Timing of cervical spine stabilisation and outcome in patients with rheumatoid arthritis

M. Schmitt-Sody · C. Kirchhoff · S. Buhmann ·
P. Metz · C. Birkenmaier · H. Troullier ·
V. Jansson · A. Veihelmann

Received: 24 October 2006 / Revised: 8 December 2006 / Accepted: 14 January 2007 / Published online: 20 March 2007
© Springer-Verlag 2007

Abstract One complication of rheumatoid arthritis (RA) is the involvement of the cervical spine (CS). Although prophylactic stabilisation is recommended, the timing at which this should occur is poorly defined. The aim of our study was to evaluate the course of neurological symptoms in terms of the timing of surgery. A total of 34 patients with RA and CS involvement were surgically stabilised. These patients were classified using the Ranawat (RW) score both preoperatively and at an average of 54 months post-operatively. For each patient, the presence of atlantoaxial and subaxial subluxation as well as vertical migration of the odontoid was recorded. The anterior atlantodental interval was also assessed pre- and post-operatively. Improvement was obtained in 20 patients, the clinical situation remained unchanged in three patients and three patients manifested

disease progression. In terms of the RW score, the 16 patients with pre-operative RW grades I–II showed no deterioration at the post-operative follow-up, with 13 of these patients showing an improvement; the 12 patients with pre-operative RW grades IIIA–IIIB did not show any improvement of neurological symptoms at follow-up, although seven of these patients subjectively assessed the symptoms to be less severe after surgery; three other patients showed a worsening of symptoms. Our results suggest that preventive stabilisation of CS in RA leads to acceptable results, although the complications of the surgery are obvious. However, early operative treatment may delay the detrimental course of cervical myelopathy in RA.

Résumé la colonne cervicale (CS) des patients présentant une arthrite rhumatoïde (RA) peut être instable. Le but de cette étude est d'évaluer l'évolution neurologique des signes cliniques en concordance avec la chirurgie. 34 patients présentant une arthrite rhumatoïde ont été stabilisés chirurgicalement. Les patients ont été classés suivant le score de Ranawat (RW) pré et postopératoire. Pour chaque patient, l'existence d'une sub luxation atlanto axoïdienne ou d'une migration de l'odontoïde ont été analysées de même que l'espace antérieur C1, C2 en pré et postopératoire. une amélioration est obtenue chez 20 patients, 3 patients ont présenté une situation stationnaire et 3 patients une aggravation malgré la chirurgie. Le score de Ranawat (I et II) ne s'est pas détérioré chez 16 patients, 13 patients ont été améliorés. Pour 12 patients avec un score de Ranawat (IIIA et IIIB) ceux-ci n'ont pas présenté d'amélioration des signes neurologiques, cependant, la symptomatologie subjective était moins importante chez 7 d'entre-eux. Une aggravation des symptômes est apparue chez 3 patients. notre étude nous permet de penser que la stabilisation préventive de la colonne cervicale dans l'arthrite rhumatoïde permet d'avoir

M. Schmitt-Sody (✉) · C. Birkenmaier · H. Troullier ·
V. Jansson · A. Veihelmann
Department of Orthopaedic Surgery, Campus Grosshadern,
Ludwig-Maximilians-University Munich,
Marchioninistrasse 15,
81377 Munich, Germany
e-mail: mschmitt@med.uni-muenchen.de

C. Kirchhoff
Department of Traumatology, Campus Innenstadt,
Ludwig-Maximilians-University Munich,
Munich, Germany

S. Buhmann
Institute of Clinical Radiology, Campus Grosshadern,
Ludwig-Maximilians-University Munich,
Munich, Germany

P. Metz
Institute for Surgical Research, Campus Grosshadern,
Ludwig-Maximilians-University Munich,
Munich, Germany

Table 1 Epidemiological data^a of the enrolled patients (*n*=28), according to pre-operative Ranawat score

Patient no.	Age (years)	Fusion level	Surgical technique	Laminectomy	Ranawat classification (grades)	
					Pre-operative	Post-operative
1	73	C1–C2	Wiring technique according to Gallie	–	I	I
2	50	C1–C2	Wiring technique according to Gallie	–	I	I
3	59	C1–C2	Wiring technique according to Gallie	–	I	I
4	70	C1–C2	Wiring technique according to Gallie	–	I	I
5	52	C1–C2	Hartshill rectangle	–	I	I
6	75	C0–C3	Luque triangle	+	I	I
7	73	C0–C2	Ransford loop	+	I	I
8	75	C1–C2	Wiring technique according to Gallie	–	II	I
9	67	C1–C2	Wiring technique according to Gallie	–	II	I
10	51	C1–C2	Wiring technique according to Gallie	–	II	I
11	53	C0–C3	Luque rectangle	+	II	I
12	66	C0–C3	Luque rectangle	+	II	I
13	70	C0–C3	Luque triangle	+	II	II
14	64	C0–C4	Luque rectangle	+	II	II
15	58	C0–C3	Luque triangle	+	II	II
16	61	C0–C2	Ransford loop	+	II	I
17	60	C3–C4	Morscher plate ventral	+	II	I
			Hartshill rectangle dorsal			
18	68	C1–C2	Wiring technique according to Gallie	–	IIIA	IIIB
19	33	C1–C2	Wiring technique according to Gallie	–	IIIA	IIIA
20	49	C1–C2	Hartshill rectangle	–	IIIA	IIIA
21	70	C0–C3	Luque triangle	+	IIIA	IIIA
22	61	C0–C4	Luque rectangle	+	IIIA	IIIB
23	79	C2–C4	Orosoko plate ventral	+	IIIA	II
		C0–Th1	Luque triangle dorsal			
24	70	C0–Th3	Zervifix dorsal	+	IIIA	IIIA
25	58	C2–Th4	Zervifix dorsal	+	IIIA	IIIA
		C4–Th1	Morscher plate ventral			
26	76	C2–C4	Orosoko plate ventral	+	IIIA	IIIA
		C0–Th1	Luque triangle dorsal			
27	56	C1–C2	Wiring technique according to Gallie	–	IIIB	IIIB
28	78	C0–C4	Luque rectangle	+	IIIB	IIIB

^a Data are given on age in years, fusion level, surgical technique as well as pre-operative and follow-up Ranawat score.

des résultats tout à fait acceptables. Cependant, quelques complications peuvent être observées, le traitement précoce permet de retarder la survenue d'une myélopathie cervicale.

Introduction

In patients with rheumatoid arthritis (RA) the involvement of the cervical spine is a common complication that often results in anatomical deformities, particularly those of the upper cervical spine [7]. This phenomenon has been described in various studies carried out during the last century [2, 6]. Clinical as well as radiological signs of rheumatoid changes of the cervical spine are present in up to 86% of all RA patients [11, 15]. The most common type of anatomical cervical spine deformity is anterior atlanto-axial subluxation (AAS), followed by subaxial and vertical

subluxation [8]. These forms of subluxation are most frequently found in patients who have had the disease 10 years or longer [14] and who have often remained asymptomatic over an extended period of time. The most common symptom in patients with RA involvement of the cervical spine is neck pain; however, they run the risk – and thus the potential – of serious complications, such as neurological deficits, myelopathy, tetraparesis and even sudden death [16]. Serious progression of the disease is a well-known development when the rheumatoid cervical spine deformity is left untreated. In this context, long-term follow-up studies have revealed radiological signs of worsening of the cervical spine deformities in up to 40% of the patients [17]. In those patients suffering from RA with medication, refractory neck pain, neurological deficits and myelopathy, surgical decompression and stabilisation constitute the most common therapeutic regimen [10].

Table 2 Ranawat (RW) score^a: pre-operative and at follow-up

Pre-operative RW score	Post-operative (follow-up) RW score				Improvement
	I	II	IIIA	IIIB	
I (<i>n</i> =7)	7 (100%)				
II (<i>n</i> =10)	7 (70%)	3 (30%)			7 (70%)
IIIA (<i>n</i> =9)		1 (11%)	6 (67%)	2 (22%)	1 (11%)
IIIB (<i>n</i> =2)				2 (100%)	0

^a I, No neurological symptoms; II, paresthesia, weakness subjectively, hyperreflexia; IIIA, sensomotoric deficit, myelopathy; IIIB, tetraparesis.

However, to date, there is very little information available in the literature on the ideal time for surgical intervention aimed at treating stabilising or delaying the onset of neurological deficits [9]. Divergent opinions also exist on the appropriate time for stabilisation, probably due to the unpredictability of the progression of the disease, as manifested by radiological signs, as well as the poor correlation between increasing spinal deformity and the development of neurological deficits. A further complicating factor is that the neurological evaluation of patients with severe RA is difficult because of the presence of the arthritic deformity and loss of muscle strength due to diffuse atrophy and neuropathy.

The aim of this study was, therefore, to evaluate the outcome of patients with RA following cervical spine stabilisation. We also compared the pre-operative symptoms of RA patients presenting either with or without neurological deficits with their post-operative pathology.

Patients and methods

Between 1900 and 2002 all patients suffering from RA and treated surgically for cervical spine disorders were enrolled in this study. The criteria for RA as set down by the American Rheumatoid Association (ARA) were met by all of the surgically treated patients [1]. The severity of disease from the clinical point of view as well as the neurological symptoms were assessed by an independent neurologist using the Ranawat (RW) score. The pre-operative RW scores for these patients ranged from grade I to IIIB [13];

based on their pre-operative neurological state, these patients were then classified into four subgroups, namely RW I, RW II, RW IIIA and RW IIIB. At a mean follow-up period of 54 ± 26 months, the same neurologist re-evaluated the patients, again using the RW score. The patients were also asked to complete a standard questionnaire during the follow-up, the aim of which was to assess their subjective satisfaction following the surgical procedure.

Plain radiographs as well as computed tomography (CT) images of the cervical spine were read and evaluated by a radiologist, both pre-and post-operatively, in terms of pre-operative pathologies and post-operative results. The presence of AAS and/or subaxial subluxation (SAS) as well as vertical migration of the odontoid (VMO) was recorded and quantified. In addition, the anterior atlanto-dental interval (AADI) was assessed both pre-and postoperatively.

Results

Of the 34 patients suffering from RA who were surgically treated for cervical spine disorder in this study, three died before the follow-up examination due to pre-existing cardio-vascular disease, one died of pneumonia and two died of unknown causes. All six of these patients died following their post-operative release from hospital. Thus, a total of 28 patients (five men and 23 women) were enrolled in this study. The mean age of the patients at the time of surgery was 62 ± 10 years (men: 62 ± 8 years; women: 63 ± 13 years). At the time of the pre-

Table 3 Improvement at follow-up as assessed subjectively (by means of a questionnaire) by each patient

Pre-operative RW score ^a	Subjective assessment of post-operative results			
	Worse	Fair	Good	Excellent
I (<i>n</i> =7)		1 (14%)	3 (43%)	3 (43%)
II (<i>n</i> =10)	1 (10%)	3 (30%)	5 (50%)	1 (10%)
IIIA (<i>n</i> =9)	2 (22%)	3 (30%)	4 (44%)	
IIIB (<i>n</i> =2)		2 (100%)		

^a I, No neurological symptoms; II, paresthesia, weakness subjectively, hyperreflexia; IIIA, sensomotoric deficit, myelopathy; IIIB, tetraparesis

Table 4 Radiological data on clinical features of the enrolled patients

Patient	Fusion level	AAS ^a	AADI (mm) ^b		VMO ^a	SAS ^a
			Pre-operative	Post-operative		
1	C1–C2	+	5	2	–	–
2	C1–C2	+	7	3	–	–
3	C1–C2	+	5	5	–	–
4	C1–C2	+	8	4	–	+
5	C1–C2	+	5	4	+	–
6	C0–C3	+	4	4	+	+
7	C0–C2	+	8	4	+	–
8	C1–C2	+	7	3	–	–
9	C1–C2	+	5	5	–	–
10	C1–C2	+	5	4	–	–
11	C0–C3	+	6	5	+	–
12	C0–C3	+	6	2	+	+
13	C0–C3	+	8	7	+	–
14	C0–C4	+	4	3	+	+
15	C0–C3	+	5	4	–	+
16	C0–C2	+	5	4	–	–
17	C3–C4	–	3	4	–	+
18	C1–C2	+	4	5	–	–
19	C1–C2	+	7	3	–	–
20	C1–C2	+	4	5	–	–
21	C0–C3	+	4	3	–	+
22	C0–C4	+	6	4	+	+
23	C2–C4, C0–Th1	+	5	5	–	+
24	C0–Th3	+	7	2	+	+
25	C2–Th4, C4–Th1	–	4	3	–	+
26	C2–C4, C0–Th1	+	5	3	+	+
27	C1–C2	+	5	5	–	–
28	C0–C4	+	8	5	–	+

^a AAS, Atlantoaxial subluxation; VMO, vertical migration of the odontoid; SAS, subaxial subluxation: +, present; –, not present

^b The pre- and post-operatively evaluated anterior atlantodental interval (AADI) in millimeters

operative evaluation, the mean duration of disease was 19 ± 12 years (men: 15 ± 10 years; women: 23 ± 14 years). All patients underwent a posterior stabilisation; in four patients an additional ventral fusion was performed. A fixation combined with bone grafting was performed in all patients; to this end, a corticocancellous bone graft was harvested from the iliac crest. All patients receiving occipitocervical fusion presented irreducible atlantoaxial dislocation and, therefore, fusion was always combined with laminectomy of the C1 to decompress the spinal cord. Irreducible atlantoaxial dislocation was defined when the dislocation was not reduced on a radiograph showing the full extension position of the cervical spine, and when it could not be reduced by skull traction performed before surgery. (for more detail see Table 1).

None of the patients with a pre-operative RW grade of I ($n=7$) showed an increased RW grade at follow-up; in addition, the minimum subjective assessment of the post-operative results was 'fair'. (for details see Table 2). The ten patients with a pre-operative RW grade of II, manifest-

ing symptoms such as paresthesia, subjective weakness or hyperreflexia, also showed no deterioration in terms of the post-operative RW score and, in fact, 70% of these patients were upgraded to RW grade I. In the subjective post-operative assessment, only one of these patients complained of worsening neck pain in comparison to his preoperative symptoms, whereas the other nine patients (90%) assessed the results of the surgery to be fair to excellent (see Table 2). Of the nine patients given a pre-operative RW grade of IIIA, only one patient presented with an improved RW score (to grade II) post-operatively, whereas the status of six patients did not change and two patients showed worsened neurological symptoms, with a downgrading to RW grade IIIB at the time of follow-up. However, seven of these patients expressed satisfaction with the results of the surgery on the subjective assessment. Patients with an pre-operative RW grade of IIIB ($n=2$) showed no improvement with respect to the RW score, but they did assess the results from the surgery as being fair on the questionnaire (see Table 3).

Of the patients with a pre-operative RW grade of I and II, 70% showed an overall improvement of the initial symptoms at the follow-up. In contrast, only 11 and 0% of patients with a pre-operative RW grade of IIIA and IIIB, respectively showed an improvement (see Table 2).

In terms of the radiological evaluation, the isolated presence of AAS was observed in 11 patients, whereas isolated SAS was present in two patients. In all cases, deformity resulted from progressive destructive changes. No patient reported a history of prior trauma. A combination of AAS and SAS was present in five patients, although only three conditions were considered to be the source of symptoms. AAS in combination with VMO was found in four patients, and a combination of AAS, SAS and VMO was found in six patients. The mean pre-operative anterior atlantodental interval (AADI) was 5.5 ± 1.5 mm, and the mean post-operative interval was 3.9 ± 1.2 mm (see Table 4). However, no significant changes relating to these radiological parameters were found, and there was no positive correlation between the radiological and neurological symptoms.

The following complications appeared post-operatively: two patients showed pseudarthrosis, which was initially not evident clinically. In addition, two patients had to undergo a revision due to dislocated cerclagewires and broken screws, most likely related to osteoporosis. In another two patients, instability was present in the spinal segments below the stabilisation area (1: C4–5; 1: C6–7).

Discussion

In patients suffering from RA, involvement of the cervical spine is a common problem that necessitates the involvement of both the rheumatologist as well as the orthopaedic surgeon for a sound therapeutic regimen.

However, a certain degree of controversy exists regarding the appropriate treatment in patients with radiologically confirmed cervical spine instability but an absence of neurological symptoms. Standardised criteria for surgical treatment are difficult to find, and although such criteria as radiological signs of vertical and horizontal instability of the suboccipital area are used, a variety of symptoms exist. An increase in cervical instability does not necessarily correspond with the appearance or presence of neurological symptoms. Pain and signs of myelopathy on a magnetic resonance image (MRI) are the most frequent and obvious features, however these are not consistently encountered. In many cases, surgical treatment is performed only at a later stage of disease, once neurological deficits are apparent; the reasoning for this is most likely due to the difficulty of the surgical procedure as well as the risk of pre- and post-operative complications. In addition, the poor correlation

between radiological signs of cervical instability and neurological deficits leads to poor results, with one exception: the upward migration of the dens [2, 17]. Moreover, the progression of the symptoms, as defined by radiological/radiographic evidence, was observed in a mean of 45% (35–80%) of patients presenting with neck pain. However, very little is known about the progress of patients presenting without any significant symptoms [3]. Neurological symptoms have been estimated to progress in only 15–36% of all patients. For these reasons, we did not assess quantitatively the radiological signs of instability in this study. The aim of our study was to investigate the outcome of the enrolled patients with surgical fusion of the cervical spine, focussing on a comparison of the patients' neurological symptoms between pre- and post-operative.

The neurological symptoms were determined objectively using the established Ranawat score [13] and subjectively by asking the patients to complete a questionnaire that focussed on such aspects as the satisfaction of the patient about the outcome. This questionnaire also posed the question of whether the patient would undergo the procedure again. In addition, the presence of AAS and/or SAS as well as VMO was recorded and quantified. The AADI was assessed pre- and post-operatively.

As described in the literature, the most common and earliest level of cervical dislocation is between C1–C2, with resultant neck pain often resulting in the necessity for surgical decompression and dorsal spinal fusion. Various operation techniques are available, such as the techniques according to Gallie, Rodgers or Brooks, whereas in our department, we prefer the CerviFix system (SYNTHES Spine, Paoli, Pa.). In the case of a dens dislocation leading to myelomalacia, the surgical fusion of the cervical spine needs to be extended to include the occiput, whereas in the case of subaxial instability a longer fusion treatment should be performed which also often includes the occiput. Due to the variety of surgical stabilisation procedures that are possible, we did not assess the different procedures in this study.

The results of our study clearly demonstrate that a surgical decompression and stabilisation of the cervical spine in patients with RA is an adequate therapy and superior to conservative treatment when performed on a preventive basis before any neurological symptoms occur or develop. However, in this study, only patients given a pre-operative RW grade of II improved following surgery, with 70% of the pre-operative RW grade II patients clinically assessed to have attained RW grade I at the post-operative follow-up; these patients also provided the best subjective results. This up-grading was not detectable in patients with pre-operative RW grades of IIIA and IIIB, although most patients with these assessments did report subjective improvement. These findings are in accordance

with a number of other studies reported in the literature. Chan et al. also reported an improvement in the RW score in three out of four patients primarily scored as RW grade II, whereas no improvement was found for those patients primarily scored grades IIIA and IIIB [5]. In a retrospective study, Casey et al. reported an improved RW score in four of four patients with atlanto-axial instability who were pre-operatively given RW grade III [4]. These authors also discriminated between isolated atlanto-axial and subaxial instability and, as expected, they found a higher need for surgical treatment and poor improvement of neurological symptoms postoperatively in the patient group with subaxial instability than in those with isolated atlanto-axial instability. Olerud et al. found a one-level improvement of scores in six of 12 patients and a two-level improvement in two patients, although these authors did not make a subclassification [10].

In our study, only 11% of the patients with a pre-operative RW grade of IIIA and none of the two patients with a pre-operative RW grade of IIIB could be evaluated as having a lower RW score, which indicates an improvement, following surgery. Peppelman et al. are the exception in reporting a definite improvement of neurological symptoms – expressed in terms of at least a one-level difference in RW score – for almost all of their RW grade IIIB patients following surgery [12]. The results of this study are the best to date in terms of cervical stabilisation in patients with RA. However, these authors did not provide any information on whether the RW classification of the patients was carried out by a neurologist, as done in our study, or by other means. In comparison to our study, however, these researchers did find similar results in terms of a decrease in the formation of subaxial segments pannus after immobilisation of the atlanto-axial segments as well as a subsequent reduction of inflammatory destruction of bony and ligamentous structures following early stabilisation. Serious complications have been reported in the literature in terms of dislocation of screws and cerclagewires due to osteoporotic bones as well as pseudoarthrosis. Furthermore, many patients suffer from age-related multimorbidity, as evidenced in our study by four patients dying during the follow-up from pre-existing disease and pneumonia.

Conclusion

In conclusion, our results clearly demonstrate that patients with RA and cervical instability should be treated surgically before the appearance of neurological symptoms for the following two reasons: (1) in most cases the cervical

instability is progressive and can lead to myelomalacia and associated neurological deficits; (2) the outcome of the surgical stabilisation is better when performed as a preventive measure – before the onset of any neurological deficits.

References

1. Arnett FC, Edworthy SM, Bloch DA, McShane DJ, Fries JF, Cooper NS, Healey LA, Kaplan SR, Liang MH, Luthra HS (1988) The American Rheumatism Association 1987 revised criteria for the classification of rheumatoid arthritis. *Arthritis Rheum* 31:315–324
2. Bland JH (1990) Rheumatoid subluxation of the cervical spine. *J Rheumatol* 17:134–137
3. Boden SD (1994) Rheumatoid arthritis of the cervical spine. Surgical decision making based on predictors of paralysis and recovery. *Spine* 19:2275–2280
4. Casey AT, Crockard HA, Bland JM, Stevens J, Moskovich R, Ransford AO (1996) Surgery on the rheumatoid cervical spine for the non-ambulant myelopathic patient – too much, too late? *Lancet* 347:1004–1007
5. Chan DP, Ngian KS, Cohen L (1992) Posterior upper cervical fusion in rheumatoid arthritis. *Spine* 17:268–272
6. Conlon PW, Isdale IC, Rose BS (1966) Rheumatoid arthritis of the cervical spine. An analysis of 333 cases. *Ann Rheum Dis* 25:120–126
7. Halla JT, Hardin JG, Vitek J, Alarcon GS (1989) Involvement of the cervical spine in rheumatoid arthritis. *Arthritis Rheum* 32:652–659
8. Heywood AW, Learmonth ID, Thomas M (1988) Cervical spine instability in rheumatoid arthritis. *J Bone Joint Surg Br* 70:702–707
9. Kothe R, Wiesner L, Ruther W (2002) Rheumatoid arthritis of the cervical spine. Current concepts for diagnosis and therapy. *Orthopade* 31:1114–1122
10. Olerud C, Larsson BE, Rodriguez M (1997) Subaxial cervical spine subluxation in rheumatoid arthritis. A retrospective analysis of 16 operated patients after 1–5 years. *Acta Orthop Scand* 68:109–115
11. Pellicci PM, Ranawat CS, Tsairis P, Bryan WJ (1981) A prospective study of the progression of rheumatoid arthritis of the cervical spine. *J Bone Joint Surg Am* 63:342–350
12. Peppelman WC, Kraus DR, Donaldson WF III, Agarwal A (1993) Cervical spine surgery in rheumatoid arthritis: improvement of neurologic deficit after cervical spine fusion. *Spine* 18:2375–2379
13. Ranawat CS, O'Leary P, Pellicci P, Tsairis P, Marchisello P, Dorr L (1979) Cervical spine fusion in rheumatoid arthritis. *J Bone Joint Surg Am* 61:1003–1010
14. Santavirta S, Kankaanpää U, Sandelin J, Laasonen E, Kontinen YT, Slati P (1987) Evaluation of patients with rheumatoid cervical spine. *Scand J Rheumatol* 16:9–16
15. Smith PH, Benn RT, Sharp J (1972) Natural history of rheumatoid cervical luxations. *Ann Rheum Dis* 31:431–439
16. Webb FW, Hickman JA, Brew DS (1968) Death from vertebral artery thrombosis in rheumatoid arthritis. *Br Med J* 2:537–538
17. Weissman BN, Aliabadi P, Weinfeld MS, Thomas WH, Sosman JL (1982) Prognostic features of atlantoaxial subluxation in rheumatoid arthritis patients. *Radiology* 144:745–751