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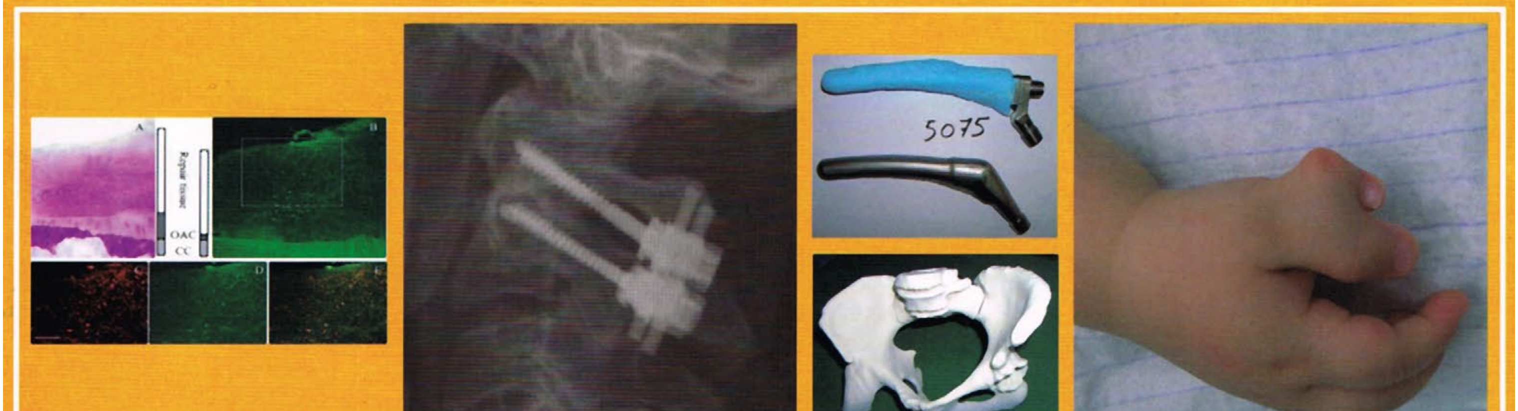

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OSTA-PEK CAGE RECONSTRUCTION AFTER CERVICAL CORPECTOMY FOR ADVANCED CERVICAL SPONDYLOSIS: A RETROSPECTIVE MULTICENTRIC STUDY

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ABSTRACT

The treatment of cervical spine spondylosis has changed recently from the use of autograft with a lot of donor site morbidity to the use of cages to reconstruct the spine when corpectomy has been performed. We evaluate the clinical and radiological outcome of patients treated with radiolucent carbon composite frame cages with space for bone graft and anisotropic elasticity as substitute for the strut graft compared with the autograft and the other types of cages, be it associated with other fixation techniques.

INTRODUCTION

That mankind was not meant to walk upright is seen in the amount of degenerative diseases in spine. Nowadays, as we live longer and there are more high velocity accidents with cervical fractures or sprains, we are more and more confronted with (posttraumatic) degeneration at the cervical spine. Since the 1950's, great improvement have been made to cure these problems. In 1953, Cloward introduced the anterior cervical arthrodesis that, with some changes, remains the golden standard for cervical spondylosis.[18]

This method however can not cure every case of spondylosis. Compressive myelopathy at the cervical spine is the most clinically significant problem associated with ossification of the posterior longitudinal ligament (PLL) and advanced cervical spondylosis.[11] Several methods for decompression and fusion have been investigated, with changing results. Common problems are bone graft donor site related, displacement or collapse of the graft and non-union. This study analyses the outcome and radiological findings for an anterior cervical corpectomy with use of carbon composite Osta-Pek frame cage (Fig 1), as a support with space for grafts for the interbody fusion in three centres (Leuven, Belgium; Brest and Dijon, France).[8]

MATERIAL AND METHODS

We retrospectively checked all our cervical corpectomy cases. Between June 2000 and May 2006, 93 patients were treated with carbon composite Osta-Pek frame cage (Co-Ligne AG, Switzerland) after cervical corpectomy of 1 or more levels for different reasons in our 3 centres (tables 1 and 2).

The approach to the cervical spine was through a Smith-Robinson anterior cervical approach. A left sided skin incision is made and after sharp dissection of the platysma, the superficial layer of the deep cervical fascia is opened longitudinally. The carotid artery is localised by palpation of the pulsation. The middle layer of the deep cervical fascia is carefully divided. When the sternomastoid muscle is retracted laterally with the carotid artery, the anterior aspect of the cervical spine can be palpated. The oesophagus, trachea and thyroid are retracted medially. The deep layers of the deep cervical fascia are bluntly divided. The longus colli muscle is reflected subperiostially from the spine. With this exposure; sufficient room is available for the needed corpectomy and resection of the intravertebral discs above and below the corpectomy and if needed of associated ill discs.

The complete corpectomy is performed using rongeurs for the anterior 2/3 of the vertebral body, and the posterior 1/3 is removed with a high speed burr. When the corpectomy has been done, there is a perfect view on the PLL. (Fig 2)

Once corpectomy (with or without resection of the PLL) and decompression of the myelon has been performed, interbody fusion is completed with the carbon composite Osta-Pek frame cage, a long carbon fibre reinforced PEKEKK (PolyEther-KetonEtherKetoneKetone) cage, filled with autologue bone either recycled bone from the removed vertebra(e) or from the iliac crest. Measuring of the size of the cage is done by placing a trial cage in loco and checking the position of the spine clinically and with X-ray control when the traction in the spine is released. In some cases, this construction is reinforced by anterior cervical plating to provide more stability. After placement of a suction drain in the prevertebral area, skin is closed. Additional posterior procedure (secondary laminectomy to treat congenital stenosis of the cervical canal) was needed in some cases.[9]

Postoperatively, every patient is immobilised for at least 6 weeks with a semi-rigid collar to protect the osteosynthesis.

RESULTS

From our 93 patients operated (table 1), 86 had at least 6 months follow up (range 6 months - 5 years and 11 months, mean 2 years and a half). From these 86 patients; 63 had degenerative pathology, 37 had myelopathy, 18 had cervicobrachialgia and 8 had a combination of myelopathy an cervicobrachialgia; 15 patients had a fracture of the cervical spine (4 with neurological problems at arrival at the emergency room), 1 patient that already had undergone an anterior cervical interbody fusion (ACIF) elsewhere and had developed a pseudarthrosis and 7 patients had a neoplastic cervical problem preoperatively (table 2). Looking at the corpectomy cases because of degenerative pathology, age varies between 29 an 80, (mean 56). Among these 63 patients, there are 39 cases of male and 24 cases of female. 6 patients had a 2 level corpectomy (3 cases C4 + C6, 1 case of C4 + C5, 1 case C5 + C6 and 1 case of C6 + C7), 10 patients had a 1 level corpectomy associated with ACIF on another level and 47 had a 1 level corpectomy. The posterior longitudinal ligament was removed in 58 cases. Note that 7 of the patients with myelopathy received a secondary laminectomy to treat congenital stenosis of the cervical canal, because anterior decompression through corpectomy was not sufficient. With the use of this type frame cage, bone graft harvesting from the iliac crest was only necessary in 9 of the 63 cases (table 3). In 39 cases, extra stability was provided by anterior plating, 24 patients a treated without plates (table 4).

Data were obtained preoperatively, immediate postoperatively and at the polyclinic. Radiological data were gathered day 1, 8, 30, 60, 90, 180, 360 post-op. 2 patients that were operated for cervicobrachialgia complained of persistent arm pain and needed revision surgery with increasing foraminotomy. 1 patient had a non-union and needed additional stabilisation by posterior arthrodesis. 1 patient that was not immediately relieved from his pain postoperatively evolved well with physiotherapy after finishing his six weeks of immobilisation in his collar. 4 patients had a remainder of postoperative pain and/or weakness and 8 patients compared there situation after surgery slightly better than before the intervention. The rest of the patients had an outcome they declared themselves as good or even very good. No pseudarthrosis were found on the X-rays, nor is migration of cages reported. 5 cages settled into the inferior endplate due to either osteoporosis or perhaps excessive traction on the spine peroperatively. Bony fusion is seen in every case at the 6 months follow-up X-ray except for 1 case (fig 3 and 4).

DISCUSSION

Cervical problems related to the PLL have always been an endeavour for the spine surgeon. Golden standard technique for disc hernia with very good result is the ACIF, either with autograft, titanium cages or carbon composite cage filled with bone grafts or bone morphogenetic protein.[1] But for cervical corpectomy, the results so far are not that encouraging. There is a lack of agreement regarding the most appropriate way to treat patients with a spondylosis in which corpectomy is necessary.

Autograft and donor site morbidity

The best fusion rates yet in anterior cervical fusion involve the incorporation of autogenous bone. Tricortical iliac grafts or fibular struts are biologically satisfactory (fusion rates between 93 and 97%).[12] However the use autograft requires a second surgical procedure, with inherent risk of nerve damage, haematoma, infection, iliac crest fracture, drainage or donor-site pain. When allografts are used, these problems are eliminated, but may lead to increased graft subsidence and extrusion rates, and decreased fusion rates (87%).[3]

Stability

The strut graft (fibula or iliac crest) has been used mostly, but also in various ways, e.g. Robinson-Smith, Cloward, Bailey and Badgley, "dove-tail" technique, "key-hole" technique and "notch and peg".[10] To reinforce these constructions and to improve the outcome, the anterior cervical fusion is sometimes augmented with anterior plate and screw fixation[2,3,7,14] or posterior cervical instrumentation (placed in a secondary posterior approach) or a combined technique of anterior and posterior instrumentation.[7,13,15] These techniques improve the fusion rate slightly. As alternative to these elaborate techniques and to avoid instability, a partial corpectomy has already been suggested by resecting only the anterior 2/3 of the vertebral body and both cranial and caudal disc, creating a larger space allowing easier access through which the PLL is removed[5]; or by an open-window corpectomy technique, in which only the posterior wall is removed and the anterior and lateral portions of the vertebral corpus is left intact.[11]

Cages

Other options in reconstruction of the cervical spine when corpectomy is necessary, is the use of cages, filled either with autogenous bone or bone morphogenetic protein as in classic ACIF. Synthetic materials such as hydroxyapatite implants, polymethylmethacrylate, biocompatible osteoconductive polymer, titanium discs and ceramics titanium have been introduced to replace the autologous bone graft or the allograft.[8] Cage-assisted reconstruction has been shown to confer biomechanical advantages (immediate stability) in the anterior column because of the rigidity provided by the construction, but often associated plating is also needed to have a sufficiently stable construction.[12,18] Titanium cages are known to give good results in ACIF procedures because of the osteoinductive properties of titanium. Other potential advantages are immediate anterior column stability, good biocompability and reduction of instrumentation morbidity.[4] The used titanium cages can be divided in three design groups: screw, box and cylinder; but none of these subgroups have significantly superior results in biomechanical in vitro tests, only the screw subgroup is less able to control bending and extension than cages with a cylinder design.[6] Another design of cage has been described by Woiciechowsky as a distractable titanium cage that has the advantage of avoiding overdistraction because they can be adjusted to the size exactly needed.[17] But unless the osteoinductive property of titanium, non-union and dislodgement of the cage does occur. An additional disadvantage is the difficulty to evaluate the bony fusion on X-ray or CT-scan because of its inherent opaqueness.

Radiolucency

Trying to overcome the latter, different radiolucent cages are developed, with a small opaque marker to be able to evaluate the position of the cage postoperatively. Some of these types of radiolucent cages are in fact a polyester mesh impregnated with poly-L-lactic-acid (PLLA) or only PLLA, conferring only temporary rigidity to the cage during bony fusion.[16] The PLLA is resorbed by the human body. The cages we used in this study are carbon fibre reinforced PEKEKK, which are radiolucent as well as the PLLA cages, but they are not resorbed by the human body and do not collapse. Even after years, the cage will still be in place and give an extra support to the cervical spine in combination with the bony fusion, which is a great advantage looking at the frequency of (auto- or allo-) graft collapse. In both types of cages, bony fusion can be evaluated very easily on plain X-ray, CT-scan and MRI with minimal to no artefact compared to the titanium cages.[1,12,16]

Biomechanics

Compared to the titanium cages that are made from isotropic material, the Osta-Pek cage is, like bone, anisotropic and thereby allows more physiological load. Carbon cage consists of similar elasticity as the bone thus it is known to have more or less the same biomechanical properties as a vertebra, and stimulates bone formation and improving the quality of fusion by allowing micromotions.[8] The long carbon fibres are aligned in the sagittal plane, according to the normal trajectory of the dominant bone trabeculae, and the load that both a vertebral body and cage must bear. When bony fusion is achieved, normal load to the bone can take place due to the elasticity of the carbon fibres, by not hampering the small movements by the stiffness of the cage.[12] To give a normal alignment in the postoperative spinal curvature, the cage is wedge shaped, with the anterior side being higher than the posterior side.[8]

Procedure related complications

Due to osteopenia or caused by excessive distraction, 5 cages settled into the inferior endplate, but did not needed revision surgery. 2 patients that underwent the surgery for brachialgia complained of persisting arm pain after the operation. These 2 patients were revised with an increasing foraminotomy. No failure or migration of cages is seen on the X-rays at the last follow-up. 1 patient developed a non-union and needed additional posterior material (Case 49). No patients developed haematoma or postoperative infection. Neither cerebrospinal fluid leakages are reported, nor nerve damage. In the cases we needed grafts from the iliac crest; there was pain as donor site morbidity in 3 from the 9 cases.

Other cases

As seen in table 1, this type of cage is also of great use in cases of resection of neoplastic problems in cervical vertebrae and in case of fractures of the cervical spine. The patients who had a corpectomy because of a tumour still have a stable cervical spine, with less tumour mass in their body. Those who have had corpectomy because of a cervical fracture (burst fractures and fractures with neurological implications), also had a stable construction after surgery and all traumatic neurological resolved very soon after surgery. This type of cage can even be used as an option in revision surgery for failed ACIF (1 patient) with pseudarthrosis. This patient complained preoperatively from severe cervicobrachialgia, and she recovered very well of her preoperative problems after the revision surgery with the Osta-Pek cage.

CONCLUSION

Anterior decompression of the myelon remains the standard procedure for myelopathy or severe spondylosis with cervicobrachialgia. Point of view clinical outcome, our group of patients we treated with an Osta-Pek cage have results as good as with the classic autograft. There are even advantages: there is less donor site morbidity (still exists if there is not enough bone to fill the cage, or the quality of bone is that poor); and compared with the other type of cages, there are less complications and no artefact is seen X-rays and scans to evaluate the bony fusion. By its relative elasticity and shape adapted to the spine, the cage even improves bony fusion and compared to strut-graft and the PLLA cage, cage height does not change as does the graft when there is pseudarthrosis or graft collapse. Despite the biomechanical advantages, sometimes there is some impaction in the inferior end plate or non-union. With our experience we now perform stand alone constructions in single level corpectomy cases with good quality of bone, and cage with anterior plating in multilevel or poor bone quality cases, to overcome this impaction. This type of cage can even replace vertebrae in the cervical spine after complex cervical fractures or in tumour resection cases and is also a good solution to treat complex pseudarhtrosis cases after former spine surgery.

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Table 1: Retrospective analysis of all the corpectomy cases. For every case mentioning gender; age at time of intervention; indication(myelopathy, cervicobrachialgia, combination of former, fracture with or without neurological problems, tumours and hypertrophic pseudarthrosis)(see also table 2); level of corpectomy; level of associated discectomy, date of intervention; osteosynthese (yes or no); type of graft used (corpus vertebrae, crista iliaca, combined or without grafts); resection of PLL (yes or no); radiological signs of fusion at 6 months posteratively; recovery of neurological signs, force, pain; and impaction from the cage in the end plate of the caudal vertebra.

N°	Gend	Age	Diag	Niv corp	Niv disc	Int. Date	Osteosynth	Graft	Resec PLL	Fusion	Postop	Impact
1	M	76	M	C4+C6		28/11/2003	N	CV+CI	Y	Y	3/5	
2	M	75	M	C5		22/10/2003	Y	CV	Y	Y	4/5	
3	F	73	M	C6		19/11/2003	Y	CV	Y	Y	3/5	Y
4	M	53	C	C5		14/10/2003	Y	CV	Y	Y	4/5	
5	F	59	M	C4+C6		12/05/2003	N	CV	Y	Y	3/5	
6	M	47	M	C6	C3-C4	06/10/2003	Y	CV	Y	Y	5/5	
7	M	42	M	C6	C4-C5	04/10/2002	Y	CV	Y	Y	3/5	
8	M	42	C	C6		28/11/2003	Y	CI	Y	Y	4/5	
9	F	62	M	C4+C6		27/08/2003	N	CV	Y	Y	5/5	
10	M	56	M	C6	C3-C4	11/07/2003	N	CV	Y	Y	4/5	
11	M	20	F	C7		22/06/2003	Y	CV	Y	Y	5/5	
12	M	42	M	C6		16/05/2003	Y	CV	Y	Y	4/5	
13	M	69	M	C4	C5-C6	04/04/2003	N	CV	Y	Y	4/5	
14	M	77	Fneur	C7		25/02/2003	N	CV	Y	Y	3/5	
15	M	68	C	C4	C5-C6	03/02/2003	Y	CV	Y	Y	3/5	
16	F	46	T	C7		29/01/2003	N	CI	Y	Y		
17	M	54	M+C	C6		04/04/2003	Y	CV	Y	Y	4/5	
18	M	55	M	C4		20/01/2003	N	CV	Y	Y	5/5	
19	M	19	F	C7		30/11/2002	Y	CV	Y	Y	5/5	
20	M	19	F	C5		29/11/2002	Y	CV	Y	Y	5/5	
21	M	23	Fneur	C6		25/11/2002	Y	CI	Y	Y	5/5	
22	M	50	C	C6		20/11/2002	N	CV	Y	Y	4/5	
23	M	24	F	C6		29/10/2002	Y	CV+CI	Y	N	5/5	
24	M	18	F	C5		23/10/2002	Y	CV	Y	Y	4/5	
25	F	69	M+C	C5		06/09/2002	Y	CV	Y	Y	4/5	Y
26	F	42	C	C6		18/07/2002	Y	CV	Y	Y	1/5	
27	M	51	C	C6		18/07/2003	N	CV	Y	Y	4/5	
28	F	49	C	C6		06/07/2002	N	CV	Y	Y	5/5	
29	M	29	M+C	C6		15/01/2002	N	CV	Y	Y	4/5	
30	M	62	M	C5		16/05/2002	Y	CV	Y	Y	4/5	
31	F	63	M	C5	C6-C7	06/12/2003	N	CV	Y	Y	5/5	
32	M	52	M	C6	C4-C5	10/12/2003	N	CV	Y	Y	4/5	
33	F	51	M+C	C6		19/12/2003	Y	CV	Y	Y	4/5	
34	F	60	M	C5		03/04/2003	Y	CV+CI	Y	Y	4/5	
35	M	40	M	C6		16/06/2000	Y	CI	Y	Y	4/5	
36	F	59	C	C6		22/01/2004	Y	CV	N	Y	4/5	

N°	Gend	Age	Diag	Niv corp	Niv disc	Int. Date	Osteosynth	Graft	Resec PLL	Fusion	Postop	Impact
37	F	63	C	C5		28/01/2004	Y	CV	N	Y	2/5	
38	F	49	M	C5		15/03/2004	Y	CI	Y	Y	1/5	
39	M	55	C	C6		19/03/2004	Y	CV	Y	Y	4/5	
40	M	44	C	C5		19/03/2003	Y	CV	N	Y	4/5	
41	F	75	T	C3		31/03/2004	Y	CI	Y	N	4/5	
42	M	60	T	C5		13/01/2004	Y	-	Y	N	5/5	
43	F	55	C	C6		27/06/2003	N	CV	Y	Y	5/5	
44	F	49	M	C6		20/06/2003	N	CV	Y	Y	5/5	
45	F	48	PS	C4		28/04/2003	N	CV	Y	Y	4/5	
46	M	49	C	C6		25/04/2003	N	CV	Y	Y	5/5	
47	M	52	Fneur	C5		25/04/2003	Y	CV	Y	Y	5/5	
48	M	53	C	C6		31/01/2003	N	CV	Y	Y	5/5	
49	M	74	M	C5	C3-C4	18/12/2003	Y	CV	Y	N	4/5	
50	M	54	C	C4		18/12/2003	Y	CV	Y	Y	5/5	
51	M	48	T	C5		02/07/2004	Y	CI	Y	N		
52	F	67	M	C6		05/07/2004	Y	CI	Y	Y	4/5	
53	F	51	Fneur	C6		16/07/2004	Y	CV	N	Y	3/5	
54	F	71	M	C6	C4-C5	04/06/2004	Y	CV	Y	Y	4/5	Y
55	F	33	F	C6		07/07/2004	Y	CI	Y	Y	4/5	
56	F	48	M	C6		29/07/2004	Y	CV	Y	Y	4/5	
57	M	74	T	C3		23/07/2004	Y	CI	Y	N		
58	M	47	M	C5		19/08/2004	Y	CV+CI	Y	Y	4/5	
59	M	53	M	C6		23/09/2004	Y	CV	Y	Y	4/5	
60	F	71	T	C6		08/10/2004	Y	CI	Y	Y	4/5	
61	M	25	F	C5		28/10/2004	Y	CV	Y	Y		
62	M	58	M+C	C5	C3-C4	06/11/2004	Y	CV	Y	Y	3/5	
63	M	77	M+C	C4		08/11/2004	Y	CV	Y	Y	4/5	
64	M	62	M	C6		15/12/2004	Y	CV+CI	N	Y	2/5	
65	M	40	F	C7		26/12/2004	Y	CV	Y	Y	3/5	
66	M	68	M	C4		13/01/2005	Y	CV	Y	Y	4/5	
67	M	77	M	C4		05/11/2004	N	CV	Y	Y	4/5	Y
68	M	75	M	C4+C5		30/11/2004	Y	CV	Y	Y	2/5	
69	M	53	T	C4+C5		03/12/2004	Y	-	Y	N	4/5	Y
70	M	33	M	C5		04/02/2005	Y	CV	Y	Y	3/5	
71	F	34	M+C	C6		11/02/2005	Y	CV	Y	Y	4/5	
72	F	14	F	C7		18/02/2005	Y	CV	N	N	1/5	
73	M	68	M+C	C5		27/04/2005	Y	CV	Y	Y	4/5	
74	F	56	M	C6+C7		10/05/2005	Y	CI	Y	Y	4/5	
75	M	47	F	C5		01/11/2005	Y	CV	N	?	4/5	
76	M	72	T	C7		01/02/2006	Y	CI	Y	?	1/5	
77	M	22	F	C7		05/09/2005	Y	CV	Y	Y	3/5	
78	M	43	T	T1		11/01/2006	Y	CI	Y	?		
79	F	61	T	C7		04/03/2006	Y	CI	Y	?		
80	M	55	M+C	C5		17/05/2006	Y	CV	Y	?	4/5	
81	M	60	T	C6		28/04/2006	Y	CI	Y	?		
82	M	60	C	C6		05/07/2004	N	CV	Y	Y	2/5	
83	M	55	C	C4		03/02/2005	N	CV	Y	Y	3/5	
84	F	53	C	C5		17/02/2005	N	CV	N	Y	4/5	
85	F	71	M	C5+C6		11/03/2005	N	CV	Y	Y	4/5	
86	M	80	M	C5		04/01/2005	N	CV	Y	Y	4/5	Y
87	M	45	M	C5		21/04/2005	Y	CV	Y	Y	4/5	
88	M	58	M	C6		22/04/2005	N	CV	Y	Y	4/5	
89	F	66	M	C6		13/05/2005	Y	CV	Y	Y	4/5	
90	F	46	M	C6		10/06/2005	Y	CV	Y	Y	4/5	
91	F	43	M	C6		15/11/2005	Y	CV	Y	Y	4/5	
92	F	57	M	C5		04/04/2006	Y	CV	Y	?		
93	M	74	M	C5		11/04/2006	Y	CV	Y	?		

Table 2: Indications in patients with > 6 months follow-up

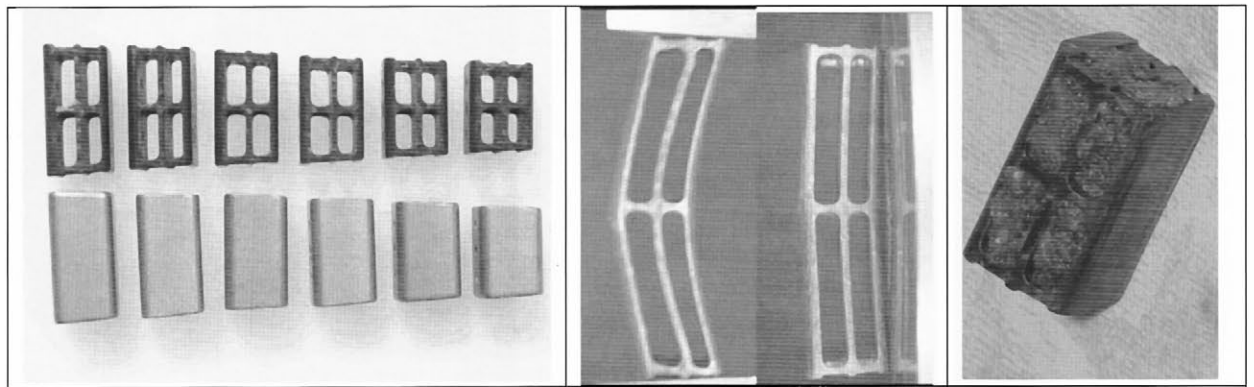
Indication	Number of patients	Gender distribution
Myelopathy (M)	37	22M/15F
Cervicobrachialgia (C)	18	12M/ 6F
Myelopathy and cervicobrachialgia (M+C)	8	5M/ 3F
Fracture (F and Fneur)	15	12M/ 3F
Tumour (T)	7	4M/ 3F
Hypertrophic pseudarthrosis (PS)	1	0M/ 1F

Table 3: Grafts used to fill the cages in degenerative and the other cases (fracture, tumour, revision surgery) (>6 months follow-up)

Type of graft	Number of cases degenerative	Number of cases other
Iliac crest	5	7
Resected vertebral body	54	13
Combination	4	1
No graft used	0	2

Table 4: Stand alone cage / cage with osteosynthesis for stability in degenerative cases with > 6 months follow-up.

Numbers of levels	1 level	1 level + ACIF	> 1 level
With osteosynthesis	31	6	2
Without osteosynthesis	16	4	4

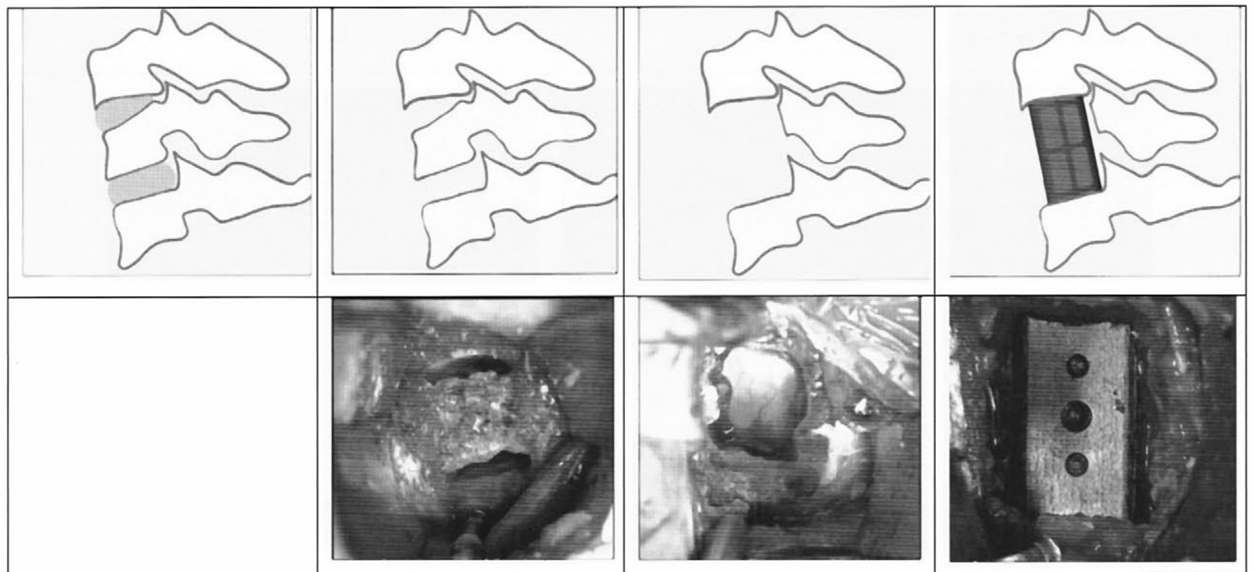


Cage inventory set
25.1-17.6 mm cages

50 mm cage specimen
Under 500 kg static load
Cage after static load

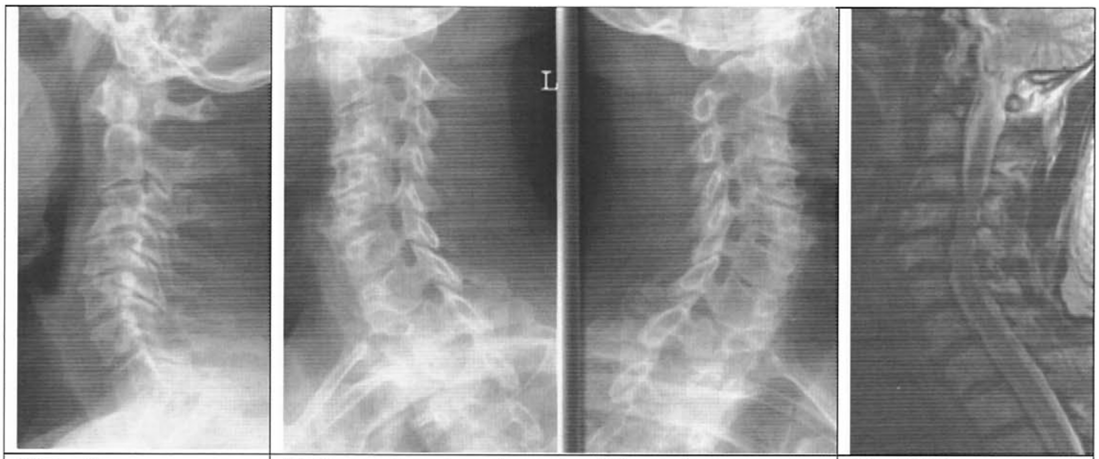
Cage filled with
autografts

Fig 1: cages

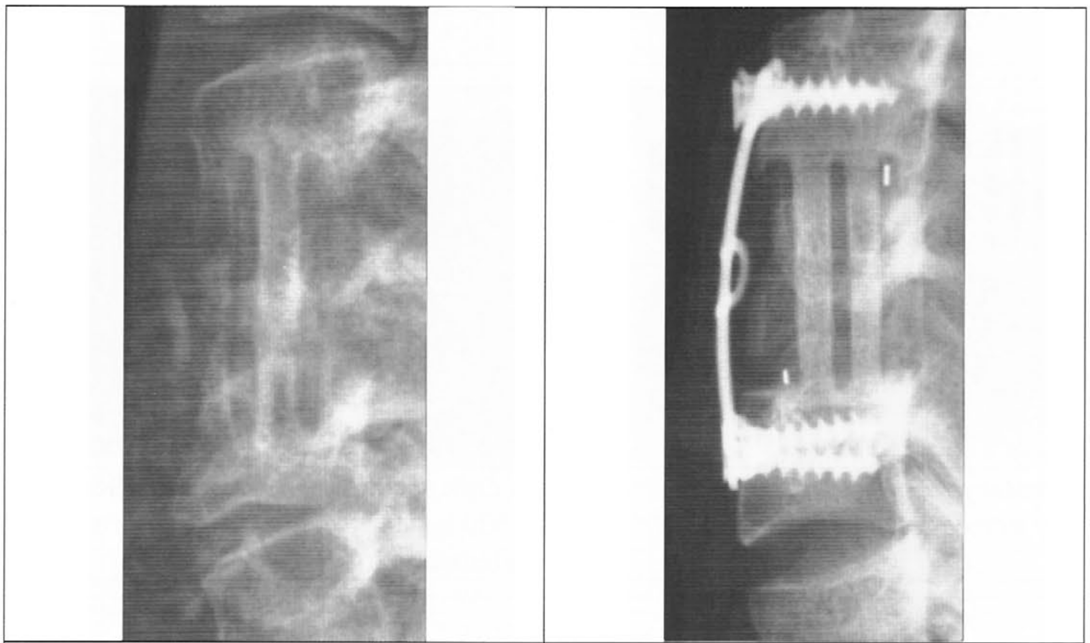


Cervical spine | Discectomy | Corpectomy | Cage in situ

Fig 2: Surgical technique

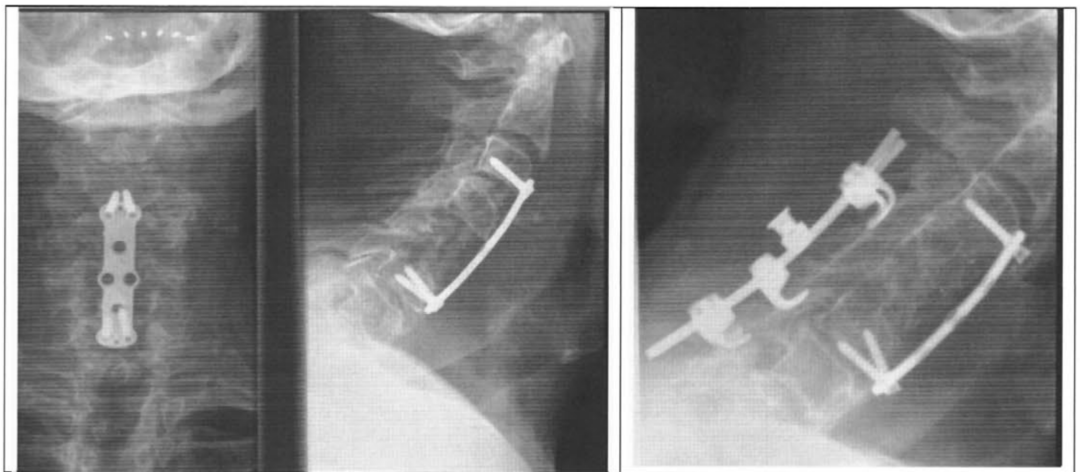


Plain X-ray	¾ X-ray showing stenosis of foramina	T2- MRI



Post-op without plate, bony fusion	Postop with plate, bony fusion

Fig 3: Pre-and postoperative X-rays



Post-op, non-union	Post-op, after revision surgery

Fig 4: case 49: non-union, needed revision surgery with posterior stabilisation