The advantages of submandibular gland resection in anterior retropharyngeal approach to the upper cervical spine

Ghassan S. Skaf · Amira S. Sabbagh ·
Usamah Hadi

Received: 22 March 2006 / Revised: 14 August 2006 / Accepted: 6 September 2006 / Published online: 30 September 2006
© Springer-Verlag 2006

Abstract Anterior surgery to the upper cervical spine, although rare, several successful approaches were described in the literature. To avoid the risks and limitations of transoral approach, the anterior retropharyngeal approach was developed. In this study, we describe our experience with anterior retropharyngeal approach to the upper cervical spine and discuss the significance of resecting the submandibular gland. From July 2001 to July 2004, we performed six anterior prevascular retropharyngeal approaches to the upper cervical spine. The series included five males and one female, ranging in age from 26 to 60 years (mean = 46). All six patients were intubated with nasotracheal cannula. The submandibular gland was mobilized and removed in all patients allowing adequate exposure of the arch of C1, C2, and C3 vertebral bodies. The anterior retropharyngeal approach permitted an adequate access to anteriorly situated lesions from C1 to C3 in all six patients, without the risks and limitations of trans-mucosal surgery. This approach allowed us to perform decompression of the spinal cord and reconstruction of the anterior column of the spine with bone graft and internal fixation. Careful removal of the submandibular gland provided better visualization of the

arch of C1 and C2. No facial nerve palsy was seen in any of the six patients. Anterior retropharyngeal approach to the upper cervical spine combined with removal of the submandibular gland permits exposure of the anterior spine similar to that obtained by the trans-mucosal route, and provides a safe simultaneous arthrodesis and instrumentation during the primary surgical procedure without the potential contamination of the oropharyngeal cavity. Removal of the submandibular gland allows better exposure with less retraction and thus avoids severe injury to the mandibular branch of the facial nerve.

Keywords Retropharyngeal approach · Submandibular gland upper cervical spine · Facial nerve palsy · C1–C2 stabilization

Abbreviation

T2WI T2-weighted image

Introduction

Anterior surgery of the upper cervical spine is a rare condition since surgical pathology of the cervical spine is in most cases localized to the lower region (C3–C7).

Although several successful anterior approaches to the upper cervical spine have been described in the literature, transoral approach, first described by Fang and Ong [4], has been used sporadically as it provides direct exposure for anterior decompression of the spinal cord and the brain stem [2]. This approach is primarily indicated for pathology cranial to C3

G. S. Skaf (✉) · A. S. Sabbagh
Department of Surgery,
American University of Beirut Medical Center,
Beirut, Lebanon
e-mail: gskaf@aub.edu.lb

U. Hadi
Department of Otolaryngology,
American University of Beirut Medical Center,
Beirut, Lebanon

vertebra and it was found to be associated with a high infection rate [4]; however, recent studies have revealed a greater consistency of this approach, with a lower incidence of infections than that previously described by Fang and Ong [4]. When a more caudal exposure is necessary, then a tongue splitting approach, glossotomy, is required; however, it is also accompanied with complications such as tracheostomy.

To avoid the risks and limitations of transmucosal surgery, the anterior retropharyngeal prevascular or retrovascular approach was developed. Originally described by Southwick and Robinson [11] for exposure of C3 through T1; De Andrade and MacNab [3] further developed a cranial extension of this approach to achieve exposure to C1 and C2. McAfee et al. [9] later modified this technique to include resection of the submandibular gland and transection of the digastric muscle for superior exposure.

In this study, the authors describe their experience with the anterior retropharyngeal approach to the upper cervical spine including the indications and postoperative management; and discuss the significance of resecting the submandibular gland in this approach.

Materials and methods

From July 2001 to July 2004, the authors operated on six patients by means of a prevascular retropharyngeal approach to the upper part of the cervical spine. The series included five males and one female, ranging in age from 26 to 60 years (mean = 46). The data from the series are reported in Table 1.

Patients

The data of the patients are listed in Table 1. Preoperative traction was not used in these patients. All patients were intubated with a nasotracheal cannula to achieve the maximum intraoperative elevation of the mandible. Three patients were extubated immediately, one patient was extubated after 12 h, and one patient was kept intubated and later tracheotomized because of severe respiratory failure.

Surgical technique

In an “S” type incision, with a curve located around 4 cm below the lower border of the mandible, the skin and the platysma were raised to the lower border of the mandible. The anterior facial vein is located doubly tied and cut. The upper tie is left long, with a hemostat

applied to the end and reflected upward, thus protecting the ramus mandibularis. The anterior facial vein runs superficial to the gland (Figs. 1, 2). The facial artery ramus runs through the posterior part of the gland (Fig. 3). It is ligated and cut twice, once at the lower edge of the mandible as well as close to the external carotid artery. Mobilization and upward reflection of the gland exposes the hypoglossal nerve medial to the tendon of the digastric muscle. The posterior border of the mylohyoid muscle is identified and retracted anteriorly. This allows identification of the Wharton’s duct as well as lingual nerve (Fig. 4). The duct is ligated and divided. The lingual nerve is attached to the submaxillary gland superiorly. The parasympathetic fibers entering the gland are ligated and transected allowing the lingual nerve to retract into the floor of the mouth. This achieves complete mobilization and removal of the submandibular gland. After completing the dissection medial to the carotid bundle, the posterior belly and the hypoglossal nerve are easily retracted superiorly without tension, thus exposing the cervical vertebral bodies from C1 to C6.

The halo device was never used. A Philadelphia collar was applied in all five patients.

Results

Anterior retropharyngeal access to the upper cervical spine combined with resection of the submandibular gland permitted adequate exposure to the arch of C1, C2, as well as C3 vertebral bodies and completion of the surgical plan (Fig. 5).

In the patient with C2–C3 disc herniation and anterolisthesis (patient 1), complete neurologic recovery was obtained after anterior decompression, fusion, and plating. Fusion of the arthrodesis was obtained. The results remained stable 3 years after surgery.

In the patient with C3–C4 osteomyelitis (patient 2), an anterior cervical decompression, fusion and plating at C2–C5 was performed. A halo was recommended postoperatively but was refused by the patient. A neck collar was applied instead. One-month follow-up, X-ray showed failure of the anterior plate as compared to immediately post-op. The patient underwent a posterior cervical fixation using pedicles lateral mass screws. The patient continues to exhibit complete neurologic recovery at follow-up evaluation 2 years after surgery.

In the patient with failed anterior plate done elsewhere (patient 3), a posterior decompression and fusion C3–C6 using lateral mass plates was performed

Table 1 Clinical data on six cases of retropharyngeal surgery to the upper cervical spine

Patient	Sex/ age	Diagnosis	Symptoms	Anterior procedures	Postoperative care	Posterior procedures	Brace	Follow-up	Complications	Results
1	F, 60	C2–C3 disc herniation + lysthesis	Neck pain, acute cervical myelopathy	ACDF C2–C3 + plate	Extubation immediately	None	Collar	3 years	None	Complete neurologic recovery; solid fusion
2	M, 56	C3–C4 osteomyelitis + severe kyphosis	UE weakness, myalgia	ACDF C2 → C5 + plate	Extubation after 12 h	C2 → C5 lateral mass plate	Collar	2 years	Difficulty swallowing for 2 months	Complete neurologic recovery; failed anterior plating; solid posterior fusion
3	M, 52	Failed anterior decompression and plating for cord compression	UE and LE weakness, inability to walk	Removal of failed cervical plate + ACDF C2 → C5	Extubation immediately	Posterior C2 → C5 fusion with lateral mass plate	Collar	1 year	Difficulty swallowing for 2 weeks	Improved lower extremities strength; UE unchanged; solid fusion
4	M, 26	Fracture C2 body	Incomplete spinal cord injury	C2 partial corpectomy, C2–C3 fusion + plate	Kept intubated	None	Collar	2 months	None	Death in 2 months; respiratory failure; solid fusion
5	M, 46	Rheumatoid arthritis + spinal cord compression C2 → C4	Spastic gait, UE weakness	C3–C4 corpectomy + C2 → C5 fusion + plate	Extubation immediately	Posterior cervical fusion C3–C6	Collar	1 year	None	Good neurologic recovery; solid fusion
6	M, 37	C2 odontoid fracture Type II	None	C2 odontoid screw	Extubation immediately	None	Collar	2 years	None	Remained neurologically intact

Fig. 1 Sublingual space containing A Wharton duct, B sublingual gland, C lingual nerve, F submandibular gland and L tongue. With permission from [17]

followed by anterior retropharyngeal approach for removal of the failed anterior plate and spinal cord decompression of C2–C3 followed by fusion using titanium cage and plating (Fig. 6).

In the patient with C2 vertebral body fracture (patient 4), a good solid fusion of the arthrodesis was obtained (Fig. 7), but failed extubation and later tracheotomized because of severe respiratory failure. The patient died 2 months after surgery from pulmonary embolism.

In the patient with rheumatoid arthritis and cervical myelopathy (patient 5), a posterior decompression and fusion using lateral mass plates and screws at C3–C6,

Fig. 2 Facial vessels in the posterior pole of the gland F, in the “vascular pole” (circled): D digastric muscle, G common carotid artery, H hyoid bone, I internal carotid, N external carotid, T facial artery. With permission from [17]

followed by anterior decompression and fusion with titanium cage followed by plating at C2–C4 was performed. The patient showed good neurologic recovery and fusion at the arthrodesis at follow-up evaluation 1 year after surgery.

In the patient with C2 odontoid fracture type II P (patient 6), a single anterior titanium screw was placed. He remained neurologically intact postoperatively. A neck collar was placed for 2 months postoperatively.

Discussion

Several anterior approaches to access the upper cervical spine are used. The transpharyngeal approach provides excellent exposure to C1 and C2; however, it should be reserved mainly for biopsies, aspirations, and drainage of infections [4, 13]. This approach also allows direct communication between the buccal cavity, rich in pathogenic bacteria, and the column; which, when associated with bone grafting, carries a potential incidence of infection.

The lateral retropharyngeal approach is not as direct as the anterior approach, however, it has a lower incidence of infection with bone grafting than the transmucosal approach because of the absence of contamination with oropharyngeal flora. Despite this, it is associated with a high rate of postoperative complications. These include airway obstruction, difficulty swallowing secondary to retropharyngeal edema and hematoma, injury to the hypoglossal nerve, injury to the mandibular branch of the facial nerve (Fig. 8), disruption of the recurrent laryngeal nerve function secondary to prolonged retraction of the carotid sheath, hemorrhage, and injury to the spinal accessory nerve resulting in a motor defect of the sternocleidomastoid and trapezius muscles [7, 14, 16].

The final alternate approach to the upper cervical spine is the anterior retropharyngeal approach, and was used in our patients (Fig. 5). The approach was described by McAfee et al. [9]. An advantage of this anterior extraoral approach over the transmucosal exposure is that it achieves an expansible exposure of the anterior spine, with visualization similar to that obtained by the transmucosal route, and permits performance of spinal cord decompression up to the clivus and reconstruction of the anterior column of the spine with strut grafts and internal fixation [8]. An advantage of this approach over the lateral exposure is that it enables the surgeon to place screws perpendicular to the articular surfaces [13].

Vender et al. [15] have summarized the advantages of anterior retropharyngeal approach in accessing

Fig. 3 Intraoperative picture

anteriorly situated lesions from C1 to C3 (Fig. 9). Besides achieving a wide, bilateral exposure, the approach avoids the potential contamination of the oropharyngeal cavity and thus provides for a simultaneous arthrodesis and instrumentation during the primary surgical procedure. It also provides a safer environment for a simultaneous intradural procedure and management of a cerebrospinal fluid fistula [15].

In addition, in elderly patients, a consistent series of anatomic events occur as a result to the aging process of the face. As the mandible shrinks, the subman-

dibular gland as well as the muscles that make up the floor of the mouth is pushed inferiorly [10]. Consequently, ptosis of the soft tissues of the chin and banding or cording of the muscles of the anterior neck develop [12].

An advantage of removing the submandibular gland over retracting it is that it avoids injury to the mandibular branch of the facial nerve (Fig. 8). According to House and Brackmann [6], the facial nerve grading system is intended for use when a patient's facial nerve is injured. Minimizing the injury to marginal mandibular branch of the facial nerve requires thorough knowledge of the anatomy of the submandibular triangle (Figs. 10, 11). A good knowledge of the anatomical structures that the surgeon encounters during the surgical approach is of utmost importance in order to avoid damaging vascular and nervous vital structures (Fig. 4).

Fig. 4 Schematic drawing showing *A* Wharton duct, *B* sublingual gland, *C* lingual nerve, *D* mylohyoid muscle, and *E* digastric muscle. With permission from [17]

1. The horizontal skin incision should be placed in a skin crease approximately 3 cm below the mandibular edge, through the platysma muscle.
2. The nerve lies deep to the platysma and superficial to the anterior facial vein and the lateral fascia of the submandibular gland.
3. In the elderly patients, the nerve may curve down to the level of the hyoid bone.

During surgical exposure of the submandibular gland, the nerve can be protected by following one of three routes.

1. Ligation and superior retraction of the anterior facial vein and artery, thus elevating the ramus mandibularis away from the surgical field and out

Fig. 5 Intraoperative surgical exposure of the vertebral bodies and corresponding lateral fluoroscopy

Fig. 6 **a** A 52-year-old male with failed C1–C2 Brooks posterior arthrodesis and later failed anterior cervical plate. MRI of the cervical spine shows significant kyphosis and spinal cord compression. Lateral X-ray of the cervical spine shows almost complete dislodgement of the anterior cervical plate. **b** Posterior

decompression and fusion C3–C6 using lateral mass plates followed by anterior retropharyngeal approach for removal of the failed anterior plate and spinal cord decompression of C2–C3 followed by fusion using titanium cage and plating

of range of self-retractors that might be used to open up the wound (Fig. 10).

2. Dissection stay on the gland in a plane medial to the lateral gland fascia, thus carrying the nerve that runs deep to platysma and lateral to the fascia investing the submaxillary gland out of the superficial field.
3. Direct identification of the nerve when possible. A nerve stimulator may be helpful especially in revision cases.

Another advantage of removing the gland instead of retracting it is that it avoids a very frequent injury of the facial nerve; which is palsy of the facial nerve. This

injury is classified as grade I–VI according to the criteria of House and Brackmann [6]. Laus et al. [8] reported, in a study, four cases of marginal mandibular branch palsies out of ten cases that underwent a pre-vascular and retrovascular approach without gland removal, but in few cases of their series by opening the lower part of the capsule of the submandibular gland.

However, submandibular gland excision is often associated with a variety of postoperative complications. Complications could be of short term or long term. The short-term complications include acute facial, lingual and hypoglossal nerve damage, infection and hematoma [5]. The most common long-term complications are neurological deficits related to

Fig. 7 **a** A 26-year-old male with incomplete quadriplegia. X-ray of the cervical spine shows C2 vertebral body fracture with significant instability. Sagittal T2-weighted image MRI shows

significant spinal cord compression with myelomalacia at C2–C3 level. **b** Lateral cervical X-ray showing C2–C3 fusion and anterior plating after decompression

Fig. 8 Course and distribution of facial (VII) nerve and the marginal mandibular branch

damage to the marginal mandibular, lingual or hypoglossal nerves and scar problems [1, 5]. In a study conducted by Berini-Aytes et al., neurological complications were observed in 16% of the cases. The most common nerve involved was the hypoglossal nerve. These complications resolved in a mean period of 4 months in 37.4% of these cases. The remaining cases who were observed to have a permanent neurological deficit, the facial nerve was the most frequently affected (7.7%) followed by the hypoglossal (2.9%)

Fig. 9 Intraoperative radiograph showing the anterior access up to the anterior arch of C1

and then the lingual nerve (1.4%). No vascular injuries were observed in these patients [1].

In the presence of the submaxillary gland, great tension is required to expose the body of C2–C3 resulting in possible neuropraxia to the hypoglossal nerve. It also makes the insertion of the plate and screws more difficult with the possibility of nonunion and injury to the spinal cord.

Conclusion

The anterior retropharyngeal approach by removing the submandibular gland is a surgical approach for the upper cervical spine. It permits exposure of the anterior spine similar to that obtained by the trans-

Fig. 10 Schematic drawing on right shows 5 internal jugular vein, 6 carotid vessels, and 7 digastric muscle. With permission from [17]

Fig. 11 Schematic drawing on right shows 4 thyrolinguofacial venous trunk, 5 internal jugular vein, 6 stylohyoid muscle, and 7 digastric muscle. With permission from [17]

mucosal route; it allows the surgeon to place screws perpendicular to the articular surfaces, avoiding the potential contamination of the oropharyngeal cavity; and avoids severe injury to the marginal submandibular branch of the facial nerve. Thus, this approach provides a safe simultaneous arthrodesis and instrumentation during the primary surgical procedure. Although removing the submandibular salivary gland may be followed by a number of complications, most of them can be avoided if the appropriate surgical technique is applied.

Acknowledgments The authors thank Dr. Jorge Guerrissi, Head of the Department of Plastic and Reconstructive Surgery, Hospital C. Argerich, Buenos Aires, Argentina and Dr. Mutaz Habal, Editor-in-chief of the Journal of Craniofacial Surgery for their permission to use their schematic illustrations that were utilized in our manuscript.

References

- Berini-Aytes L, Gay-Escoda C (1992) Morbidity associated with removal of the submandibular gland. *J Craniomaxillofac Surg* 20:216–219
- Crockard HA, Calder I, Ransford AO (1990) One-stage transoral decompression and posterior fixation in rheumatoid atlanto-axial subluxation. *J Bone Joint Surg Br* 72:682–685
- de Andrade JR, Macnab I (1969) Anterior occipito-cervical fusion using an extra-pharyngeal exposure. *J Bone Joint Surg Am* 51:1621–1626
- Fang HSY, Ong GB (1962) Direct anterior approach to the upper cervical spine. *J Bone Joint Surg Am* 44:1588–1604
- Hald J, Andreassen UK (1994) Submandibular gland excision: short- and long-term complications. *ORL J Otorhinolaryngol Relat Spec* 56:87–91
- House JW, Brackmann DE (1985) Facial nerve grading system. *Otolaryngol Head Neck Surg* 93:146–147
- Johnson RM, Murphy MJ, Southwick WO (1992) Surgical approaches to the spine. In: Rothman RH, Simeone FA (eds) *The spine*. WB Saunders, Philadelphia, pp 1067–1696
- Laus M, Pignatti G, Malaguti MC, Alfonso C, Zappoli FA, Giunti A (1996) Anterior extraoral surgery to the upper cervical spine. *Spine* 21:1687–1693
- McAfee PC, Bohlman HH, Riley LH Jr, Robinson RA, Southwick WO, Nachlas NE (1987) The anterior retropharyngeal approach to the upper part of the cervical spine. *J Bone Joint Surg Am* 69:1371–1383
- Ramirez OM, Robertson KM (2001) Comprehensive approach to rejuvenation of the neck. *Facial Plast Surg* 17:129–140
- Southwick WO, Robinson RA (1957) Surgical approaches to the vertebral bodies in the cervical and lumbar regions. *J Bone Joint Surg Am* 39:631–644
- Sykes JM (2001) Rejuvenation of the aging neck. *Facial Plast Surg* 17:99–107
- Vaccaro AR, Lehman AP, Ahlgren BD, Garfin SR (1999) Anterior C1–C2 screw fixation and bony fusion through an anterior retropharyngeal approach. *Orthopedics* 22:1165–1170

14. Vaccaro AR, Ring D, Lee RS, Scuderi G, Garfin SR (1997) Salvage anterior C1–C2 screw fixation and arthrodesis through the lateral approach in a patient with a symptomatic pseudoarthrosis. *Am J Orthop* 26:349–353
15. Vender JR, Harrison SJ, McDonnell DE (2000) Fusion and instrumentation at C1–3 via the high anterior cervical approach. *J Neurosurg* 92:24–29
16. Whitesides TE Jr (1994) Lateral retropharyngeal approach to the upper cervical spine. In: Sherk HH (ed) *The cervical spine: an atlas of surgical procedures*. JB Lippincott, Philadelphia, pp 71–77
17. Guerrissi JO (2001) *J Craniofac Surg* 12(3):299–303
18. Guerrissi JO (2002) *J Craniofac Surg* 13(3):478–482