Anterior cervical fusion for radicular-disc conflict performed by three different procedures: clinical and radiographic analysis at long-term follow-up

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Abstract

Purpose Purpose of the study was to analyze in a retrospective way the clinical and radiographic outcome of three different surgical techniques in patients who underwent anterior cervical fusion.

Methods Eighty-six patients affected by symptomatic cervical disc herniation or spondylosis underwent cervical anterior fusion. Patients were divided in three groups considering the surgical technique. Clinical outcomes were evaluated by Visual Analog Scale, Odom's criteria, Neck Disability Index. Radiographic evaluation included standard and functional X-rays.

Results At 7 years mean follow-up, a comparable improvement in clinical symptoms was observed in all groups. Radiographic findings showed a solid fusion in all patients but seven cases in group 2 showed a subsidence of the cage.

Conclusions As shown by the obtained clinical and radiographic results, the anterior interbody fusion with

stand-alone peek cage containing β -tricalcium phosphate could be considered an effective and reliable procedure.

Keywords Fusion · Cervical disc herniation · Anterior approach · Cervical cage

Introduction

Soft disc herniation and spondylosis are the most common causes of cervical radicular pain. Surgical treatment finds a concrete indication when conservative treatment fails. In the last years, anterior cervical discectomy and fusion have been considered one of the most effective surgical solutions in the treatment of these diseases. Discectomy alone could not be performed in cervical spine to avoid the development of a progressive disc degeneration, augmentation of the local kyphosis and instability. Interbody fusion plays a crucial role in restoring and preserving the physiological intervertebral space height and the physiological lordosis of the cervical spine.

In 1955, Smith and Robinson [1] and 3 years later Cloward [2] proposed for the first time an anterior discectomy associated to fusion for cervical disc degeneration treatment. Later, the use of an anterior plate to avoid graft extrusion, generally an autologous iliac bone graft, was introduced [3–5]. Interbody fusion devices have been developed to avoid possible complications due to bone harvesting from the donor site, to increase immediate stability of the cervical spine after decompression and to promote bone fusion. Although some authors still advise the use of plate fixation, other studies suggest, with their encouraging results, that the use of plate fixation is deemed not necessary when an interbody fusion device is implanted [6–10]. The introduction of a stand-alone cage allows a reduction of surgical time.

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The purpose of our study was to analyze in a retrospective way the clinical and radiographical results of three groups of patients who underwent anterior cervical fusion for radicular-disc conflict due to soft disc herniation or spondylosis, by comparing three different surgical techniques.

Materials and methods

From January 1999 to January 2007, 86 patients affected by cervical soft disc herniation or spondylosis underwent anterior discectomy and fusion. Clinical and radiological results were analyzed in a retrospective consecutive study. Involved levels vary between C3 and C7. All surgical procedures were conducted by the senior author who chose the surgical technique according to the material implant and technical evolutions. The retrospective analysis was performed by an independent surgeon.

Inclusion criteria were: single or double level cervical disc disease, no previous cervical surgery, progressive radiculopathy, correspondence with MRI imaging and clinical symptoms, need for urgent surgical treatment or no responsiveness to at least 3 months conservative treatment. Exclusion criteria were: multilevel disc herniation, revision surgery, advanced cervical spondylosis, prevalence of myelopathy symptoms.

Preoperative evaluation was made in all cases by clinical examination and radiological examination with X-rays and MRI. Patients were divided in three groups considering the employed surgical procedure: group 1, discectomy and anterior cervical fusion with tricortical iliac bone graft and plate fixation; group 2, discectomy and anterior cervical fusion with stand-alone titanium cage augmented with cancellous bone from iliac graft; group 3, discectomy and anterior cervical fusion with stand-alone peek cage augmented with β -tricalcium phosphate. Postoperative clinical evaluation was based on Odom's criteria, Neck Disability Index and Visual Analog Scale. Radiographical follow-up was based on standard and functional X-rays at 3 months, 1 and 2 years, and at last follow-up. At standard X-ray, the disc height, the local and global lordosis and the fusion rate in Smith–Robinson ACDF were evaluated. A solid fusion in ACDF with cages was considered to be achieved in the presence of a good stability at functional X-rays at last follow-up. In patients with myelopathy symptoms, a postoperative MRI was also performed.

Surgical technique

A standard left-side anterior approach to the cervical spine was performed in all patients by horizontal skin incision

after radiological identification of the involved level. To achieve a better gap of the intervertebral disc, a Caspar distractor was used. Discectomy was always performed using operative microscope to obtain a more accurate disc and osteophyte removal. Attention was paid to avoid damages to the cortical structures of the bony endplates. In group 1 after discectomy, a tricortical bone graft was taken from anterior iliac crest and applied as described by Smith–Robinson technique into the disc space. Fixation was performed using AO cervical plate and four monocortical screws. In group 2, a stand-alone titanium cage augmented with autologous bone graft was implanted. Bone graft was taken from anterior iliac crest by the minimally trephine harvesting method. In group 3, a stand-alone Peek cage augmented with β -tricalcium phosphate was implanted. All patients wore a rigid collar for 2 months.

Results

Ninety-two cervical disc radicular conflicts were observed in 86 patients, 45 males and 41 females with a mean age of 40 years (28–63 years). Six patients underwent two level discectomy and fusion. Mean follow-up was 7 years, range 5–12 years. Demographic data were collected (Table 1).

Clinical outcomes were excellent in nearly all patients independently of the performed surgical procedure; instead the radiographic results were different in the three groups. None of the patients in the analyzed groups developed any new neurological deficit. No patient in the groups developed recurrent laryngeal nerve palsy, esophageal injury, cerebrospinal fluid leak, or infections.

Group 1 consisted of 24 patients. The mean operative time was 90 min (range 70–100) for one level and 115 min for two levels (range 90–130). The mean blood loss was 100 ml (range 70–120). All patients showed a good clinical

Table 1 Patients' demographic data

Patients	Group 1 24	Group 2 29	Group 3 33
Age	32–60	28–29	29–63
Gender (male/female)	13/11	15/14	17/16
Radicular pain	10/9	11/9	14/12
Radicular-myelopathy	3	4	2
Myelopathy	1	2	2
Duration of symptoms (months)	3–15	4–17	3–18
VAS neck pain	6	5	6
VAS radicular pain	7	7	6
NDI score	35	32	31
One level	24	26	30
Two levels	3	0	3

Table 2 Summarizing table showing improving in clinical outcome in the three treated groups

	Group 1	Group 2	Group 3
Odom's criteria			
Excellent	89 %	95 %	92 %
Good	11 %	0 %	8 %
Fair	0 %	0 %	0 %
Poor	0 %	5 %	0 %
Neck Disability Index	2.3	2.1	2.2
VAS neck pain	0.8	0.7	0.6
VAS radicular pain	0.4	0.5	0.3

outcome and all except two were free of symptoms; of the two, one suffered from slight neck pain and the other one showed in the first three postoperative months, iliac donor site pain. The mean VAS neck pain was 0.8 (range 0–2), the mean VAS radicular pain was 0.4 (range 0–1), the mean NDI score was 2.3. According to Odom's criteria, excellent results were detected in 89 % of cases, good results in 11 %, no poor or fair results were detected (Table 2). Radiographic evaluation showed the achievement of a solid fusion in all cases without bone graft collapse or reabsorption and absence of pseudarthrosis in all cases. In one case, the plate was not applied in the correct site but without any postoperative clinical symptoms. No screw loosening or plate failure was observed (Fig. 1a, b). No local kyphosis was detected; a physiological lordosis was maintained unchanged at last follow-up.

Group 2 consisted of 29 patients. Mean operative time was 75 min (range 60–90). Mean blood loss was 75 ml (range 40–90). All patients showed a good clinical outcome. All patients were symptom-free except one who suffered from persistent neck pain. Mean VAS neck pain was 0.7 (range 0–2), mean VAS radicular pain was 0.5 (range 0–1), mean NDI score was 2.1. According to Odom's criteria, excellent results were detected in 95 % of cases, fair results in 5 % of patients.

No cage failure was observed at radiographic controls. Subsidence and migration of the cage into the vertebral body with reduction of the foramina height were observed in 7 patients (35 %), with preservation of cervical lordosis. Subsidence was into the superior endplate in four patients and into the superior and inferior endplates in three patients. Neither anterior nor posterior migration of the cage was observed in any patients; in all cases the radiographic evaluation showed a solid fusion (Fig. 2a–c).

Group 3 consisted of 33 patients. Mean operative time was 47 min (range 40–60) for one level and 68 min for two levels (range 60–80). Mean blood loss was 40 ml (range 30–45 ml). All patients showed a good clinical outcome

Fig. 1 a Preoperative X-ray and MRI showing a C6–C7 disc herniation with neck and radicular pain treated with Smith–Robinson technique. b 5 years postoperative X-ray showing good fusion rate

and were symptoms free except two who referred occasional neck pain. Mean VAS neck pain was 0.6 (range 0–2), mean VAS radicular pain 0.3 (0–1), mean NDI score was 2.2. According to Odom's criteria excellent results were detected in 92 % of the cases, good results in 8 %, no poor or fair results were observed. No hardware failure was observed at last radiographic follow-up. No subsidence or migration of the cage was observed. Preservation of local lordosis and intervertebral disc height was observed in all cases at last follow-up. Solid fusion was detected in all patients at last follow-up and an anterior ossification was observed in 18 patients (Fig. 3a–c).

Discussion

Clinical results were excellent in nearly all patients independently of the performed surgical procedure; however, the radiographic results were different in the three groups.

Fig. 2 **a** Preoperative X-ray and MRI showing a C5–C6 disc herniation with neck and radicular pain. **b** Immediately postoperative X-ray showing good cage positioning with a restored disc height. **c** 5 years postoperative X-ray showing cage subsidence

In our experience, all three procedures restored local and global lordosis that was unchanged at last follow-up.

Anterior approach to the cervical spine, proposed by Smith and Robinson [1], is still the most applied surgical technique in the treatment of cervical disc herniation or cervical radicular conflict due to spondylosis. Major complication of this technique is the collapse with consequent reabsorption and mobilization of the implanted bone graft. To avoid this complication, some authors suggested the possibility of fixing the bone graft with a locked plate [4, 6]. Clinical and radiographic results reported with this technique are very satisfactory in the majority of cases. The use of a locked plate, however, on the one hand reduces the risk of bone graft mobilization, on the other is burdened by the risk of screw breakage. To avoid neurological damages and reduce the infection risk and operative time, 10 years ago, an interbody fusion device as a stand-alone cage was introduced [11–14]. At the beginning, the implant of a stand-alone cage was the standard surgical procedure. Throughout, some authors reported the risk of subsidence and/or migration into the vertebral body with secondary reduction of the intervertebral disc height, also with this

Fig. 3 **a** Preoperative MRI and X-ray showing a C6–C7 disc herniation with neck and radicular pain. **b** Immediately postoperative X-ray showing good cage positioning with a restored disc height. **c** 5 years postoperative X-ray showing no cage subsidence with anterior ossifications

technique [7, 15, 16]. Also in this technique, a fixation with a plate was proposed by several authors to avoid these complications [6–8]. In the last years, the introduction of cages augmented with bone substitutes as β -tricalcium phosphate was utilized to obtain a solid interbody fusion in cervical diseases [9, 17]. This procedure admits to avoid donor-site morbidity and at the same time to reduce the surgical time. This is confirmed also in our series, in which the group 3 showed a shorter surgical time, with minor donor-site morbidity and clinical results comparable to the two other techniques. In this study, in which for the first time, at the authors knowledge, the three different surgical technique were compared, no statistical differences in clinical outcome at 5 years minimum follow-up were found. Patients with advanced neurological damage due to cervical myelopathy were obviously excluded from the study. VAS neck pain, the radicular VAS pain and the NDI score did not show any statistical difference, as seen in Table 2. Comparable clinical outcomes were registered in group 2 and 3 also for the Odom's criteria, worst results were observed in group 1.

A different trend was seen in the three groups for the radiological findings. A limit could be acknowledged for

the present study: whereas the fusion evaluation was easy for group 1, some difficulties were encountered for groups 2 and 3. When cages are implanted, the true fusion rate assessment evaluated by X-rays is uncertain. According to some authors, only a CT scan with reconstructions is suggested to identify the fusion rate [18]. However, in medical literature, standard and flexion–extension X-rays are usually accepted to perform this evaluation. According to this school of thought, absence of radiological instability signs in flexion–extension X-rays (peripheral radiolucency with associated bone sclerosis) and of subsidence in standard x-rays are considered indirect sign of a solid fusion for group 2 and 3, in the present study.

In our series in all three groups a solid fusion was observed at last follow-up. Comparing group 2 and 3, a major incidence of cage subsidence was seen in group 2 with seven cases in which standard X-ray showed a migration of the cage into the vertebral body with a consequent reduction of the intervertebral disc height. Titanium cages are supposed to have a rigid form that may predispose to subsidence and migration into the vertebral body. Subsidence, as showed in previous studies, may depend on the instability consequent to discectomy [7, 19]. A fundamental role is also played by the modulus of elasticity of the cage, the endplate preparation, or the mineral bone density [7, 19]. In group 3, no subsidence or migration of the cage or reduction of the intervertebral space was observed. A reason could be found in the major modulus of elasticity of the peek cages augmented with β -tricalcium phosphate. Moreover, in 18 cases an ossification in front of the cage was observed as an indirect sign of a completely achieved fusion. This could be due to a bone reaction to the partial instability created by discectomy and at the beginning not completely resolved by the more elastic peek cage. In all cases, the use of a stand-alone peek cage augmented with β -tricalcium phosphate showed good clinical results as comparable to the other two groups, but better radiographic findings, according also to previous studies [10].

Conclusion

All the three analyzed surgical techniques showed good efficacy in the treatment of cervical degenerative diseases. Anterior cervical interbody fusion with a stand-alone peek cage augmented with β -tricalcium phosphate is not only clinically effective in the treatment of radicular-disc conflict caused by disc herniation or spondylosis with or without initial myelopathy at one or two levels, but also give the better fusion rate. It is a no demanding surgical procedure able to reduce surgical time at lower risks for the patients.

Conflict of interest None.

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