The Craniovertebral Junction: Posterior and Anterior Approaches. State of Art.

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Introduction

In the modern surgical approach to the craniovertebral junction (CVJ), past and present live together and implement reciprocally through a better knowledge of the biomechanics, the preoperative and intra operative dynamics as well as the wide use of new instrumentation devices and endoscopy.

Furthermore, neuronavigation and robotics open new perspectives for this challenging surgery.

Historically Menezes outlined several factors influencing the specific treatment of anterior CVJ compressive abnormalities. These included: 1) the reducibility of the lesion, i.e., whether anatomic alignment be restored thus alleviating the compression, 2) the direction and the mechanics of the compression, 3) the etiology of the compression, and 4) the presence of ossification centers.

The approach to the lesion is dictated by the location and nature of the compression (1). When preoperative dynamic neuroradiological examinations demonstrate that the CVJ compression is reducible, neural decompression may be obtained by simply reducing the dislocation as well as by stabilizing the CVJ with a posterior instrumentation, either with wires, claws or screws ("functional decompression") (1; 2).

In cases in whom an accurate preoperative neuroradiological examinations, during dynamic manoeuvres and traction, demonstrate the atlanto –axial dislocation (C1 – C2 D) irreducibility along with neural compression, the surgical removal of the compression is strongly suggested by transoral route (3).

The transoral approach to the posterior pharyngeal wall has been used for years to drain retropharyngeal abscesses, but it was not until the 1940s that it was first used in the treatment of spinal abnormality (4). In 1962, Fang and Ong (5) published the first series of patients to undergo transoral decompression for irreducible atlantoaxial abnormalities. The high rate of morbidity and mortality caused poor acceptance of the transoral approach as a means for decompression of cervicomedullary junction abnormality.

Popularized by Crockard, the microsurgical ventral approach to the CVJ has been widely described for decompression of irreducible extradural pathology (6). The shortest and most physiological route to the ventral aspect of the CVJ is represented by an anterior approach through the pharynx. The use of the operating microscopes, high- speed drills, self-retaining mouth retractors, flexible oral endotracheal tubes, intraoperative fluoroscopy, and electrophysiological monitoring has made this procedure much more safer (7). However, there are still technical difficulties with the operating microscope, such as the need to see and work through a narrow opening in a deep cavity; to improve visualization,

soft-palate splitting and even hard-palate resection along with extended maxillotomy are occasionally required. These processes increase operating time and may result in significant postoperative morbidities such as velo-pharyngeal incompetence. (8).

To overcome such complications, endoscopic assisted procedures for CVJ decompression have been developed starting from the experience with the use of the endoscope for transsphenoidal pituitary surgery and cervical spine. An update to the concept of classical transoral microsurgical decompression is now strongly provided by the most recent literature dealing with the introduction of the endoscopy in spine surgery.
On the other hands and surprisingly, to overcome the irreducibility of CVJ, some alternative procedures to anterior decompression and posterior instrumentation and fusion has been proposed recently:

1) Transoral anterior decompression along with anterior fusion of chronic irreducible C1- C2 D with spinal cord compression has been suggested by Subin et al. in 1995. The removal of the dens as well as callus, granulation, and scar tissue and to excise the cartilage of the articular surfaces of the C1- C2 D joints has been advocated along with postoperative skull-cervical biaxial traction, tracheostomy care, nasal feeding, and Minerva cast (9).

2) Transoral atlantoaxial reduction with plate system has been designed and proposed by Yin et al in 2005 in order to avoid or reduce the need of drastic external postoperative immobilization and proposed to facilitate one-stage anterior operation, capable of simultaneously decompressing the ventral spinal cord as well as reducing and fusing the C1- C2 D segment (10).

3) Posterior reduction of fixed atlantoaxial dislocation along with fixation has been advocated by Goel et al. in 2005. Such a procedure does not require the removal of any osseous spinal element. Facet joints must be opened posteriorly, after excising the capsule and bilaterally exposed widely after sectioning of the large C2 ganglion. A titanium spacer containing bone graft must be secured in the distracted and reduced facet joints fixed with plates and screws bilaterally (11).

These experiences confirm that nowadays surgical options to treat irreducible C1- C2 D are still matter of debate and a new algorithm for patient selection for the most rational, effective and safe surgical procedure is strongly claimed by the new generation of spine surgeon worldwide.

In this review from the recent literature we comment papers dealing with new trends in CVJ surgery by investigating on:

1) the new developments in video assisted anterior surgery of the CVJ (1- Baird CJ, Conway JE, Sciubba DM, Prevedello DM, Quiñones-Hinojosa A, Kassam AB:. Radiographic and anatomic basis of endoscopic anterior craniocervical decompression: a comparison of endonasal, transoral, and transcervical approaches. Neurosurgery. 2009 Dec;65(6 Suppl):158-63; 2- Wesley Hsu, Jean Paul Wolinsky, Ziya L. Gokaslan,Daniel M: Sciubba: Transoral approach to the cervical spine. Neurosurgery 66:A 119- A 125,2010)

and

2) the possibility to overcome both the classic and the new video - assisted anterior approaches to preoperative irreducible C1 – C2 D by means of intraoperative reduction (1 - Wang C, Yan M, Zhou HT, Wang SL, Dang GT: Open reduction of irreducible atlantoaxial dislocation by transoral anterior atlantoaxial release and posterior internal fixation. Spine. 2006 May 15;31(11); 2 - Massimiliano Visocchi, Domenico Pietrini, Tommaso Tufo, Eduardo Fernandez, Concezio Di Rocco: Preoperative irreducibile C1 – C2 dislocations: intraoperative reduction and posterior fixation: "the always posterior strategy" Acta Neurochir (2009) 151: 551 – 560) .

A) INTRAOPERATIVE REDUCTION, INSTRUMENTATION AND FUSION OF CRANIOVERTEBRAL JUNCTION DISLOCATIONS

1) Wang C, Yan M, Zhou HT, Wang SL, Dang GT: Open reduction of irreducible atlantoaxial dislocation by transoral anterior atlantoaxial release and posterior internal fixation. Spine. 2006 May 15;31(11)

Information

The authors perform a retrospective study of surgical outcome of 33 patients with irreducible C1- C2 D, in order to evaluate the safety efficacy of their new strategy of one stage anterior release and posterior fixation and fusion to reduce and stabilize the dislocation. In the authors' opinion the traditional treatment of symptomatic C1- C2 D (ventral decompression by transoral approach) is accompanied with high morbidity and mortality. It does not correct the swan neck deformity, which could precipitate the degenerative changes in the lower cervical spine. The authors recognized the contraction of the muscles, ligaments, and capsules of atlantoaxial joint as the factor preventing the reduction and that most of C1- C2 D might be reduced by anterior atlantoaxial joint release without the odontoid resection. Further reduction and stabilization might be then achieved by special posterior fixation. Data dealing with a consecutive series of patients with irreducible C1 – C2 D surgically treated were analyzed. Dislocation or reduction was assessed before surgery, immediately after surgery, and at the final follow-up. Etiology, instrumentation, levels fused, and complications were all documented.

Analysis

The mean age was 32 years (range, 7-63 years). Thirty three patients underwent open reduction for irreducible C1 – C2 D by transoral anterior atlantoaxial release and posterior instrumentation; 11 out 33 patients (33%) were " children and adolescents" (age ranging between 7 – 17 years). The pathology included os odontoideum in 8 patients, occipitalization of C1 in 19 patients, malunion of odontoid fracture in 5, and relaxation of transverse ligament of atlas in 1. Twenty five patients presented neurologic signs and symptoms. Anterior release was performed without odontoid resection in all cases. Four patients underwent transarticular C1-C2 screw fixation, 3 had C1-C2 pedicle screw and plate fixation,

and 26 required occipitocervical fixation. Twenty-five cases resulted in an anatomic reduction, 8 had partial reduction. Complication included one dysphagia and two nasal phonations. The mean follow-up period was 33.7 months (range, 24-55 months). There was no pseudarthrosis, and all but 1 of the patients with neurologic deficit showed improvement.

The safety and efficacy of the transoral anterior atlantoaxial release in the reduction of C1- C2 D is underlined by the authors. According to the authors conclusions most of the so-called irreducible/fixed C1- C2 D could become reducible after anterior release without odontoid resection. The posterior short-segment atlantoaxial or occipitocervical fixation, especially the plate screw instrumentation, could achieve further reduction and provide immediate stabilization. The authors conclude that one-stage anterior release and posterior instrumentation and fusion are a safe and reliable operation in experienced hands.

2) Massimiliano Visocchi, Domenico Pietrini, Tommaso Tufo, Eduardo Fernandez, Concezio Di Rocco: Preoperative irreducible C1 – C2 dislocations: Intraoperative reduction and posterior fixation: "The always posterior strategy" Acta Neurochir (2009) 151: 551 - 560

Information

According to Menezes' algorithm, preoperative dynamic neuroradiological investigation in C1 – C2 dislocations (C1C2D) instability are strongly advocated in order to rule out those patients who are not eligible for posterior fixation and fusion without previous anterior transoral decompression. Anterior irreducible compression due to C1C2D instability needs transoral anterior decompression. The authors reviewed their experience in order to assess such a paradigm by reporting their experience. In twenty three patients operated for CVJ instability, X-Ray, computerized tomography (CT) scan and magnetic resonance (MR) imaging of the CVJ showed variable C1C2D in all the cases. Preoperatively irreducible C1C2D was demonstrated only in 3 (2 paediatric Down Syndromes; 1 Rheumatoid Arthritis (13.04%); the remaining 19 (86.9%) all showed reducibility of C1-C2 dislocation.

After unsuccessfully traction test conducted in the preoperative phase in sedation, it was possible to completely reduce the C1C2D and proceed to posterior fixation in all the patients under general anaesthesia (with a combination of axial traction with light extension of the neck on the chest and a light flexion of the head on the neck by using a Mayfield head holder) and during posterior fixation by using a precise "timing sequences fixation technique". Wiring (C0 and C3 were fixed first being stretched up to approximately 10 pounds, then C2 in order to pull up this vertebra last by forcing approximately 8 pounds). or screwing procedures with fusion along with postoperative external orthosis and neuroradiological assessment of C1C2D were performed.

Analysis

The instrumentation produced a lever effect with a pulley like mechanism which accomplished to force the CVJ complex up to its reduction. At maximum follow up (34 – 55 months - mean 45.33 months) the clinical picture was improved or remained stationary in all the patients. In all the cases the instrumentation produced a lever effect with a pulley like mechanism which accomplished to force the CVJ complex up to its reduction. The authors conclude that preoperative irreducibility of the C1C2D would not be an absolute indication to transoral decompression, finally they conclude that an attempt to reduce the shift under general anaesthesia and during posterior fixation should be tried in Down syndrome, Os Odontoideum and Rheumatoid Arthritis.

Considerations

Eight out of 33 patients (24.4%) among the Wang series and the 2 out of 3 (66%) "irreducible" patients of the Visocchi paper were harbouring an os odontoideum (12; 13).

The Wang's one stage transoral anterior atlantoaxial release and posterior internal fixation is the last of the Group dealing with intraoperative surgical releasing strategies (summarized as 1; 2; 3 in the introduction) (9; 10; 11). Such a strategy is addressed to "irreducible" dislocations identified in the operating room with an empiric traction test performed by the surgeon under general anesthesia. Although it appears an interesting, original and promising technique it seems also time consuming, uncomfortable, surgically complex, demanding and potentially dangerous due to the increased risk of injuring the vascular vertebral supply and the nerve roots.

Interestingly, this open reduction of irreducible CVJ has been performed and proposed without odontoid resection (i.e "C1 –C2 D decompression") although possible (and without significant adjunctive risk in my opinion) with the transoral approach used. The Visocchi's paper offer a new perspective in the management of "irreducible" dislocations and, in the meantime, rises the problem of the patient selection.

In order to identify "irreducible" dislocations, two simple traction tests are proposed in: 1) SUPINE POSITION "long lasting" (6 hours) awake preoperative traction test (one eight of the patient's body weight) with fluoroscopic assessment; 2) PRONE POSITION "short lasting" (5 min) traction test to be performed in the Operating Room, under general anaesthesia, with Mayfield 3 pins head holder producing axial (vertical traction) and sagittal "forced" manipulation, under continuous fluoroscopic control ("with a combination of axial traction with light extension of the neck on the chest and a light flexion of the head on the neck").

Since such a manoeuvre takes around 5 minutes, the authors consider this technique a "simple manoeuvre" suitable for "preoperative irreducible C1 –C2 D". In three "truly irreducible" cases the authors obtained a complete reduction during the instrumentation and felt to be encouraged to conclude: that an "always posterior strategy" would be suggested in cases of preoperative irreducible C1-C2 D. Instead of a double intervention initially with an anterior decompression, according to Wang, an attempt to reduce C1C2D would be always performed under general anaesthesia.

Reduction of stable C1C2D can be achieved by the lever effect with a pulley like mechanism can be obtained by following precise surgical steps for both techniques. Preoperative irreducibility of the C1C2D would not be an absolute indication to transoral decompression.

Soon after the publication of the Visocchi paper, Wang in his Letter to the Editor, further supported the efficacy and safeness of 1) his intraoperative traction test under miorelaxation and general anaesthesia and the "one stage" 2) transoral releasing with 3) posterior instrumentation and fusion (14).

Nevertheless the complications reported by Wang (one case of dysphagia and two cases of nasal phonation - 1% of the Wang series) are strictly related to the transoral procedure and rise the question on the opportunity to use such an approach.

Prudence on the transoral "release" has been stressed also by Kerschbaumer, another Author performing transoral decompression in irreducible C1 – C2 D, who states: " (….) transoral approach has several difficulties (i.e. limited opening of the mouth, postoperative infection, pharyngeal wall healing, oedema of the mucosa (…)" (15).

To be pointed out that to overcome the inconveniences of the transoral approach in irreducible C1 –C2 D some authors has suggested a posterolateral cervical odontoidectomy (16). In the Visocchi series tracheostomy was never needed since transoral approach was not performed (17; 18).

Due to the overall surgical balance of the transoral atlantoaxial joint release procedure, it should be more advisable and effective a) " first to decompress "totally" (odontoidectomy) and then fixate posteriorly rather than to b) "predispose" for posterior fixation without any intraoperative confirmation of the effectiveness atlantoaxial joint release.

Conclusions

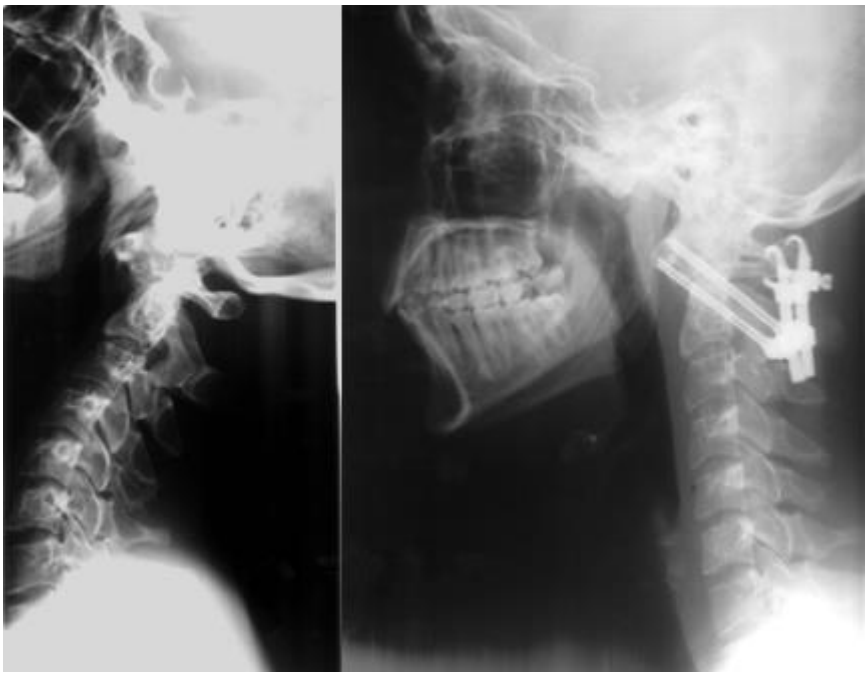
The paper selected rises a delicate question: can we change the roles?

As matter of fact all we need to accept is the new concept that posterior instrumentation, which is considered a sort of internal orthosis, can start to be considered "per se" an internal permanent "traction" system.

Nevertheless a "consensus" literature concerning the precise steps to be followed worldwide in order to definitively identify true "reducible" and "irreducible" C1-C2 D is strongly needed and all the paper cited could contribute to rise the attention to this challenging topic.

Fig 1: Preoperative irreducible C1 – C2 dislocation after Surgery (personal observation)

Before (left) After (right) Surgery



B) THE CRANIOVERTEBRAL JUNCTION: ENDOSCOPIC ASSISTED ANTERIOR APPROACHES

1) Baird CJ, Conway JE, Sciubba DM, Prevedello DM, Quiñones-Hinojosa A, Kassam AB:. Radiographic and anatomic basis of endoscopic anterior craniocervical decompression: a comparison of endonasal, transoral, and transcervical approaches. Neurosurgery. 2009 Dec;65(6 Suppl):158-63

Information

The Authors present the results of a cadaveric study aiming to evaluate the surgical access to the CVJ by using 3 endoscopic approaches: endonasal, transoral, and transcervical. The entry site was defined as: 1) the endonasal approach (inferior midline of the nasal bone), 2) the transoral approach (the tip of the upper incisor), and 3) the transcervical approach (the skin at the C4-C5 level). Image guidance was used in 1 specimen for each approach; fluoroscopy was used in every case. The Vitrea imaging station (Vital Images Inc., Minnetonka, MN) was used to evaluate the angles and distances to the target of the approach, centered on the tip of the odontoid.

Analysis

Adequate lower clivus and craniocervical decompression was achieved using the endonasal and transoral approaches. Lower clivus decompression was not achieved with the transcervical approach. The average distance to the surgical target was as follows: endonasal (94 mm), transoral (102 mm), and transcervical (100 mm). The angle of attack was as follows: endonasal (28 degrees), transoral (30 degrees), and transcervical (15 degrees). The working

area at the base of the field was as follows: endonasal (1305 mm2), transoral (1406 mm2), and transcervical (743 mm2).

The Authors conclude that the endonasal and transoral approaches allow wide exposure with large working angles to the CVJ. The transcervical approach accesses the odontoid for resection from the body of C2 to the lip of the basion. The angles of attack in the transcervical approach when centered on the surgical target are limited, but this approach offers a clean, sterile operative field. Clinical investigation will be required to determine the optimal indications for each approach.

2) Wesley Hsu, Jean Paul Wolinsky, Ziya L. Gokaslan,Daniel M: Sciubba: Transoral approach to the cervical spine. Neurosurgery 66:A 119- A 125,2010

Information

This article discusses fundamental concepts regarding anatomy, perioperative considerations, and technical aspects critical to this important approach to the CVJ. A number of anterior approaches have been described to allow exposure to the midline and lateral aspects of both the cranial base and upper cervical spine. The transoral-transpharyngeal approach, a technique that is well known to many spine surgeons, provides surgical access to the anterior clivus, C1, and C2. Transoral approaches provide the fundamental anatomy and technique upon which the more complex jaw-splitting approaches are based (i.e. "transoral extended approaches" with transmaxillary and transmandibular extentions).
The transoral-transpharyngeal approach historically remains the "gold standard" for anterior approaches to the cervical spine.
The surgical risks dealing with the lateral exposure (toughly 15 to 20 mm bilaterally off the midline from the inferior clivus to the C3 body) consists of trauma to 1) the Eustachian tube orifice, 2) hypoglossal nerve, 3) vidian nerve 4) vertebral artery at the C1 – C2 interface; those dealing with the longitudinal exposure (due to soft palatal splitting with velopalatine incompetence) consist of 1) nasal speech 2) dysphagia, 3) regurgitation of liquids.

Analysis

To overcome the latter complications endoscopic endonasal and endoscopic transcervical approaches are promising alternatives that may become more mainstream as experience with these approaches increases (cons: learning curve, loss of 3-dimensional visualization).

In particular endoscopic endonasal, with the incision performed above the soft palate, should limit postoperative swallowing dysfunction and minimize exposure to oral bacterial flora; moreover it is possible to remove the odontoid process without disturbing the C1 ring due to the more caudal surgical route. The endoscopic odontoidectomy via a standard anterior cervical approach has been described as the evolution of the procedure used for a transodontoid screw. Pros are: complete isolation of the oral cavity, no needs of tracheostomy and feeding tube, Cons are: oblique approach, only piecemeal removal of CVJ pathology is

allowed, not recommended for large tumors, obese, barrel chested and severely kyphotic patients.

Considerations

The huge Menezes' experience on transoral approach was started in 1977 and up to the 2008 the number of the microsurgical procedures has been calculated to be 732 (280 children) (19). This author in his paper concluded that the ventral transoral–transpalatopharyngeal approach has evolved into a safe, rapid, effective and direct approach to the ventral irreducible pathology of CVJ with minimal morbidity and mortality. Although there have been recent attempts at obtaining better visualization and reducing the surgical morbidity with endoscopically assisted procedures, Menezes has not felt the need for any of those. In his opinion,. in addition, intra- operative fluoroscopy or the use of "Stealth technology" has been of little value because, of the marked improvement in the three-dimensional imaging.

Menezes concludes that the advantages of the transoral-transpalatine approach to the craniocervical region compared with other operative approaches in irreducible pathology are that:

(1) the impinging bony pathology and granulation tissue that accompanies chronic instability is easily accessible, (2) the patient is placed in the extended position as opposed to the flexed position, thus, decreasing the angulation on the brain stem during surgery, and (3) surgery is performed through the avascular median raphe and through the clivus.

No doubts that the indications for the transoral operation at the anterior craniocervical border have to be fairly exact, but why the recent literature progressively support both 1) endoscopic assisted and 2) navigated transoral approach, just the same that Menezes did not highlight?

In our opinion two possible explanations of these interesting trends are:

1) Contrary to Menezes' experience, some papers claim significant oropharyngeal morbidity from splitting the soft palate associated with the transoral approach. Jones reported a striking difference in oropharyngeal complications when analyzed with regard to splitting of the soft palate (no splitting vs splitting complication rate: 1/5); oropharyngeal complications dropped to a15.4% in those patients who did not undergo splitting of the soft palate, as compared with 75% in the split soft palate group. The Author concludes that this procedure should be discontinued where it is not absolutely necessary (20).

2) The progressive worldwide blooming of transoral procedures, thanks to the intensive care and the intraoperative neurophysiological monitoring techniques improvements (once considered pioneering and very selective), are spreading the expertise in this surgery to a new population of surgeons. New trends in technology drive from the "old fashioned referenced" micro surgeons to the young spine surgeons, more committed in video- assisted and minimally invasive procedures.

State of Art

Endoscopic Assisted Procedures: Endonasal

Recently, increased diffusion in the use of the endoscope for transsphenoidal pituitary surgery led some studies to explore the possibility of applying the endoscopic endonasal approach in the surgical treatment of skull base lesions other than pituitary tumors. In recent years some papers have reported anatomical studies and surgical experience in the endoscopic endonasal approach to different areas of the midline skull base, from the olfactory groove to the CVJ (21). In 2002 Alfieri was the first to perform a cadaveric study on totally transnasal endocopic odontoidectomy through one or two nostril routes, by following the Jho's endonasal paraseptal technique (22). Rodlens endoscopes, which were 2.7 or 4 mm in diameter, 18 cm in length with 0-, 30-, and 70-degree lenses, were used. The surgical landmarks leading to the craniocervical junction were the inferior margin of the middle turbinate, nasopharynx and the Eustachian tubes. The nasopharynx was readily identified following the inferior margin of the middle turbinate. The line drawn between the Eustachian tubes indicated the juncture between the clivus and atlas. The author concluded that "..contrary to a conventional transoral approach, this endoscopic endonasal approach provides unlimited access to the midline clivus and a potential of carrying out surgical decompression at the ventral craniocervical junction without adding C1-2 instability" (23). Three years later Cavallo confirmed such an observation on cadaveric study (24).

After the intuition of Alfieri, in 2005 Kassam operated the first case through a fully transnasal endoscopic resection of the odontoid in a 73- year old woman affected by rheumatoid arthritis (23; 25). In his historical report, Kassam's recommended equipment consisted of 1) navigation system; 2) a zero degree endoscope; 3) long angled endonasal drill, 4) ultrasonic aspirator; 5) bayoneted handheld microinstrumentation and concluded: "The transoral approach remains the "gold standard" but in contrast with this "... the defect created by transnasal approach is above the level of soft palate and should not be exposed to the same degree of bacterial contamination".

Further anatomic studies performed by Messina one year later concluded that similar to the transoral approach, the endoscopic endonasal provides a direct route to the surgical target, but it seems related to less morbidity. Nevertheless, as matter of fact thinks are less simple.

The group of Kassam pulished in 2009 the concept of the "Nasopalatine line" (NPL) which is the line created by connecting the most inferior point on the nasal bone to the most posterior point on the hard palate in the midsagittal plane.

Intersection of this line with the vertebral column is measured relative to the inferior aspect of the body of C2 along its posterior surface (Fig 1) (26). The NPL is a reliable predictor of the maximal extent of inferior dissection, and odontoid surgery can reliably be performed according to the preoperative radiological study of the possible anatomical limitations of the endonasal approach. In conclusion this approach is recommended by the authors in selected cases as valid alternative to the transoral microscopic approach for the resection of the odontoid process of C2 and should be performed only by surgeons very skilled in endoscopic endonasal surgery and in endoscopic cadaver- dissections, (21; 25).

Endoscopic Assisted Procedures: Transoral

The 30-degree endoscope has been proposed for transoral approach to avoid full soft-palate splitting, hard-palate splitting, or extended maxillo/mandibulotoy (27). Using the endoscope, the operator is able to look in all directions by rotating the instrument. Because the light source is at the level of the abnormality, superior illumination can be obtained. With the aid of an endoscope, abnormalities as high as the midclivus can be visualized without extensive soft- or hard-palate manipulation.

The last high profile cadaveric study recently available in the Literature is the one of the Ammirati Group which quantifies the surgical volume gained by this approach: the surgical area exposed over the posterior pharyn- geal wall is significantly improved using the endoscope (606.5 -127.4 mm3) compared with the operating microscope (425.7 100.8 mm3), without any compromise of surgical freedom (P 0.05). The extent of the clivus exposed with the endoscope (9.5 0.7 mm) without splitting the soft palate is significantly improved compared with that associated with microscopic approach (2.0 0.4 mm) (P 0.05). (30). With this paper it is well demonstrated that with the aid of the endoscope and image guidance, is it possible to approach the ventral CVJ transorally with minimal tissue dissection, no palatal splitting, and no compromise of surgical freedom. In addition, the use of an angled-lens endoscope can significantly improve the exposure of the clivus without splitting the soft palate.

Endoscopic Assisted Procedures Transcervical

Wolinsky first described in 2007 an alternative endoscopic route to the anterior CVJ with the endoscopic transcervical approach (28; 29). The need of this option deals with the limitation of transpharyngeal approaches above mentioned. When the pharynx is traversed, the operative field is virtually contaminated with oral flora. Risk for infection, poor pharyngeal healing, and meningitis (if the dura is transgressed) can all be increased. Moreover the transcervical exposure is familiar to neurosurgeons, and the trajectory proposed by the Author allows deep-seated basilar invaginations to be decompressed. The postoperative recovery time is shorter. Patients are able to ingest food orally shortly after removal of the endotracheal tube. In patients without preoperative dysphagia, there is no need for a tracheostomy or gastric or duodenal feeding tube as a result of the procedure. Nevertheless the odontoid decompression is too oblique and partial although without disturbing the C1 ring. To gain access to the lower clivus C1 ring has to be removed but the angle of attack makes this portion of dissection most difficult or impossible. Finally, in our opinion, in cases of impression basilaris or other high pathologies such an approach could be uncomfortable and challenging (Fig 3).

Navigated Transoral Approach

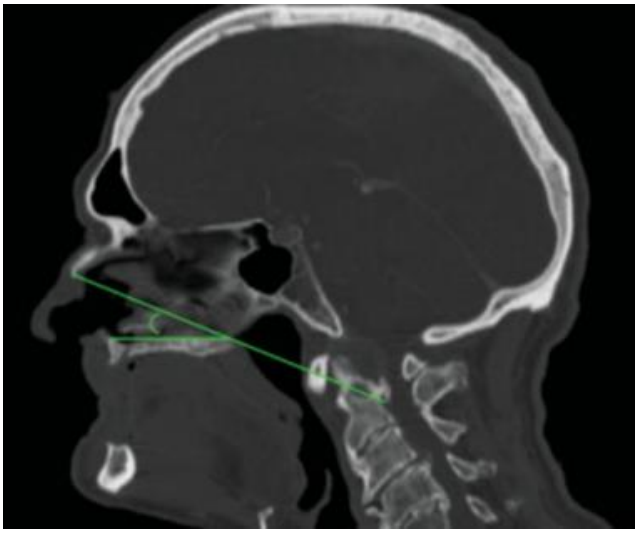
The use of image guidance can significantly enhance one’s ability to visually reconstruct the magnified 3-dimensional anatomy imaging and it allows a thorough inspection of the anatomic images in multiple reconstructed views before and during the surgical procedure (30). In other words preoperative simulation of the approach helps to better plan the surgical technique and

intraoperative use allows to avoid fluoroscopy. Registration procedure requires 5 to 10 minutes. Although the error associated with spinal shift is not completely eliminated, the calculated accuracy is less than 1 mm. Moreover robotic surgical technology has found growing applications and increasing acceptance. Although early adaptation of this technology to head and neck surgery is limited, it shows great potential (31). Along with the neuronavigation advantages, robotics allows: 1) improved fine motor control with a tremor filter, 2) articulated instruments and 3) the ability to perform two-handed surgery through small openings (32).

Conclusions

As far as possible to summarize from the literature and conclude according to personal experience, although blooming in the worldwide literature, pure endonasal and cervical endoscopic approach deserve consideration but still has some disadvantages: 1) the learning curve and 2) the lack of 3-dimensional perception of the surgical field which could be an operationally limiting factor. Image clarity will be diminished when endoscopes smaller than 2.7 mm are used. Standard 4-mm endoscopes give a good image quality, but 2.7-mm scopes provide better maneuverability;. 3) a limited working channel, according to the variability of the nasopalatine line, which can make difficult to remove huge tumors like the one shown in Fig 3.
In our opinion endoscopically assisted transoral surgery with 30 degrees endoscopes represents an emerging alternative to standard microsurgical techniques for transoral approaches to the anterior CVJ. Used in conjunction with traditional microsurgery and intraoperative fluoroscopy, it provides a safe and improved method for anterior decompression without or with a reduced need for extensive soft palate splitting, hard palate resection, or extended maxillotomy. Virtually no surgical limitations do exist for endoscopically assisted transoral approach, compared with the pure endonasal and transcervical approaches.
So far, the endoscope deserves an interesting role as “support” to the standard transoral microsurgical approach since 30° angulated endoscopy strongly improve the visual but not the working channel and volume.
Consequently, although we take advantage by endoscopy, we continue to perform the soft palate splitting, since at the maximum follow up, no one patient complained nasal speech, dysphagia or regurgitation of liquids.
Transoral (videoassisted) approach still remain the gold standard compared to the “pure” transnasal and transcervical approaches due to the wider working channel provided by the former technique. Experience is required with greater numbers of patients and long-term follow-up to further validate this promising technique.
Furthermore, the use of image guidance systems before surgery allows a correct planning and during endoscopic procedures gives the surgeon a constant orientation in the surgical field, thus increasing the accuracy and the safety of the approach, although the use of contrast medium fluoroscopy “per se” represents an “ever green” old fashion image guidance system still effective.

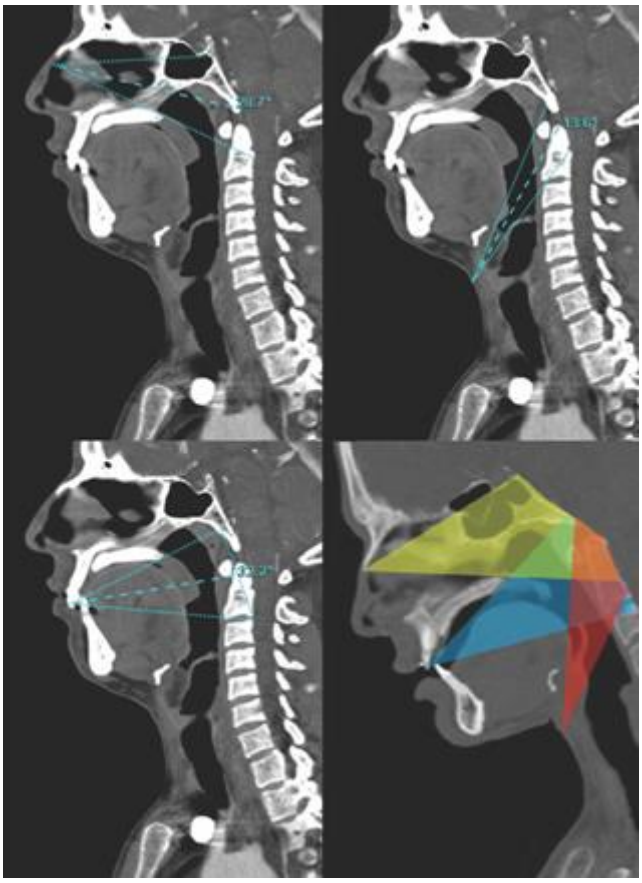
Fig 1: The Nasopalatine Line



Measured by connecting the most inferior point on the nasal bone to the most posterior point on the hard palate in the midsagittal plane (see text).

From de Almeida JR, Zanation AM, Snyderman CH, Carrau RL, Prevedello DM, Gardner PA, Kassam AB. Defining the nasopalatine line: the limit for endonasal surgery of the spine. Laryngoscope, 119:239–244, 2009

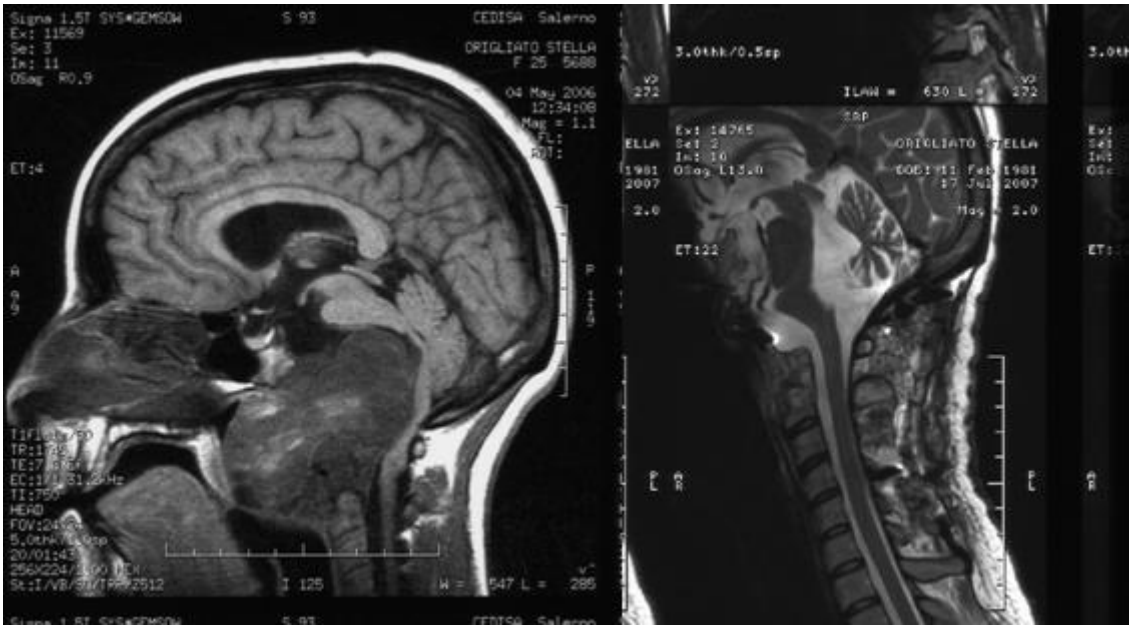
Fig 2:



Computed tomographic scans demonstrating the surgical trajectory and angles for the endonasal approach (A), the transoral approach (B), and transcervical approach (C). D, common surgical area of the 3 approaches is represented by the overlapping illumination. These meas- urements were taken from 30 randomly selected patients with no obvious craniocervical junction abnormality.

From Baird CJ, Conway JE, Sciubba DM, Prevedello DM, Quiñones-Hinojosa A, Kassam AB. Radiographic and anatomic basis of endoscopic anterior craniocervical decompression: a comparison of endonasal, transoral, and transcervical approaches. Neurosurgery 2009

Fig 3:



Huge chordoma in 26 yrs lady before (left) and after (right) endoscopic assisted transoral microsurgical approach, not suitable for endoscopic endonasal and transcervical approach (personal observation)

Final Considerations

The wide acceptance of Menezes' algorithm in the treatment of CVJ abnormalities has been followed by an impressive worldwide blooming of transoral procedures, which was allowed by the contemporary improvement in intensive care and associate intra and peri-operative neurophysiological monitoring techniques.

Consequently, a new generation of enthusiast neurosurgeons was stimulated towards this complex type of surgery, requiring considerable anatomical expertise which can be gained only from cadaveric studies as well as the ability to adapt to new technology, which are currently developed. Among them, endoscopy provides great advantages by reducing surgical invasiveness. However, as for all types of technological advancement, also endoscopy should be taken into consideration after a careful evaluation of its advantages and limitations in order to avoid the risk of a sort of scientific fanaticism.

On the other hand, even though the cumulated experience based on Menezes' algorithm assure considerable safety in approaching this difficult surgery, the young neurosurgeons should avoid the risk to be much aggressive by challenging accepted dogma as, for example, trying to reduce "irreducible" CVJ dislocations in the operating room, as in the paper here discussed.

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