Technical Report

Atlantoaxial anterior transarticular screw fixation: a case series and reappraisal of the technique

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Abstract

BACKGROUND CONTEXT: Atlantoaxial instability is commonly treated with C1–C2 fixation performed via posterior approaches. Although anterior transarticular screw (ATS) fixation, performed with a classic retrosyringeal approach, was described more than 10 years ago, the published literature still lacks a comprehensive analysis of the procedure and a real case series.

PURPOSE: We report a series of patients treated with atlantoaxial ATS, describing the surgical procedure in detail and discussing advantages and disadvantages of the technique.

STUDY DESIGN: The study design includes case series and technical report.

METHODS: We prospectively enrolled 15 patients affected by atlantoaxial instability secondary to trauma, degenerative diseases, or inflammatory diseases. Anterior transarticular screw fixation was performed with anteroposterior open-mouth and lateral intraoperative radiographs. All patients were evaluated radiologically at follow-up to identify bone fusion.

RESULTS: Anterior transarticular screw was performed successfully in 14 patients without complications. The procedure was aborted in a case of vertebral invagination, and one case required revision surgery owing to C2 articular bone fracture. Solid C1–C2 fusion was achieved in all cases (at 10- to 21-week follow-up) except in an elderly patient affected by severe osteoporosis. No complications occurred.

CONCLUSIONS: Although the procedure is still not widely known, ATS allows the effective and safe treatment of C1–C2 instability even in patients with systemic comorbidities. It offers several advantages over posterior approaches. © 2015 Elsevier Inc. All rights reserved.

Keywords: Atlas; Axis; Craniocervical junction; Atlantoaxial instability; Atlantoaxial screw fixation; Transarticular screw fixation

Introduction

Atlantoaxial instability can be produced by numerous pathologic conditions, such as trauma (the most frequent cause), neoplasm, malformation, and inflammatory and degenerative joint diseases. Because of the introduction of posterior C1–C2 wiring by Gallie [1] in 1939, the surgical instrumentations and their materials evolved together with the surgical approaches. The Gallie procedure evolved with the Halifax clamps in 1975 [2], and Grob and Magerl [3] described posterior transarticular screwing in 1987. In 1994, Goel first introduced C1 lateral mass screws [4]; these were modified with polyaxial screws by Harms and Melcher [5] in 2001, and Wright [6] further developed posterior fixation techniques by introducing C2 intralaminar
screws in 2004, reducing the risk of vertebral artery injury (especially in case of high vertebral artery groove in the C2 body) without reducing the stability of the construct. Today, the techniques pioneered by Grob and Magerl [3], Harms and Melcher [5], and Wright [6] offer a complete range of surgical options for posterior approaches to the atlantoaxial junction.

Anterior approaches to this unique anatomic region have been limited to the transoral approach [7], which is associated with a high rate of infectious complications, and the direct lateral approach [8], which requires bilateral exposure. For these reasons, an anterior approach is rarely chosen for C1–C2 fixation. In 2003, Reindl et al. [9] performed an atlantoaxial anterior transarticular screw (ATS) fixation using the classic retropharyngeal Smith-Robinson approach; in 2005, the same group published a biomechanical study suggesting the effectiveness of this technique in C1–C2 stabilization [10]. Since then, few case reports [11,12] and some technical variants including percutaneous or minimally invasive surgical procedures [13–16] have been published; however, the approach is still unknown by most spine surgeons.

Between 2009 and 2013, we performed 14 anterior atlantoaxial screw fixations in patients affected by trauma or degenerative or inflammatory pathology. This case series describes the technique in detail and discusses the advantages and disadvantages of this approach.

Materials and methods

From January 2009 to June 2013, 15 patients (10 men and 5 women) were selected for atlantoaxial ATS in our department. The main age was 59.2 (range 27–81) years. All patients suffered from atlantoaxial instability and were studied at admission with thin slice computed tomography (CT) scanning and magnetic resonance imaging (MRI). In two cases, we performed CT angiogram of the craniocervical junction to evaluate the anatomy of the vertebral artery.

Twelve patients came to our attention with traumatic injury of the craniovertebral junction (80.0%). Two patients (13.3%) suffered from unilateral C1–C2 degenerative osteoarthritis, and one patient (6.7%) had retrodental pannus secondary to rheumatoid arthritis. The traumatic group included six patients with Landells Type II fractures (Table 1) with atlas transverse ligament disruption (ATLD), verified by cervical MRI: one patient with basilar invagination, three with ATLD, and three with Landells Type II fractures with Anderson Type II odontoid fracture. All patients were studied postoperatively with CT scan and flexion–extension cervical spine radiographs. C1–C2 solid fusion was defined according to the classification of Brantigan, Steffee, and Fraser (BSF-3) on CT images [17,18]. The patients’ demographic characteristics, clinical data, and radiological data are listed in Table 2.

Operative technique

After orotracheal intubation with an “armored” tube, each patient is placed supine on a radiolucent table with the head fixed straight and in extension with a radiolucent Mayfield head holder. In cases of C1–C2 articular distraction or subluxation, it is advisable to avoid fixing the head with a head holder to manipulate the joint and to achieve adequate C1–C2 compression for fusion. In these cases, a rigid radiolucent spacer can be placed behind the neck to contrast C2 posterior shifting when reducing atlantoaxial anterior subluxation.

The mouth can be kept open with any radiolucent device. We usually prefer to use a shaped cork from Millesime Champagne or Franciacorta for itsatraumatic and flagrant features (Fig. 1). The armored tracheal tube is mobilized laterally with cotton pads to avoid interference with the anteroposterior (AP) open-mouth visualization of C1 lateral masses.

Because this is a fluoroscopy-guided procedure, clear visualization of the C1 lateral masses and the C1–C2 joints is mandatory to proceed safely. In some cases, because of the superimposition of the occipital bone or the inferior dental arch, the superior and lateral rims of C1 lateral masses in the AP views can be difficult or even impossible to visualize clearly. Consequently, it is advisable to verify the opening of the mouth preoperatively and to use two C-arms for laterolateral (LL) and AP open-mouth views to optimize the operative time and avoid trajectory mistakes (Fig. 2). In patients with a short neck or prominent chest, the extension of the neck can be modified by placing a thicker pad under the shoulders to obtain the most favorable trajectory to the C1–C2 joint.

Once the fluoroscopic AP and LL images are acceptable, as in dens screwing, a classic C4–C5 left anterior retropharyngeal approach is performed. The prevertebral dissection must be extended cranially to the anterior tubercle of C1. In cases of platybasia or basilar invagination, the extreme depth of the surgical field and the craniocervical angles can make this procedure very difficult, if not impossible.

After level confirmation by fluoroscopy, while the surgeon’s assistant holds the pharyngeal wall with long smooth valves to minimize the risk of pharynx perforation (if a Synframe retractor or similar is unavailable [DePuy Synthes Synframe® Retractor System, West Chester, PA, USA]), the surgeon proceeds to incise and detach the longus colli and longus capitis muscles from the anterior surface of C1 and C2, exposing the joint. The joint capsule is then incised, and the articular surfaces are scarified with the aid of long curved curettes. The joint is then filled with bone matrix to promote fusion; we employed equine xenograft (corticocancellous collagenated prehydrated bone mix, Tecnoss Mp3, 5-cc syringe [Tecnoss Mp3®, Giaveno, Italy]).

The technique described by Lu et al. [19] and first applied by Reindl et al. [9] identifies the K-wire entry point on the undersurface of the overhanging lip of the lateral mass of C2, 4 to 5 mm lateral to the base of the odontoid process, with 25° of lateral inclination (Fig. 3). The entry points are checked...
with fluoroscopy. If needed, the prominent anterior cortex of the C2 vertebral body can be thinned with a high-speed diamond ball drill to achieve the correct angulation.

Every author describes the AP and LL direction angles with extreme precision. Nevertheless, during surgery, small variations in surgical anatomy often do not allow the application of the perfect entry point and the planned trajectory. It is much safer and easier to identify the correct direction targets of the K-wire in the live AP and LL views (Fig. 4): the superolateral margin of the C1 lateral mass in the AP view, without passing the lateral or superior cortical rims where the vertebral artery and C0–C1 articulation trauma can occur, and the posterior third of the C1 lateral mass in the LL view, with an eye toward avoiding passage beyond the posterior cortical rim where the ipsilateral vertebral artery usually runs.

The AP and LL angulations should be well evaluated when introducing the K-wire because this procedure often does not allow small variations in direction after the wire is in the bone. High resistance is encountered when perforating the inferior articular surface of C1 and in the case of sclerotic bone, when a dedicated cannulated drill bit can be helpful. Two 3.5- or 4.0-mm cannulated partially threaded screws (malleolar set) are inserted after wires’ measurement (length ranging 20–26 mm); one should pay attention to avoiding accidental further advancement of the K-wires beyond the anatomic limits already described. After the final radiological check, a drainage stent is left in place, and the platissma muscle and skin are sutured in the usual manner. The patient should be able to eat and be mobilized actively on the first postoperative day and should wear a Philadelphia collar for 30 days.

Results

All patients underwent surgery within 2 days of hospital admission. In three patients, we performed a bilateral ATS plus a dens screw to treat unstable odontoid fractures (21.4%). Bilateral ATS fixation was accomplished in 11 patients (78.6%). In cases of basilar invagination, the extreme depth of the surgical field combined with the short neck and prominent chest rendered ATS unsafe and induced us to proceed with posterior fixation. The mean operating time

Table 1
Landells classification of atlas fractures

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Fracture confined to single arch and did not cross the equator of the atlas. Either arch could be involved</td>
</tr>
<tr>
<td>II</td>
<td>Fracture involved both arches and crossed the equator of the atlas; two or more fragments may be present</td>
</tr>
<tr>
<td>III</td>
<td>Lateral mass fracture; fracture line extends into one arch only</td>
</tr>
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</table>

Table 2
Patients’ demographic characteristics, clinical and radiological data of the case series

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age (y)</th>
<th>Etiology</th>
<th>Radiological diagnosis</th>
<th>Neurological impairment (ASIA)</th>
<th>Comorbidities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>49</td>
<td>Inflammatory: rheumatoid arthritis</td>
<td>Retrodental pannus</td>
<td>D</td>
<td>NYHA Class 2</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>74</td>
<td>Traumatic: car accident</td>
<td>ATLD</td>
<td>B</td>
<td>Pulmonary contusions, bilateral pleural effusion, and femur fracture</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>27</td>
<td>Traumatic: car accident</td>
<td>Landells Type II fracture+ATLD</td>
<td>E</td>
<td>Splenic injury, Class 1</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>55</td>
<td>Traumatic: fall from 3-m height</td>
<td>ATLD</td>
<td>E</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>78</td>
<td>Traumatic: car accident</td>
<td>Landells Type II fracture+ATLD</td>
<td>C</td>
<td>Bilateral pleural effusion, wrist fracture, and COPD</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>75</td>
<td>Traumatic: car accident</td>
<td>Landells Type II fracture+Anderson Type II odontoid fracture</td>
<td>E</td>
<td>Pulmonary contusions, bilateral pleural effusion and humerus fracture</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>69</td>
<td>Degenerative</td>
<td>Left C1–C2 unilateral spondyloarthritis</td>
<td>E</td>
<td>None</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>53</td>
<td>Degenerative</td>
<td>Left C1–C2 unilateral spondyloarthritis</td>
<td>E</td>
<td>NYHA Class 1 heart failure</td>
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<tr>
<td>9</td>
<td>F</td>
<td>81</td>
<td>Traumatic: domestic fall</td>
<td>Landells Type II fracture+ATLD+Anderson Type II odontoid fracture</td>
<td>E</td>
<td>Severe osteoporosis, NYHA Class 2 heart failure, and COPD</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>53</td>
<td>Traumatic: fall from an olive tree</td>
<td>Landells Type II fracture+ATLD</td>
<td>E</td>
<td>Shoulder dislocation</td>
</tr>
<tr>
<td>11</td>
<td>M</td>
<td>71</td>
<td>Traumatic: fall from an olive tree</td>
<td>Landells Type II fracture+Anderson Type II odontoid fracture</td>
<td>E</td>
<td>Bilateral pleural effusion</td>
</tr>
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<td>12</td>
<td>M</td>
<td>48</td>
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<td>ATLD</td>
<td>E</td>
<td>Pneumothorax</td>
</tr>
<tr>
<td>13</td>
<td>M</td>
<td>33</td>
<td>Traumatic: car accident</td>
<td>Landells Type II fracture+ATLD</td>
<td>E</td>
<td>Multiple fractured ribs, pulmonary contusions, and bilateral pleural effusion</td>
</tr>
<tr>
<td>14</td>
<td>M</td>
<td>59</td>
<td>Traumatic: fall from 3-m height</td>
<td>Landells Type II fracture+ATLD</td>
<td>C</td>
<td>Multiple fractured ribs, pulmonary and cerebral contusions, and bilateral pleural effusion</td>
</tr>
<tr>
<td>15</td>
<td>M</td>
<td>63</td>
<td>Traumatic: fall from an olive tree</td>
<td>Landells Type II fracture+ATLD+basilar invagination*</td>
<td>E</td>
<td>Cerebral contusions</td>
</tr>
</tbody>
</table>

ATLD, atlas transverse ligament disruption; COPD, chronic obstructive pulmonary disease; NYHA, new york heart association.
was 83.6 (range 45–150) minutes. The mean intraoperative blood loss was 49.3 mL.

Early mobilization was possible in all patients with the use of a Philadelphia collar. The mean time until mobilization was 1.9 (range 1–3) days including the interval between surgery and nonsuction drainage removal, except in one case of severe neurological impairment (American Spinal Injury Association Classification Type C). All patients wore the collar for 30 days and underwent clinical and radiological follow-ups (mean follow-up 25.9 months and range 6–60 months). There were no incidents of infection, implant failure, or morbidity caused by the procedure.

Case 5 required revision surgery to reposition the right screw because of the fracture of the anterior cortical rim of the C2 articular bone. Computed tomography scans and dynamic cervical radiographs confirmed bone fusion and adequate stability in 13 patients after a mean duration of 15.8 (range 10–21) weeks. Computed tomography at the 30-month follow-up of an 83-year-old patient with severe osteoporosis documented effective fixation without solid C1–C2 fusion. One patient (Case 12) died 40 months after surgery owing to acute myocardial infarction. Clinical and surgical data are described in Table 3.

Cases

Case 9

An 81-year-old woman presented with craniocervical trauma after an accidental fall. A CT scan and MRI performed in the emergency department revealed a Landells Type II fracture with ATLD and an Anderson Type II odontoid fracture (Fig. 5, Top). Although neurologically intact,
this patient was affected by severe osteoporosis, chronic obstructive pulmonary disease, and heart failure (New York Heart Association Class 2). She underwent odontoid screw fixation and ATS fixation in a single procedure. The patient mobilized on the first postoperative day, when a CT scan confirmed stable C1–C2 fixation (Fig. 5, Middle); she was discharged on the sixth postoperative day with a Philadelphia collar to be worn for 30 days. This patient recovered completely; at the 30-month follow-up examination, the CT scan showed atlantodental fusion without C1–C2 arthrodesis (Fig. 5, Bottom).

Case 10
A 53-year-old man was transported to our emergency department after an accidental fall from an olive tree. At admission, the patient was neurologically intact, had right shoulder dislocation, and complained of neck pain. He underwent craniocervical CT scan, which revealed a Landells Type II fracture plus ATLD. Magnetic resonance imaging examinations revealed fractures of the anterior and posterior arcs of C1 associated with a transverse ligament disruption (Fig. 6, Top). The patient underwent ATS and mobilized on the first postoperative day after nonsuction drainage removal. A postoperative CT scan confirmed the correct positioning of the screws and the filling of the joints with bone paste (Fig. 6, Middle). He was discharged on the fifth postoperative day, and the wearing of a Philadelphia collar was indicated for 30 days. At the 38-month follow-up, the CT scan demonstrated complete C1–C2 fusion (Fig. 6, Bottom) and the patient resumed normal activities.

Case 13
This 33-year-old man presented with a Landells Type II fracture with ATLD after he sustained major craniocervical trauma in a car accident (Fig. 7, Top). Neurologically

<table>
<thead>
<tr>
<th>Patient</th>
<th>Treatment</th>
<th>Operative time (min)</th>
<th>Blood loss (mL)</th>
<th>Neurological impairment: ASIA preoperative</th>
<th>Neurological impairment: ASIA postoperative at follow-up</th>
<th>Follow-up (mo)</th>
<th>Bone fusion (wk)</th>
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<tr>
<td>1</td>
<td>ATS</td>
<td>45</td>
<td>20</td>
<td>D</td>
<td>E</td>
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<td>20</td>
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<tr>
<td>2</td>
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<td>55</td>
<td>30</td>
<td>B</td>
<td>C</td>
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<td>21</td>
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<tr>
<td>3</td>
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<td>C</td>
<td>D</td>
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<td>18</td>
</tr>
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<td>6</td>
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<td>80</td>
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<td>E</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>7</td>
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<td>70</td>
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<td>E</td>
<td>E</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>8</td>
<td>ATS</td>
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<td>E</td>
<td>E</td>
<td>29</td>
<td>11</td>
</tr>
<tr>
<td>9</td>
<td>ATS+dens screw fixation</td>
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<td>60</td>
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<td>E</td>
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<td>19</td>
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<td>10</td>
<td>E</td>
<td>E</td>
<td>38</td>
<td>19</td>
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<tr>
<td>11</td>
<td>ATS+dens screw fixation</td>
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<td>70</td>
<td>E</td>
<td>E</td>
<td>42</td>
<td>18</td>
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<tr>
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<td>ATS</td>
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<td>40</td>
<td>E</td>
<td>E</td>
<td>40*</td>
<td>12</td>
</tr>
<tr>
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<td>60</td>
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<td>E</td>
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<td>ATS</td>
<td>150</td>
<td>70</td>
<td>C</td>
<td>D</td>
<td>60</td>
<td>14</td>
</tr>
</tbody>
</table>

ATS, anterior transarticular screw.

* Lost to follow-up.
intact, he suffered from fractures to multiple ribs, pulmonary contusions, and bilateral pleural effusion. He underwent ATS fixation on the second day after hospital admission. The intraoperative radiological LL views revealed a progressive lateral subluxation of the C1 lateral masses, which made the screw positioning extremely tricky. Because of the altered anatomic C0–C1–C2 relations documented on the postoperative CT scan, we were concerned that we would have to proceed with an occipitocervical fixation; however, additional controls demonstrated solid and complete C1–C2 fusion at the 48-month follow-up examination (Fig. 7, Middle and Bottom).

Discussion

Even when there is no need to decompress neural structures, atlantoaxial instability is commonly treated via posterior approaches, using the techniques of both Grob and Magerl [3] and Harms and Melcher [5]. Considering the risks and limits of the transoral [7] and direct lateral approaches [8], these techniques were never a valid alternative to the posterior approaches until 2003, when Reindl et al. [9], after the anatomic study Lu et al. [19] on cadavers, used the classic Smith-Robinson retropharyngeal approach to perform an anterior transarticular C1–C2 fixation in a case of traumatic instability.

Sen et al. [10] published a biomechanical study in 2005 supporting the good stability of the ATS construct and emphasizing the limited stiffness in flexion-extension movements. Lapsiwal et al. [20] reported the same conclusions the following year in Neurosurgery. After an accurate and detailed anatomic and radiological studies, in 2006, Koller et al. [13] described a very interesting modification of the surgical technique of Lu et al. [19]. In this variation,
the screw entry point lies underneath the pinafore of C2, increasing the screw purchase in the bone of the C2 promontory and improving the stability of the construct (Fig. 3).

In recent years, except for an anatomic study describing variations in entry point (C2 pars interarticularis) and direction (lateral to medial) [14], Chinese authors have described minimally invasive and percutaneous ATS procedures [15–19]. When we take into account the experience acquired in our patient series (the largest ever reported), we believe that atlantoaxial ATS offers numerous advantages over posterior approaches.

First of all, the position of the patient on the surgical table should be considered. As in screw fixation of a dens fracture, the patient is positioned supine and with the head fixed in extension. In cases with atlantoaxial instability (ie, ATLD), the posterior approaches need the head to be fixed in flexion, thus increasing the risk of spinal cord compression. Anterior transarticular screw eliminates that risk. Furthermore, the supine position is highly preferable in polytrauma patients (who frequently have sternum or rib fracture, pulmonary contusions, and extremities fractures) and in patients suffering from cardiorespiratory pathologies, in which the prone position alters respiratory dynamics by decreasing respiratory compliance even in nonobese patients [21–23].

During posterior approaches, it is necessary to disconnect the muscles of the suboccipital triangle inserting on the C2 laminae. These muscles have high spindle receptor density, handling proprioceptive inputs during head flexion and rotation [24]. Although not yet clinically demonstrated, posterior approaches can have a negative effect on the complex integrative mechanism involved in head-eye movements. Furthermore, the surgical anatomy of ATS avoids the risk of trauma to the spinal cord and C2 roots, and

Fig. 6. Axial and coronal computed tomography images of Case 10. (Top) A preoperative C1 Landells Type II fracture with atlas transverse ligament disruption. (Middle) Early postoperative control revealing anterior transarticular screw and synthetic bone matrix in the joint. (Bottom) Fusion of the atlantoaxial joints and C1 anterior and posterior arches at the 38-month follow-up examination.
the surgeon does not have to deal with bleeding from the venous plexuses surrounding the vertebral artery or the C2 root.

Regarding the rigidity of the construct, in their mechanical studies, Sen et al. [10] and Lapsiwala et al. [20] pointed out the lesser rigidity of ATS compared with Grob and Magerl [3] or Harms and Melcher [5] with posterior wiring only in flexion-extension movements. This difference has never been clinically significant, either in our series or in the published literature, most likely because the atlantoaxial joint accounts only for 12% of flexion-extension movements of the cervical spine [10], thus rendering the construct rigid enough to promote fusion. As highlighted by our long-term radiological follow-up, it is recommended that the surgeon spends enough time scarifying the C1–C2 articular surfaces to induce bone fusion, and although not proven in the literature, in cases of severe osteoporosis, triple screw fixation may add stiffness and bolster the likelihood of fusion to the construct (eg, Case 9). Considering the working angle, which is nearly tangential to the anterior spinal wall, working inside the joints is a complicated and uncomfortable maneuver that can be performed with long curved curettes rather than with a high-speed drill. The impressive C1–C2 fusion revealed for Case 13 at long-term follow-up (Fig. 7, Bottom) demonstrates that occipitocervical fixation can be avoided with C1–C2 ATS, even in extreme destructive cases.

Although it is unsuitable for triple screw fixation (dens + ATS), the technical variant described by Koller et al. [13] provides better screw purchase in the C2 promontorium. Furthermore, it enables fixation in patients with a C2 articular fracture, with a high vertebral artery groove, or with a thin anterior rim of the superior articular surface of C2 anatomic condition that increases the risk of screw mobilization. Attention should be paid calculating carefully the optimal direction of the K-wire because small variations

Fig. 7. Axial and coronal computed tomography images of Case 13. (Top) Preoperative C1 burst fracture with atlas transverse ligament disruption. (Middle) Early postoperative control depicting the anterior transarticular screw fixation. (Bottom) Complete C1–C2 fusion at the 48-month follow-up examination.
in angles at the entry point could mean passing posterior or lateral limits in C1 lateral masses.

Li et al. [15] and Wang et al. [16] each reported small series of minimally invasive and purely percutaneous anterior transarticular C1–C2 fixation; the latter used the technique by Koller et al. [13] and discussed the benefits and results of such treatment [25]. Like many spine surgeons, we are fans of minimally invasive surgical spine procedures, and we have a long experience with them; however, we also believe that the anterior retropharyngeal approach is already minimally invasive because it is associated with negligible muscle trauma, minimal or no blood loss, and fast recovery. Together with the well-known risks of the standard Smith-Robinson approach (laceration of the pharyngeal and esophageal wall, carotid artery injury, transient dysphagia, and dysphonia) [15,25], C1–C2 ATS potential complications are related to the trajectory of K-wire and screws, that is, damages of vertebral arteries, dural sac, and spinal cord.

C1–C2 ATS is contraindicated in cases of fixed rotatory atlantoaxial luxation and cases in which spinal cord decompression is necessary. We believe rotatory C1–C2 subluxation is a relative contraindication because it is possible to reduce it in the operating room with cervical traction or by directly manipulating the joints and then proceed with ATS under direct visualization of the C1–C2 articulation. Other relative contraindications include all craniocervical malformations and anatomic conditions that result in an extremely deep and narrow surgical field (eg, platymbasia, basilar invagination, and low mandible projection), which renders the procedure unsafe. In our patient with basilar invagination, we were unable to control the surgical instrumentation safely, and we proceeded with a posterior fixation.

Conclusions

Atlantoaxial instability is a challenging problem for any spine surgeon, and a good knowledge of all surgical approaches to this complex anatomical area can enable the surgeon to choose the best technique according to each patient’s needs. Anterior transarticular screw offers many advantages over the posterior approaches. We believe that it represents a valid alternative when neural decompression is unnecessary and as a salvage procedure in cases of dens screw fixation failure in Anderson Type II fractures.

References