Review

European Spine Journal

Eur Spine J (1993) 2: 180–190

Principles of surgical treatment of the cervical spine in rheumatoid arthritis

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Principes du traitement chirurgical de l'arthrite rhumatoïde du rachis cervical

Résumé. Près de 20% des patients atteints d'arthrite rhumatoïde se plaignent de problèmes cervicaux liés à l'instabilité et aux déformations. La douleur, la myélopathie, et de graves déficits neurologiques peuvent en être les conséquences fâcheuses. Les résultats rapportés dans la littérature n'encouragent pas à réaliser la décompression et la stabilisation chirurgicales. Cependant de nouvelles techniques chirurgicales permettent une stratégie plus aggressive vis-à-vis des problèmes complexes posés par l'instabilité rhumatoïde du rachis cervical. L'instabilité C1-C2, la plus fréquente, est traitée sans grandes complications par une fixation atlanto-axoidienne postérieure au moyen d'un vissage réalisant un montage tridimensionnel. Pour l'incorporation de l'occipital dans la fusion et l'extension de l'arthrodèse jusqu'au rachis cervical inférieur, l'auteur présente une plaque en Y en Titane, dont l'efficacité est démontrée. Alors que la stabilisation peut être réalisée par un abord postérieur, la décompression quant-à elle est faite de préférence par discectomie ou vertébrectomie antérieure. Des résultats encourageants, avec notamment une récupération neurologique importante permettent de justifier une intervention précoce dans les cas d'instabilité cervicale d'origine rhumatoïde.

Mots-clés: Rachis cervical – Arthrite rhumatoïde – Traitement chirurgical – Indication chirurgicale – Techniques opératoires

Summary. About 20% of patients with rheumatoid arthritis complain about neck problems based on instability and deformity. As a consequence, pain, myelopathy, and severe neurological deficit may occur. Results reported in the literature were not encouraging as regards surgical decompression and stabilization. However, new surgical techniques allow a more aggressive strategy towards the complex problem of the instable cervical spine in rheumatoid arthritis. The most frequent instability of C1/2 can be stabilized by a posterior atlantoaxial screw fixation, a three-dimensional multidirectional construct with few complications. For the inclusion of the occiput into the fusion and the extension of the fusion down to the lower cervical spine, a titanium Y-plate is presented as a successful implant. While through a posterior approach, stability may be achieved, decompression is preferably done by anterior diskectomy or vertebrectomy. Encouraging results with a significant recovery of neurological deficits justify an early intervention in cases of instability of the cervical spine in rheumatoid arthritis.

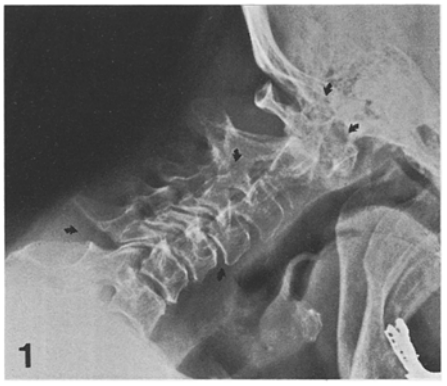
Key words: Cervical spine – Rheumatoid arthritis – Surgical treatment – Indication for surgery – Operative techniques

Introduction

From 1969 to 1984, 1294 patients with diagnosed rheumatoid arthritis (RA) presented in our hospital for treatment (orthopedic surgery). Of these patients, 248 (19.2%) had complained at least once about problems with their cervical spine and were investigated clinically and radiographically. To date, 46 (18.5%) of these selected patients have had surgery on their cervical spine. These findings are consistent with the incidence of surgery in the rheumatoid cervical spine reported in the literature [10, 72]. In this paper, the principles of diagnostics, indications, and surgical techniques will be outlined.

Historical background

Painful instabilities of the atlantoaxial joint and the suboccipital area in the rheumatoid patient (Fig. 1) have been well-known since the last century and were probably first described in 1890 by Garrod [24]. Mixter and Osgood [59] published in 1910 a technique for posterior atlantoaxial fusion with silk, forming a loop between the posterior arch of the atlas and the spinous process of C2, and they referred to an earlier publication by Lane [45]; however, grafting was not mentioned. Hadra [38] used a



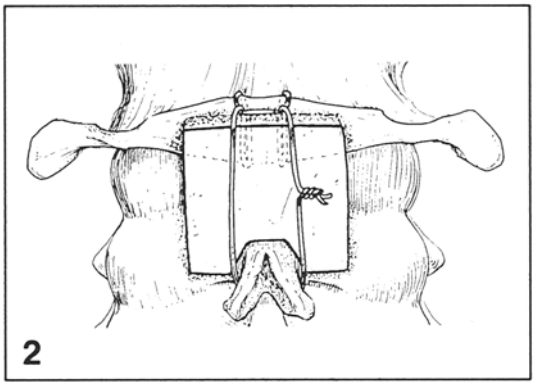


Fig. 1. Signs of rheumatoid in the cervical spine. In the occipitocervical area, there is a marked instability in the flexion view between the dens and the anterior arch of the atlas. There is an upward migration of the dens into the foramen. Spontaneous ankylosis developed between C2 and C3. A staircase phenomenon can be seen between C4 and C7, and additional instability causes pain in the segment C6/7

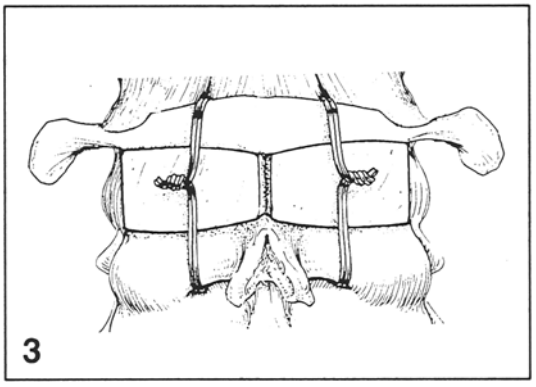


Fig. 2. The Gallie fixation of atlantoaxial instability: a single bone block is fixed by a wire loop between the posterior part of the atlas and the spinous process of the axis

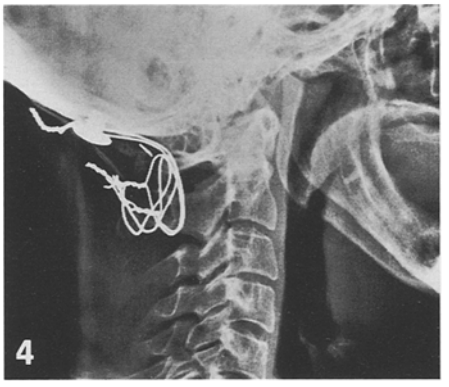


Fig. 3. Posterior atlantoaxial fixation according to Brooks [5]. Two wedge-shaped bone grafts are inserted and fixed by double wire loops bilaterally between the atlas and the axis

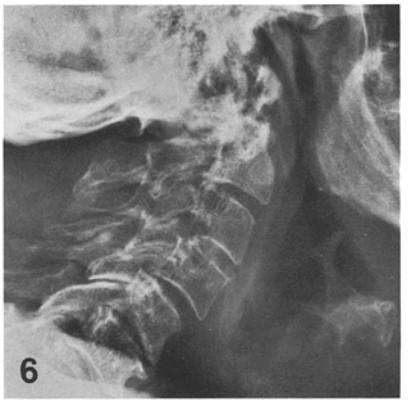


Fig. 4. Occipitocervical fusion in a 52-year-old rheumatoid patient. The atlantoaxial complex is held tight with a wire loop which extends to the occiput. The fixation of the wires is done by occipital screws. For permanent stability, a bone graft has been inserted from the occiput down to C2

Fig. 5. Significant atlantodental instability in the lateral flexion radiograph. The magnetic resonance image shows marked narrowing of the spinal canal with cord compression by retro-postitioning of the dens axis

Fig. 6. Instability of the C1/2 complex due to resorption of the dens axis

wire loop for the same procedure, but in his patients the instabilities were associated with Pott's disease. In 1939, Gallie [23] published his well-known paper and standardized this method for posterior atlantoaxial fusions of different etiologies (Fig. 2). This technique with a median bone graft fixed to the atlas and the axis with wires experienced several modifications over the following years, mainly concerning the wiring technique. Brooks [5] obtained improved stability [31, 83] by using two wedge-shaped bone grafts placed between the arch of the atlas and the lamina of C2 (Fig. 3). However, this increased stability required instrumentation with wire loops in the spinal canal. This disadvantage was recognized by Guyotat et al. [37] and Holness et al. [41] who replaced the wires with posterior clamps, fixing the atlas and the axis only posteriorly.

A direct transarticular fixation of the atlantoaxial joint was first described by Barbour in 1971 [1]. His technique required a bilateral approach to the C1/2 joint from the lateral side. A direct atlantoaxial transarticular screw fixation by a posterior approach was first performed by Magerl in 1979 [28, 29, 49]. As an innovation, this method offers a true three-point fixation of the atlantoaxial segment by adding a posterior bone graft.

Reports about occipitocervical fusion are less frequent (Fig. 4). Foerster [22] described a technique with a fibular strut graft between the occiput and lower cervical spine in a progressive atlantoaxial instability after a fractured dens.

The difficulty of fixing bone and internal fixation on the convexity of the surface of the occiput led to numerous attempts to solve this problem. Wires [2, 81], screws [36, 76], rods [21, 43, 65], bone cement [2, 3, 6, 30] and plates [32, 33, 63] were tried as internal fixation. In retrospect, the tendency of the development of new implants headed towards fixations with increased postoperative stability in spite of the difficulty of poor bone quality in rheumatoid patients.

Patho-anatomic changes of the cervical spine in RA

As a part of the locomotor apparatus, the cervical spine may be affected by RA. The main pathologic changes are ligamentous insufficiency, bone resorption, and destructive articular involvement, thus causing instability of the affected segment. The atlantoaxial segement is the most frequently affected location in RA of the cervical spine. The convexity of the joint surfaces, lacking any intrinsic bony stability, is predetermined to dislocation in cases of insufficiency of the alar and transverse ligaments [15, 16, 19, 60, 61]. The most common direction of dislocation in an anterior slippage of the atlas over the axis. The degree of anterior subluxation is commonly measured in lateral radiographs in flexion. Atlantoaxial instability is defined by an increased distance between the anterior arch of the atlas and the dens (atlantoaxial distance, ADD) which is more than the normal maximum of 3–4 mm. An ADD of more than 10–12 mm implies the complete destruction of the ligamentous control in this segement [19] (Fig. 5). Posterior dislocation occurs in cases with bony destruction of the dens (Fig. 6). Its incidence is reported to be not more than 6.7% [80] of all atlantoaxial subluxations. Atlantoaxial displacement may lead to medullary compression [14, 75, 79], but the radiological degree of subluxation is not necessarily correlated to the neurological symptoms. This may be due to adaptive changes in the slow progression of the subluxation. Also, on plain films, the rheumatoid retrodental soft tissue is not visible.

Due to anterior atlantoaxial subluxation, the diameter of the spinal canal may be significantly more compromised with the head in a flexed position [17]. An important part of the compression may be attributed to retrodental soft tissue [11, 12, 17].

The vertical instability of the upper rheumatoid cervical spine is due to bone resporption of the massae laterales of the atlas, the occipital condyles, and the joint surfaces of C2. In cases of basilar invagination, the occipital condyles and the base of the skull fold upwards, being unable to resist the gravitational forces of the head ("cranial settling"). The dens comes to lie consequential in the foramen magnum, compressing the brainstem intracranially and in the foramen magnum.

The subaxial cervical spine is involved in 10–25% of rheumatoid patients [35, 56, 73]. The segments most often involved are C3/4 and C4/5 [35]. Instability occurs first due to disk failure and anterior slippage of the cranial vertebral body. Bone resorption of the endplates causes further dislocation and kyphotic deformity [52]. Medullary and or radicular compression occur due to kyphotic deformity, vertebral translatory or rotational dislocation, and/or inflammatory tissue in the spinal canal (Fig. 7). Multiple dislocations lead to the pathognomonic "step-ladder" phenomenon.

Diagnostics

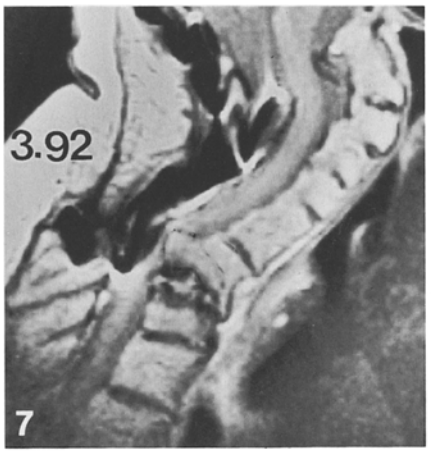
The history of patients with RA and neck pain often reveals audible, painful noises connected with motions of the head, often even audible to persons living with the patient. The pain is usually severe and chronic, difficult to treat with ordinary analgesics; however, pain relief may be achieved with immobilization in a collar. The main localization concerns the neck, craniocervical junction, and head. Pain can be the main symptom without gross instability of the C1/2 segment. Paresthesia, general weakness, reduced gait control, of loss of sphincter function may be signs of myelopathy. Information about neurological symptoms may be reported to be dependent of the head position [53]. One of our patients regularly experienced an electrical pain that ran along the spine into the lower extremities while falling asleep in a sitting position in front of the television, with the head falling forward into flexion. Another patient could reproduce paresthesias in both arms while flexing the cervical spine. In these patients, the increased compression of neural sturctures can be proven in flexion/extension MRI (Fig. 8).

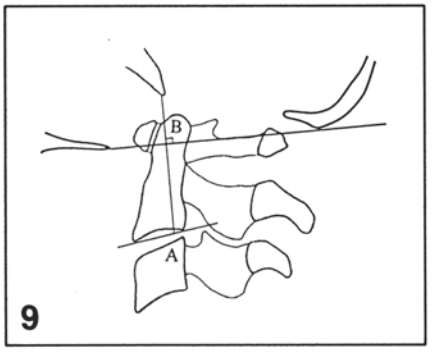
The clinical and manual investigation of a rheumatoid patient with a painful cervical spine often reveals tenderness over the neck and shoulder muscles. In some instances the atlantoaxial instability and joint crepitation may be felt on palpation of the atlantoaxial segment. Lhermitte's sign can sometimes be provoked by flexing the head, which may be associated with a palpable subluxation ("clunk test"). Neck pain is a common symptom; however, even marked instability may exist with minimal pain complaints.

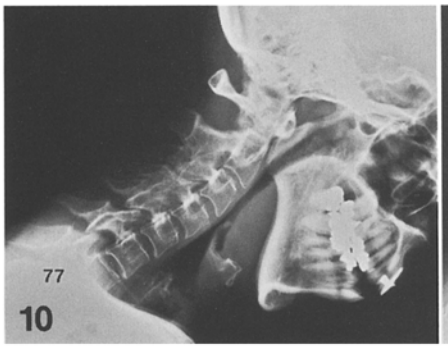
The neurological symptoms do not always correlate with the radiological signs of instability. Myelopathic symptoms with lesions of the anterior and/or posterior long tracts may be found. Dizziness, vertigo or tinnitus are symptoms of peripheral nerve compression, iatrogenic nerve injury, scar formation, and gross deformations of the extremities, which may cause difficulties in making an accurate neurological assessment in severely affected patients who have already undergone surgery on multiple limbs [44]. In these cases, neurophysiological investigations with sensory- and motor-evoked potentials and electromyography may be necessary to clarify, the results of myelopathy or radiculopathy, since these technically assisted investigations are able to identify signs of compression before clincal symptoms appear [17].

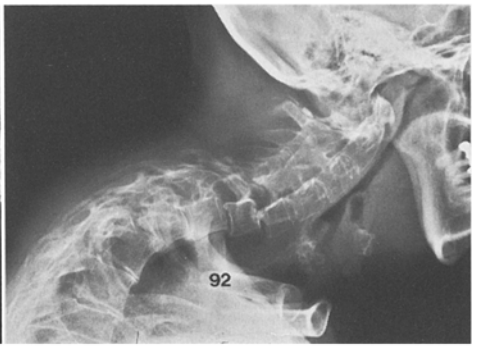
Radiological investigations

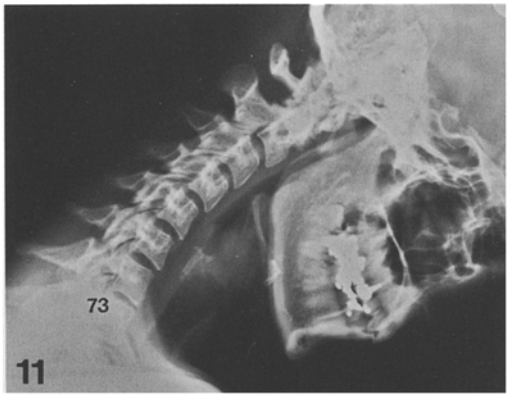
The basis is the conventional AP and lateral X-ray. Bone structure, posture and alignment, calcification, and structure are to be examined. The horizontal atlantoaxial subluxation (>8 mm ADD [44]) and upward migration of the dens can be measured in the lateral view of the craniocervical junction [54, 66]. Among these, the Redlund-Johnell method has proved to be the most accurate one in a recently published comparative study [44] (Fig. 9). The

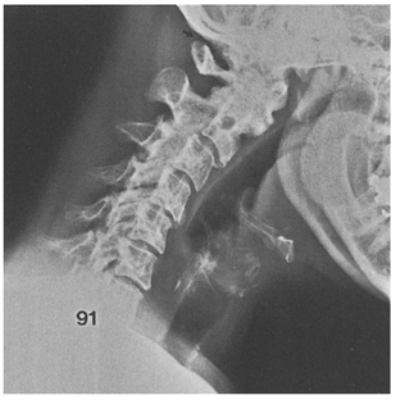


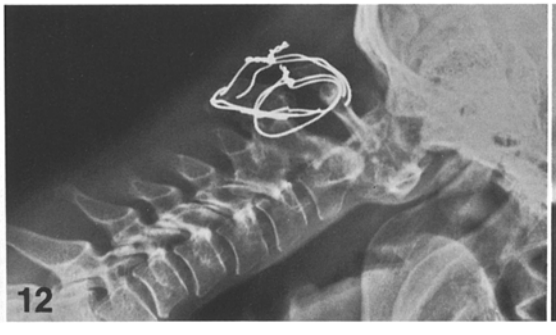












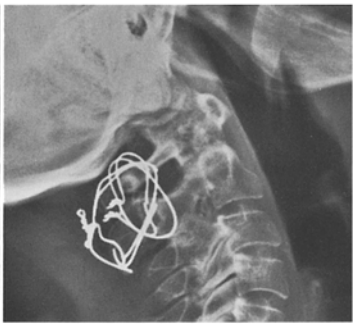


Fig. 7. Narrowing of the spinal canal in the lower cervical spine due to endplate resorption and deformity

Fig. 8. Direct visualization of the narrowing of the spinal canal in flexion/extension views by MRI

Fig. 9. Method to determine the cranial migration of the dens axis according to Redlund-Johnell: *A*, base of the vertebral body C2; *B*, intersection of McGregor line and distance occiput-C2

Fig. 10. Progression of instability in a 51-year-old patient with RA over 15 years

Fig. 11. A 45-year-old patient with RA. There is no progression in the period from 1973 to 1991, although severe and multiple surgical corrections of the extremitis were necessary

Fig. 12. Pseudarthrosis after an attempted fusion with bone graft and wires between C1 and C2. An atlantoaxial instability can be seen in flexion/extension X-rays

transoral view to visualize the atlantoaxial joints is often impossible due to the inability to position the patient correctly. One has to be aware in measuring the ADD on lateral radiographs that no details about the effective compression of the cord are known, as the soft tissues are invisible by this technique.

Functional radiographs in flexion and extension not only allow detection of instabilities in the atlantoaxial segment and the subaxial cervical spine but also provide information about the reducibility of the subluxation.

Computed tomography, magnetic resonance imaging

These imaging modalities have become indispensable in the surgical evaluation process. They are able to locate

bony (CT>MRI) or soft-tissue (MRI>CT) compression or obstruction accurately and allow a precise operative planning of the decompression. MRI in flexion and extension (Fig. 8) identifies by direct visualization the extent of compression of the retrodental infectious tissue in both positions and can provide information concerning the indication for the need of anterior decompression [12, 17]. According to Dvorak et al. [17], a significant difference in the diameter of the spinal canal in the two positions may be detected. A cord diameter of less than 6 mm in a flexed position is an indication to avoid myelopathy. Myelography as an invasive method had been replaced by MRI.

Natural history

In spite of the vast literature on this subject, the natural history of instabilities and deformities of the cervical spine in RA is still poorly understood.

Progression of atlanto-axial instability is not proven in the individual case

Pellici et al. [62] reported an incidence of approximately 40% of progression of atlantoaxial subluxations. In 82 patients with a mean follow-up period of 8.2 years (range 2–22 years), no predictive factors for progression of the instability based on radiologic investigations could be determined (Figs. 10, 11). According to the literature, men are more susceptible to progressive changes. In our series, 69% of men (contrasted to 60% of women) showed progression or new evidence of atlantoaxial or subaxial instability in their control radiographs of the cervical spine. There is no improvement of the instability, but an atlantoaxial subluxation may be reduced and fixed by a blocked dens in the foramen magnum in cases of advanced vertical instability [35].

Medullary compression with neurological deficit in connection with atlantoaxial instability is postulated by several authors [14, 57, 75, 77, 79]. Histologically verified signs of medullary compression are described in several autopsy reports [13, 39, 52, 57, 82]. So-called sudden death in RA, found in 10% of patients with RA and cervical spine involvement [57], is attributed to medullary compression in the atlantoaxial segment. Once myelopathy is manifest, conservative treatment is unable to prevent death [50, 55]; however, the mortality is due not only to the cervical pathology, but to the rapid decrease in the general condition of these severely handicapped patients as well [74]. Marks and Share [50] found a mortality rate of 50% in cases of established cervical myelopathy due to rheumatoid instability if they were not fused. In a series of Pellici et al. [62] in 1981, a 10% higher mortality rate was found in rheumatoid patients than in normal controls. Overall, patients with RA and involvement of the cervical spine are at risk for premature death [62, 74]. Progression of deformities in the subaxial spine is imminent in all affected segments without spontaneous ankylosis. Neurological involvement is more frequent in the subaxial cervical spine (69.8%) (own unpublished data).

Indications for surgery

Despite the knowledge of medullary traumatisation in advanced instability of the atlantoaxial [14, 17, 75], several authors hesitate with an indication for fusion in these patients, even for those with chronic instability [9, 64, 70]. The reasoning is a high mortality rate of up to 42% and rates of pseudarthrosis up to 50% [18, 25, 55, 84] (Fig. 12). Yet an alternative to surgical treatment of cervical instability does not exist. External fixation and immobilization with a collar or more rigid halo vest serves for comfort and eventual pain relief, but not to prevent further dislocation and risk of neurological deterioration.

Most authors accept intractable neck pain as an indication for fusion. In addition, a neurological deficit is rarely controversial [9, 47, 64, 71, 74].

Painless isolated atlantoaxial instability is considered as common, without indication for surgery by some authors [42, 48, 62]. This, however, does not take into consideration that repeat traumatisation of the medulla by the instability may cause permanent damage, and that an unstable atlantoaxial segment represents a potential risk for severe cord lesion with minor trauma. We advocate for these symptomless patients a careful clinical evaluation including neurophysiological evaluation with EMG, motor- and sensory-evoked potentials. In the absence of pathological findings, an anticipatory attitude seems to be justified. Regular annual check-ups are necessary so as to intervene rapidly in case of radiological progression or clinical deterioration.

Radiologically verified progression of atlantoaxial subluxation without neurological deficit represents, according to our concept, an indication for fusion. Since surgical results are better when done before myelopathy occurs [8], there seems no justification in waiting for deterioration. In addition, the clinical outcome and pain reduction are better if fusion is performed earlier. In a series of 70 patients with RA and atlantoaxial instability, the outcome after fusion was directly correlated with the stage of the disease in which surgery took place [26]. Brattström et al. [4] adds the fact that rheumatoid patients in advanced stages may be incapable of wearing an external support to stabilize the cervical spine to the list of indications for fusion [17]:

Atlantoaxial segment

1. Clinically relevant cervical myelopahty
2. Pathologic neurophysiologic changes (motor evoked potentials and sensory evoked potentials)
3. Spinal cord < 6 mm in flexion (MRI)
4. Spinal canal < 10 mm in flexion (X-rays)
5. Retrodental pannus > 10 mm (MRI)
6. Increasing ADD or cranial settling
7. Intractable neck pain
8. Incapacity of wearing an external support
9. Instability due to decompressive laminectomy

Inclusion of the occiput

1. Vertical instability (cranial settling)
2. Pahological changes of the atlanto occipital joints (radiographs, CT, MRI)

3. Instability of the ring of the atlas in RA (transoral decompression, decompressive procedures)

Lower cervical spine

1. Cervical myelopathy (neurophysiologic tests) or radiculopathy
2. Progression of deformity or subluxation
3. Narrowing of the spinal canal with thecal compression (disk, infectious tissue)
4. Severe pain
5. Incapacity of wearing an external support
6. Destabilizing bone resorption
7. Decompressive laminectomy

Indication for decompression

Decompression is done where compression is persistent in spite of attempted reduction (extension films, halo) or where the reduced position cannot be maintained by internal fixation and fusion. In most cases, the thecal compression is found anteriorly due to dural impression of the dens and/or retrodental pannus or kyphotic deformity of the subaxial cervical spine. This requires a transoral approach for the craniocervical junction [11, 12] or an anterior diskectomy or vertebrectomy [35] in the lower cervical spine. Only in rare cases of severe subluxation is a posterior laminectomy indicated for decompression of the thecal sac.

Surgical treatment

Rationale for surgery

To justify surgical intervention of the cervical spine in patients with RA, the following aims should be achieved:

1. Relief of pain
2. Reduction of disloaction, maintenance of anatomical position
3. Decompression of neurological tissue
4. No neurological deterioration
5. Adequate postoperative management
6. Low mortality/complication rate
7. Reasonable amount of surgery

Anesthesia

The cervical spine in RA deserves special attention by the anesthetist. Generally, these patients are severly affected by the disease and in poor general health. Nasal and fiberoptic intubation techniques prevent unnecessary manipulation of the unstable neck [11]. For procedures with potential soft-tissue swelling and airway obstruction, special postoperative care is needed. Prolonged intubation may be preferable for anterior procedures of the lower cervical spine; it is mandatory for transoral decompression for a duration of at least 24 h [12]. Tracheostomy as an additional source of possible complications, however, is seldom necessary. Positioning of the patient should be performed carefully in order not to produce iatrogenic neural damage. Pressure sores and skin defects are easily produced in these patients with corticosteroid therapy.

Atlantoaxial fusion

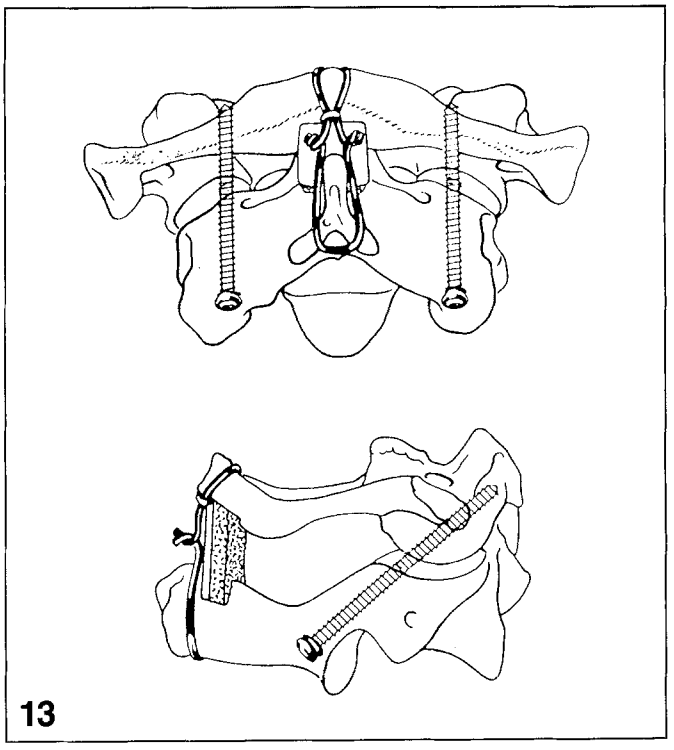
The classic technique for posterior atlantoaxial fusion includes the Gallie-type procedures [23]. Several modifications have been published [18, 20, 46]. The groundwork for this fusion procedure consists of an autologous bone graft fixed with a wire loop to the posterior part of the atlas and the spinous process of the axis (Fig. 13). The advantage lies in the simplicity of the surgery. Its disadvantages result from the inferior stability and the lack of possibility to resist translational displacement in cases of atlantoaxial subluxation [31]. Improved rotational stability is provided by the Brooks procedure [5] in which two paramedian autologous bone grafts are placed posteriorly between the atlas and the laminae of the axis. This method, however, is not recommended by the authors in subluxation of rheumatoid etiology [5], mainly because of the weak bone structures of the atlas as well as the need for intraspinal instrumentation with the wire loops.

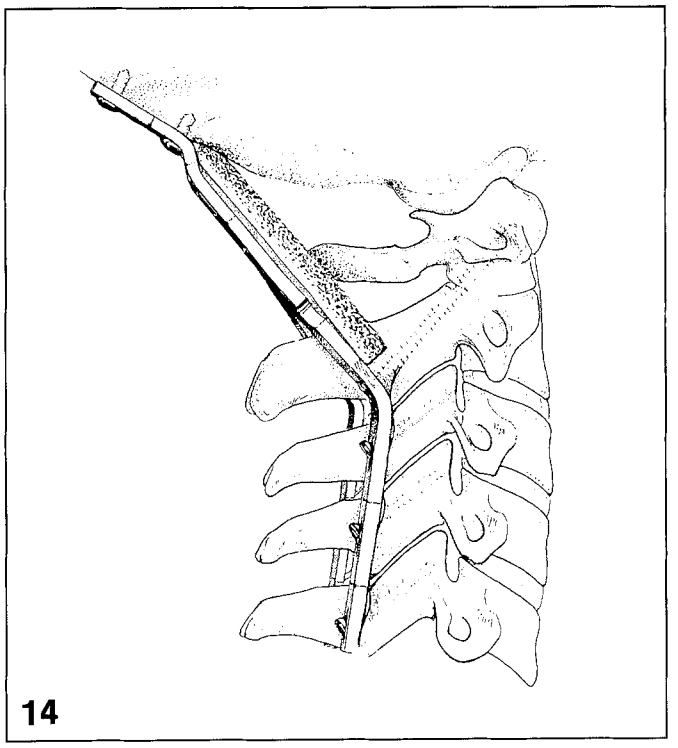
Several clamps and hooks have been designed for posterior internal fixation of the atlantoaxial segment [37, 41, 58, 67].

Our method for atlantoaxial fusion consists of a transarticular screw fixation [49]. In vitro stability test and clinical follow-up studies combined with extensive clinical experience [26, 34] showed that this technique is suitable for C1/2 fusion in RA. Contrary to the conventional wiring techniques, an immediate postoperative multidirectional stability is achieved [31]. In addition this method has proved to be excellent in permanently reducing the atlantoaxial dislocation and maintaining the reduction. There is no need for hardware or manipulation in the spinal canal, and the postoperative management is restricted to a soft collar for 6 weeks.

Operative technique. The patient is positioned prone. The head is held in a Mayfield-type fixation on the operating table in a flexed position in order allow correct placement of the transarticular screws. Through a midline approach, the posterior part of the atlas and the laminae of C2 are exposed. An important landmark is the medial border of the isthmus of the axis, which is exposed subperiostally and visualized by retraction of the interspersed soft tissue containing the greater occipital nerve (in the same way, the C1/2 joint may be directly visualized for checking the screw penetration through the joint). The drilling is performed under lateral image intensifier control. The screws are inserted according to the following rules:

1. Strictly sagittal drilling. Lateral deviation risks injury to the vertebral artery.
2. Drilling immediately lateral of the medial border of the isthmus of the axis avoids penetration into the spinal canal.
3. The inclination is controlled by radiographic control of the C-arm. The tip of the drill has to aim at the upper half of the projection of the anterior ring of the atlas.





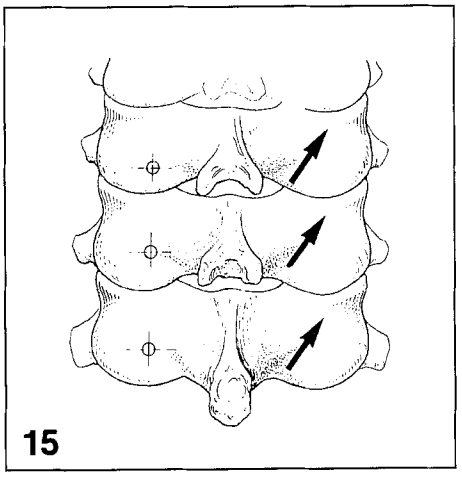


Fig. 13. The principle of atlantoaxial screw fixation: two parallel inserted screws block the C1/2 facets bilaterally. A thrid point of fixation is provided by a posterior bone graft between the posterior arch of the atlas and the spinous process of C2

Fig. 14. Lateral view of the Y-plate in place: it is firmly fixed to the occiput in the midline. The atlantoaxial segment is immobilized by the transarticular screw fixation. The lower cervical spine is incorporated in the fusion by the lateral mass screws. At this construct, flexion/extension and rotation are firmly blocked

Fig. 15. Technical detail of insertion of the screws in the lower cervical spine. The drilling is done parallel to the facet joints by merging from the midline of 30°. This technique allows a save procedure without risk of damaging the vertebral artery or nerves

The procedure is closed with the positioning of the autologous bone graft between atlas and axis (Fig. 13). In cases of a bifid ring of the atlas or absent posterior elements, the bone graft may be packed directly into the atlantoaxial joint.

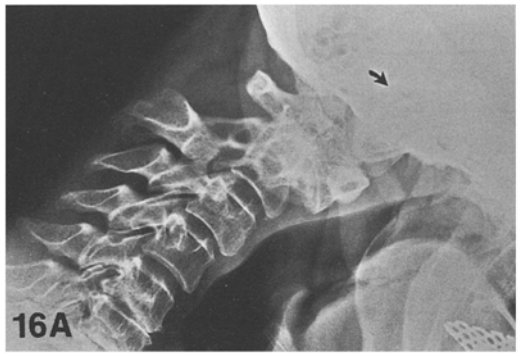
Occipitocervical fusion

To avoid cumbersome postoperative external fixation, solid internal fixation is required for occipitocervical fusions. Several devices are described in the literature: wires [55, 81] or screws [7] to fix the bone graft, wires reinforced by bone cement [4, 36], metal mesh with or without cement [48], contoured rods [65], and plates [63, 69].

The newly designed Y-plate [32] (Figs. 14, 15) combined with a transarticular atlantoaxial screw fixation seems to be an ideal implant for firm occipitocervical fixation. The firm screw fixation in the midline of the occiput in combination with the screw fixation of the atlantoaxial joints provides a reliable stability. Additional bone grafting underneath the plate provides flexion/extension stability, the rotation being blocked by the transarticular screws. This Y-plate is available in two sizes: a short for C0–2 fusion and for fusions that have to be extended in the lower cervical spine, and a long version that may be cut to the appropriate length. Thus, a "custom-made" spondylodesis for each case can be offered. As the plate is made out of titanium, postoperative imaging with MRI is possible (Figs. 16, 17).

Transoral decompression

Additional transoral decompression is indicated in cases with thecal compression of the dens or retrodental tissue which is irreducible in extension. As the compression site lies anteriorly, posterior widening of the foramen or laminectomy is rarely indicated [12] (Fig. 18). The transoral approach takes advantage of the local anatomy: the soft tissue in the retropharynx consists only of the mucosa



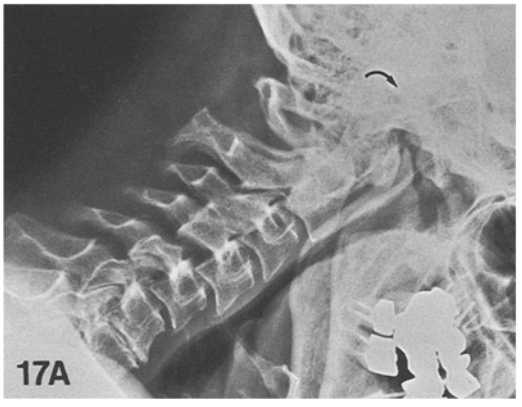


Fig. 16. A Marked atlantoaxial instability in the flexion X-ray in a 63-year-old rheumatoid patient. There is a ankylosis between C2 and C3. **B** One year after fusion, a solid fixation can be seen on flexion/extension X-rays. The fusion has been performed by the Y-plate from the occiput to C3, while the atlas is fixed in a reduced position by the transarticular screw fixation

Fig. 17. A Instability of the atlantoaxial segment in a 54-year-old rheumatoid patient. There is additional instability in the segment C4/5 and spontaneous fusion between C3 and C4. Additional instability is seen in the lower cervical spine C5/6 and spondylarthrosis and disk resorption at C6/7. **B** The fusion has been performed from the occiput down to the lower cervical spine, bridging all the instabilites seen in the flexion X-rays preoperatively

Fig. 18. Significant formation of retrodental soft tissue compressing the cord and causing severe myelopahty. Only an anterior transoral decompression may relieve the compression

and the thin longus colli muscle, inserting on the anterior tubercle of the atlas. With the use of a microscope for magnification and illumination, the resection of the dens and the retrodental soft tissue can be performed without great difficulty. This anterior decompression, however, may increase postoperative mortality [34].

Results

The main goal, to reduce pain by surgery, was achieved in a series of 32 RA patients operated on with posterior transarticular screw fixation. The pain score (0–10) was significantly reduced [78]. Secondary dislocations after posterior atlantoaxial fusion are described in the literature but were not observed in our series, and the correction of atlantoaxial subluxation was more effective with screw fixation (62%) than with the wiring technique (44%) [26].

In the literature about the wiring techniques, a rate of pseudarthrosis of 10% [40] for atlantoaxial fusion is reported, and up to 23% [68] in occipitocervical fusions. A follow-up study of 161 cases [34] showed a low rate of pseudarthrosis (0.6%) and an overall complication rate of only 5.9%. Occipitocervical fusion with the Y-plate had been performed in 23 rheumatoid patients. All patients achieved fusion, and there were no failures of the implant. No injury to the spinal cord or the vertebral artery was noticed. Neurological recovery was evident in 76% of the patients with initial deficits.

As major complications we noted five postoperative deaths, most of which were unrelated to the surgical pro-

cedure, (pneumonia, cardiac arrest, renal failure, etc.) with the remainder occurring mostly after anterior procedures [34, 35]. Frequent complications and postoperative deaths are also described in the literature [8, 9, 55]. The conclusion of these authors emphasizes that early diagnosis and intervention facilitate the surgical procedure in less severe deformities.

The subaxial cervical spine

The lower cervical spine in RA is involved in approximately 25% of patients. Dislocation and medullary or nerve root compression require reduction, stabilization, and decompression. Preoperative halo traction for better alignment may also be desirable [8, 9]; however, prolonged immobilization is poorly tolerated by these patients. We reserve this procedure for severe deformities with risk of neurological deterioration during the reduction intraoperatively.

Satisfactory results are described in the literature by different wiring techniques for posterior fusion. In our experience, the plate and screw fixation technique proved to be reliable for posterior fixation. The screws are inserted as lateral mass screws [32], thereby not penetrating the thin pedicles of the cervical vertebrae. The extension of fusion has to be restricted to the pathologically involved segments, but long-term follow-ups are needed to detect decompensation adjacent to fused segments [48].

With kyphotic deformity, medullary compression occurs anteriorly in most cases. Anterior decompression by vertebrectomy is therefore adequate treatment. The neurological recovery after a decompressive procedure even in cases in which substantial initial neurological deficits exist may be significant [35]. Due to weak bone structure, an isolated anterior procedure with graft insertion is not recommended. However, satisfactory results may be achieved in simultaneous anterior decompression and posterior fixation [35].

Discussion

The goal of surgery of the cervical spine in RA is to relieve pain, reduce deformity, and prevent progression. In the atlantoaxial joint, the transarticular screw fixation has proved to be a reliable method. There is no instrumentation in the spinal canal, and it is a segment-saving technique, in that it provides firm fixation and is able to maintain reduction of C1/2 dislocations. In cases in which occipitocervical fusion is necessary, the Y-plate in combination with transarticular screws offer an immediate postoperative stability. It is therefore no longer necessary to force the generally otherwise impaired patient into cumbersome halo or cast fixation – a soft collar is sufficient for postoperative treatment in all the described procedures. It is advisable to perform surgery at an early stage – less deformity requires a less extensive surgical procedure. In cases with neurological deficit, recovery is likely to occur, as advanced damage to the neurologic structures decreases the possibility for good results.

Comparing recently published results on surgical interventions in the cervical spine of rheumatoid patients with previous data, satisfactory outcomes are more frequently reported, the mortality rate is decreasing [8, 9, 18] and fewer complications are reported due to improved techniques [34, 35]. This should encourage the surgeons dealing with the complexity of the cervical spine in RA to widen the indications for stabilization at an early stage of the disease.

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