors have presented the preferred approach to the cervical spine from C0 down to T4. Familiarity with these approaches will allow the surgeon to tackle any pathologies involving the anterior column of the cervical spine. Although such approaches are suited for decompression of the spinal canal due to an anterior compressing pathology, fixation in the form of anterior plating does not afford the same degree of stability compared with posterior segmental fixation. As such, when multiple-level fixation and stability are required, such procedures are often combined. Thus, anterior approaches to the cervical spine should be only 1 part of the armamentarium of a spine surgeon, although an important part.

> Key Points

- The transoral approach provides access to Co to C2 with prerequisites including adequate interdental distance, neck hyperextension, and specialized retractors.
- Once the anterior tubercle of C1 is identified for the incision of the transoral approach, the main caution is not to go wider than 15 mm from the midline, lest the vertebral artery be injured.
- The anterolateral (Smith-Robinson) approach is the most commonly employed of the 3 and allows access from C3 to cervicothoracic junction.
- We prefer to approach from the right side for C₃ to C6, and from the left for cervicothoracic junction, to avoid having to protect the recurrent laryngeal nerve.

The manubriotomy approach can be either 1 or 2 sided, thereby affording customized access as far down as T4, without the morbidity of a full sternal split or clavicular osteotomies.

References

- 1. Fang HSY, Ong GB. Direct anterior approach to the upper cervical spine. J Bone Joint Surg Am 1962;44:1588–604.
- Smith GW, Robinson RA. The treatment of certain cervical-spine disorders by anterior removal of the intervertebral disc and interbody fusion. J Bone Joint Surg Am 1958;40-A:607–24.
- 3. Southwick WO, Robinson RA. Surgical approaches to the vertebral bodies in the cervical and lumbar regions. *J Bone Joint Surg Am* 1957;39-A:631–44.
- Luk KD, Cheung KM, Leong JC. Anterior approach to the cervicothoracic junction by unilateral or bilateral manubriotomy. A report of five cases. J Bone Joint Surg Am 2002;84-A:1013–7.
- Shaha AR, Johnson R, Miller J, et al. Transoral-transpharyngeal approach to the upper cervical vertebrae. Am J Surg 1993;166:336– 40.
- Biyani A, An H. Anterior upper cervical spine approaches. In: Herkowitz HN, ed. *The Cervical Spine Surgery Atlas*. 2nd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2003:69–89.
- 7. Henn JS, Lee MC, Rhoton ALJ. Transoral approach to craniocervical junction and upper cervical spine. In: Kim DH, Henn JS, Vaccaro AR, et al, eds. *Surgical Anatomy & Techniques to the Spine*. Philadelphia, PA: Saunders Elsevier; 2006:3–32.
- Winter R, Lonstein J, Dennis F, et al. Anterior upper cervical procedures. In: *Atlas of Spine Surgery*. Philadelphia, PA: WB Saunders; 1995:1–17.
- Crockard H. Midline ventral approaches to the craniocervical junction and upper cervical spine. In: Sherk H, ed. *The Cervical Spine: An Atlas of Cervical Procedures*. Philadelphia, PA: JB Lippincott Co; 1994:93–112.
- Mendoza N, Crockard HA. Anterior transoral procedures. In: An HS, Riley LHI, eds. An Atlas of Surgery of the Spine. London, UK: Martin Dunitz; 1998:55–69.
- 11. Robinson RA, Smith G. Anterolateral cervical disk removal and interbody fusion for cervical disk syndrome. *Bull Johns Hopkins Hosp* 1955;96:223–4.
- German J, Benzel E, Alexander J. Anatomy and surgical approaches and exposure of the vertebral column, the cervical spine. In: Benzel E, ed. Spine Surgery: Technique, Complication Avoidance and Management. New York, NY: Churchill Livingstone; 1999:145–56.
- 13. Silber J, Albert T. Anterior and anterolateral, mid and lower cervical spine approaches: transverse and longitudinal (C3 to C7). In: Herkowitz HN, ed. *The Cervical Spine Surgery Atlas*. Philadelphia, PA: Lippincott Williams & Wilkins; 2003:91–8.
- Hillard VH, Apfelbaum RI. Surgical management of cervical myelopathy: indications and techniques for multilevel cervical discectomy. *Spine J* 2006;6:242S–51S.
- Chang U, Lee MC, Kim DH. Anterior approach to the midcervical spine. In: Kim DH, Henn JS, Vaccaro A, et al, eds. *Surgical Anatomy & Techniques to the Spine*. Philadelphia, PA: Saunders Elsevier; 2006:45–56.
- Curylo LJ, Mason HC, Bohlman HH, et al. Tortuous course of the vertebral artery and anterior cervical decompression: a cadaveric and clinical case study. *Spine (Phila Pa 1976)* 2000;25:2860–4.
- 17. Birch R, Bonney G, Marshall RW. A surgical approach to the cervicothoracic spine. J Bone Joint Surg Br 1990;72:904–7.
- Fang HS, Ong GB, Hodgson AR. Anterior spinal fusion: the operative approaches. *Clin Orthop Relat Res* 1964;35:16–33.
- 19. Darling GE, McBroom R, Perrin R. Modified anterior approach to the cervicothoracic junction. *Spine (Phila Pa 1976)* 1995;20:1519–21.