Advantages and limitations of endoscopic endonasal odontoidectomy. A series of nine cases

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\textbf{A R T I C L E   I N F O}

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\textbf{A B S T R A C T}

\textbf{Introduction:} Transoral odontoidectomy is the treatment of choice in cases of anterior bulbo-medullary compression. The development of endoscopic procedures has made it possible to perform odontoidectomy via a minimally invasive endoscopic endonasal approach. We discuss the feasibility, advantages, and limitations of this surgical approach.

\textbf{Materials and methods:} We report a two-center retrospective series of patients who underwent endoscopic odontoidectomy between September 2011 and February 2013. Preoperative characteristics, intraoperative data, clinical course, and postoperative complications were studied. The patients were followed for a minimum of 6 months. Cervico-occipital posterior fusion was performed during the same hospital stay in cases of preoperative instability.

\textbf{Results:} Nine patients underwent decompressive odontoidectomy, for rheumatoid pannus in five cases and basilar impression in four cases. All had progressive neurological symptoms. Seven patients also underwent posterior fusion. In six patients, the C1 anterior arch was preserved. Decompression was achieved satisfactorily in all nine cases. The patients were able to resume oral feeding the day after the intervention. No patient required tracheostomy. We observed no dural fistulae or infectious complications. One patient died 2 months after the intervention of a pulmonary embolism. All patients improved in terms of their preoperative neurological status.

\textbf{Conclusion:} This short series shows the feasibility of the endoscopic endonasal approach for resection of the dens. This approach allows optimal viewing when using angulated instrumentation and seems to result in low morbidity. In some cases, this approach makes it possible to preserve the C1 anterior arch, thus limiting the risk of cranial settling.

\textbf{Level:} IV retrospective study.

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1. Introduction

Certain malformations and progressive pathologies of the craniocervical junction can result in anterior bulbo-medullary compression, requiring decompression including odontoidectomy. To perform this anterior decompression, the transoral approach is the historical standard [1,2]. The development of endoscopic endonasal approaches has progressively led to envisaging endoscopic endonasal odontoidectomy [3]. Series using this approach have been described in the literature with relatively low numbers of patients given the rarity of the indications [4–7]. Most indications for anterior decompression are related to compressive rheumatoid pannus, sometimes associated with basilar impression.

Rheumatoid pannus is usually treated with posterior fusion, which most often suffices so that regression of the compression can be obtained by treating the underlying instability. When the situation does not improve despite this absence of fusion, secondary decompression can be performed. Decompression is the first-line treatment in cases of particularly voluminous pannus that causes neurological involvement threatening the patient’s vital prognosis and therefore requiring rapid treatment, or, in cases of craniocervical junction malformations inducing compression that cannot be reduced by the apex of dens.

2. Material and methods

2.1. Patients

The nine patients in this series were operated on in two centers with the same technique (described below) between September 2011 and February 2013.
The patients presented progressive bulbo-medullary compression related to rheumatoid pannus in five of them and a craniocervical malformation in four of them (os odontoideum, occipitalization de l'atlant, and two basilar impressions). All of them presented invalidating neurological symptoms of progressive myelopathy possibly advancing to quadriaparesis.

These patients’ clinical characteristics are summarized in Table 1.

The endonasal approach was retained after a meticulous study of the preoperative CT scan to ensure that there was no anatomical conformation contraindicating this approach. The preoperative CT scan included vascular sequences to study the trajectory of the carotid and vertebral arteries.

The stability of the craniocervical junction was assessed in all patients with systematic lateral X-rays with dynamic sequences in flexion and extension with particular attention paid to C1–C2 diastasis. This was done before and after dens resection so as to assess the necessity for posterior fixation.

All patients were followed up for a minimum of 3 months (range, 3–24 months) with regular clinical and radiological evaluation with CT, MRI, and X-rays.

### Table 1

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age</th>
<th>Symptoms</th>
<th>Etiology</th>
<th>C1 arch intact</th>
<th>Fixation</th>
<th>Progression</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>84</td>
<td>Tetraparesis</td>
<td>Rheumatoid pannus</td>
<td>Yes</td>
<td>No</td>
<td>Rapid improvement</td>
<td>Death at 2 months, pulmonary embolism Persistent neuropathic pain</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>58</td>
<td>Walking problems + upper right limb involvement</td>
<td>Occipitalization of atlas</td>
<td>No</td>
<td>Yes (occipito-cervical)</td>
<td>Slow progressive improvement (2 months)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>79</td>
<td>Tetraparesis</td>
<td>Nonrheumatoid pannus</td>
<td>Yes</td>
<td>No</td>
<td>Rapid improvement</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>78</td>
<td>Upper limb involvement</td>
<td>Rheumatoid pannus</td>
<td>Yes</td>
<td>No</td>
<td>Rapid improvement</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>63</td>
<td>Upper limb involvement</td>
<td>Rheumatoid pannus</td>
<td>Yes</td>
<td>Yes (C1/C2)</td>
<td>Rapid improvement</td>
<td>Hypovolemic shock during posterior phase</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>58</td>
<td>Tetraparesis</td>
<td>Rheumatoid pannus</td>
<td>Yes</td>
<td>Yes (occipito-cervical)</td>
<td>Rapid improvement</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>32</td>
<td>Bulbar involvement</td>
<td>Basilar impression</td>
<td>No</td>
<td>Yes (occipito-cervical)</td>
<td>Slow progressive improvement</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>73</td>
<td>Upper limb involvement</td>
<td>Basilar impression</td>
<td>No</td>
<td>Yes (occipito-cervical)</td>
<td>Rapid improvement</td>
<td>Postoperative myocardium infarct</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>48</td>
<td>Tetraparesis</td>
<td>Os odontoideum</td>
<td>Yes</td>
<td>Yes (occipito-cervical)</td>
<td>Rapid improvement</td>
<td></td>
</tr>
</tbody>
</table>

2.2. Surgical technique

All surgical interventions were performed with intraoperative image intensifier guidance and neuronavigation.

The material used included a short 0° endoscope, a long 30° angled endoscope, a long angled reamer with a high-speed motor, an ultrasonic dissector and long instrumentation designed for endoscopic hypophyseal surgery.

The patients were installed in a semi-seated position with the head held in a neutral position by a Mayfield head holder.

After topical preparation of the mucous membranes, a bimal approach was begun with lateral luxation of the middle concha and in some cases, unilateral resection of a concha depending on the anatomical configuration. Whenever possible, a sparing approach was used by passing through the choanae without reaming the sphenoid sinus, the nasal septum, or the palate. The apex of the clivus was reamed in the four cases of basilar impression and in one case of rheumatoid pannus.

After identification of the anatomical landmarks (pharyngeal recesses, orifices of the Eustachian tubes), a U-shaped flap of mucous membrane was created using a monopolar scalpel, in a single plane to the bony structures, thus exposing the C1 anterior arch and the clivus apex (Fig. 1). During resection by reaming the dens and its pannus, we were able to preserve the continuity of the C1 anterior arch in six cases; in the other cases, the C1 arch was reamed to access the dens, which was resected by alternating use of the reamer, ultrasonic dissector, and Kerisson gouges, taking care not to overextend laterally and damage the C1 joint eminences. The dens was separated from the body so as to remove it en bloc whenever possible, then the pannus was progressively removed by fragmenting it under regular scopic guidance to verify

![Fig. 1. Intraoperative view at the beginning and end of the operation showing the resection of the dens and the C1 anterior arch kept intact.](image-url)
the ventrodorsal progression, until the anterior dura was visualized. In cases of basilar impression, resection of the bony pieces was wider and systematically required reaming the clivus, transsection of the C1 anterior arch, and resection of the dens.

When the decompression was satisfactory, hemostasis was obtained using hemostatic gels and biological glue. The mucous flap was repositioned by attaching it with biological glue.

When C1/C2 fusion was indicated, it was done immediately following the odontoidectomy during the same anesthesia phase (two cases) or during the same hospital stay (four cases).

3. Results

All patients presented significantly improved neurological status. Six of them underwent C1/C2 fusion shortly after the anterior decompression. For three of the patients, we were not able to perform C1/C2 fusion. These patients therefore had more frequent radiological follow-up with dynamic X-rays at D3, D15, M1, M2, M3, and then every 6 months.

We did not have to perform any tracheostomy or gastrostomy procedures. All the patients resumed a liquid diet between D1 and D2. No infection, cerebral spinal fluid fistula, or swallowing impairment were observed. We found no velar insufficiency. One female patient died 2 months after the intervention in a rehabilitation center from respiratory distress caused by pulmonary embolism (the X-rays and CT scans showed no neurological problems caused by compression or instability).

4. Discussion

We report our experience with the use of the endoscopic endonasal approach for decompressive odontoidectomy.

Resection of the dens is classically performed through a transoral approach with proven results but is responsible at times for morbidity, particularly related to scarring problems that can be complicated by infections [8]. These scarring problems are related to the presence of bacteria and saliva in the oropharynx. The endonasal approach differs in that it limits exposure to saliva by exposing the anterior craniocervical joint via the rhinopharynx.

The endoscopic endonasal approach stems from pituitary surgery that has gone through a number of modifications over the past few years with the development of surgical endoscopy [9]. Endoscopic endonasal surgery has become unavoidable for pituitary gland surgery and its use has progressively extended to the anterior base of the skull and the clivus [10,11]. In 2005, Kassam et al. were the first to describe odontoidectomy via the endoscopic endonasal approach [3].

Our technique presents special features compared to the previously described techniques [3,6].

First of all, whenever possible, we start with an approach that is as sparing as possible with no extension that may harm the sphenoid sinus, the palate, and the nasal septum, using the natural corridor following the nasal fossae and then the choanae to the rhinopharynx with no resection other than a middle concha. This approach makes it possible to preserve the minimal invasiveness of the procedure while providing sufficient exposure. We thus limit certain classically described rhinological complications and problems of velar insufficiency that can complicate postoperative recovery [12].

The other feature of our series is that it includes patients who did not undergo C1/C2 fusion.

Indeed, one of the major risks of anterior compression with odontoidectomy is secondary cranio cervical dislocation of the C1 lateral masses under the vertical pressure exercised by the weight of the head facilitated by loss of continuity of the C1 arch [7,13]. In cases of transsection of the C1 anterior arch or C1 laminectomy, C1/C2 fusion is indispensable. Although occipito-cervical fusion is the most frequent, according to Oda et al., it seems that transarticular C1/C2 fusion is the most appropriate fixation mode to limit the risk of lateral expulsion of the C1 lateral masses [14]. Cases of craniocervical dislocation have already been reported despite cervico-occipital fusion, sometimes several years after odontoidectomy [13].

Nonetheless, as other authors have reported, when the patient is particularly old and frail, presenting no pre- and postoperative instability (absence of C1/C2 diastasis), when the pannus is essentially posterior to the dens, we believe that it is possible not to perform C1/C2 fusion systematically only if there is rigorous radiological follow-up [15]. In these cases, we perform a partial odontoidectomy of the apex through an oblique downward approach passing between the clivus and odontoid apices to gain access to the rheumatoid pannus (Fig. 2). Stability is then maintained by the joint capsules, the paraspinal muscles, and the ligamentum flavum.

Preservation of the C1 anterior arch can limit C0/C1 instability and minimal resection of the odontoid apex can limit C1/C2 instability.
Nonetheless, this strategy is only warranted in particularly old and frail subjects because the absence of C1/C2 fusion can expose the patient to a long-term risk of recurrence of rheumatoid pannus or C1/C2 instability.

Other than these rare indications, we believe that C1/C2 fusion is indispensable to treat instability that can stem from resection and/or instability causing compressive rheumatoid pannus.

In cases of compressive rheumatoid pannus, C1/C2 fusion is most often performed in isolation and anterior decompresion is undertaken only if no neurological improvement is observed stemming from insufficient regression of the rheumatoid pannus or if particularly substantial compression is causing neurological involvement threatening the patient’s short-term vital prognosis. Nevertheless, certain pathological situations can require planning anterior decompresion immediately in addition to fixation. In these situations, it seems important to begin with anterior decompresion since this can facilitate reduction of a subluxation that may have been irreducible earlier. C1/C2 fusion can then be done in the reduced position (Fig. 2).

Some authors object to the limited exposure provided by the endonasal approach given the anatomic conformation of certain patients. This limit is defined as the nasopateline line that sometimes prevents exposure of the dens [16]. In our experience, such anatomic conformation is particularly rare and most often, even if there is a theoretical risk that exposure can be limited, the use of endoscopes and angulated instruments can remediate this problem. Angulated instruments can also be used to intervene on the odontoid while bypassing the C1 anterior arch.

Neuronavigation appears to be useful because, although ventrodorsal progression can easily be controlled using an image intensifier during the intervention, lateral extension can be difficult to control because of the slightly oblique exposure through the nostril. Alternating exposure through the two nostrils in our opinion does not sufficiently restore the orientation of the median line. In all cases, a careful study of preoperative images is indispensable to guarantee that any abnormal vascular trajectory is precluded such as a procidentia of the carotid arteries in their pharyngeal portion.

5. Conclusion

The endonasal endoscopic approach limits the invasiveness of odontoid surgery and allows the patient to rapidly resume oral feeding from D2 with a low risk of velar insufficiency and scarring problems.

With angulated instrumentation, odontoiodectomy can be performed while keeping the C1 anterior arch intact, which will limit the risk of cranio-cervical destabilization.

Disclosure of Interest

The authors declare that they have no conflicts of interest concerning this article.

References