Journal of Clinical Neuroscience 22 (2015) 1484–1490

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Technical Note

A novel minimally invasive technique for lumbar decompression, realignment, and navigated interbody fusion

Clemens Reinshagen [a,b,c,1], Daniel Ruess [a,1], Brian P. Walcott [d], Marek Molcanyi [a,e], Roland Goldbrunner [a], Bernhard Rieger [a,f,*]

[a] Department of General Neurosurgery, University of Cologne, Kerpener Straße 62, Cologne 50937, Germany
[b] Molecular Neurotherapy and Imaging Laboratory, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA
[c] Department of Radiology, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA
[d] Department of Neurosurgery, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA
[e] Institute of Neurophysiology, Medical Faculty, University of Cologne, Cologne, Germany
[f] Department of Neurosurgery, University of Dresden, Fetscher Straße 74, Dresden, Germany

ARTICLE INFO

Article history:
Received 11 November 2014
Accepted 3 March 2015

Keywords:
Degenerative spondylolisthesis
Interbody
Lumbar fusion
Minimally invasive

ABSTRACT

We present a novel, minimally invasive, navigation-guided approach for surgical treatment of degenerative spondylolisthesis (DS) that is a hybrid of the two most common techniques, posterior interbody fusion (PLIF) and transforaminal interbody fusion (TLIF). DS is an acquired condition with intersegmental instability of one or more lumbar motion segments. Seven patients with single level lumbar DS underwent lumbar arthrodesis utilizing the hybrid technique (HLIF) in our center. Using a standard unilateral midline approach a decompression and partial facetectomy on one side was performed, allowing for implantation of a specially designed interbody cage. Pedicle screws were placed using neuronavigation in a vertical vector on the side of the partial facetectomy and dorsolaterally (percutaneous) on the contralateral side. Patient and operative data, numeric rating scale (NRS) pain scores, core outcome measures index (COMI) and Oswestry disability index (ODI) were recorded preoperatively as well as 6 weeks, 3 months, 6 months and 1 year after surgery. All patients completed the 1 year follow-up. There was significant postoperative improvement of NRS, COMI and ODI scores at all postoperative follow-up time points ($p < 0.05$). The radiological assessments of realignment showed a reduction of listhesis from an average of 21.04% (standard deviation [SD] 5.1) preoperatively to 9.14% (SD 4.0) postoperatively ($p < 0.001$). The average blood loss was 492 ml. Post-procedure CT scans demonstrated correct implant placement in all but one patient who required a revision of a single pedicle screw. HLIF allows thorough decompression as well as realignment and interbody fusion for patients with DS and may help reduce tissue trauma in comparison to other minimally invasive lumbar fusion techniques.

1. Introduction

The two most established techniques for lumbar fusion are posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF), with the latter having the advantage of a more lateral approach to the vertebral canal, thereby, requiring less thecal sac retraction during cage implantation [1,2]. The introduction of the minimally invasive (MIS) transforaminal lumbar interbody fusion, which uses tubular dilators to implant pedicle screws, has led to a reduction in paraspinal muscle and soft tissue surgical injury [3]. Additionally, MIS-TLIF has been shown to reduce blood loss, hospital stay and postoperative infection rates compared to the standard open PLIF and TLIF approaches [4,5].

In this report, we introduce a surgical technique for lumbar decompression, realignment and navigated interbody fusion that combines advantages of the PLIF and TLIF approaches, called hybrid lumbar interbody fusion (HLIF).

2. Materials and methods

2.1. Patient population

From March 2012 to September 2012, seven patients with single level lumbar degenerative spondylolisthesis (DS) underwent nerve root decompression, realignment and arthrodesis using

* Corresponding author. Tel.: +49 351 458 2883; fax: +49 351 458 4304.
E-mail address: bernhard.rieger.com@gmail.com (B. Rieger).
[1] Contributed equally.

http://dx.doi.org/10.1016/j.jocn.2015.03.019
0967-5868/

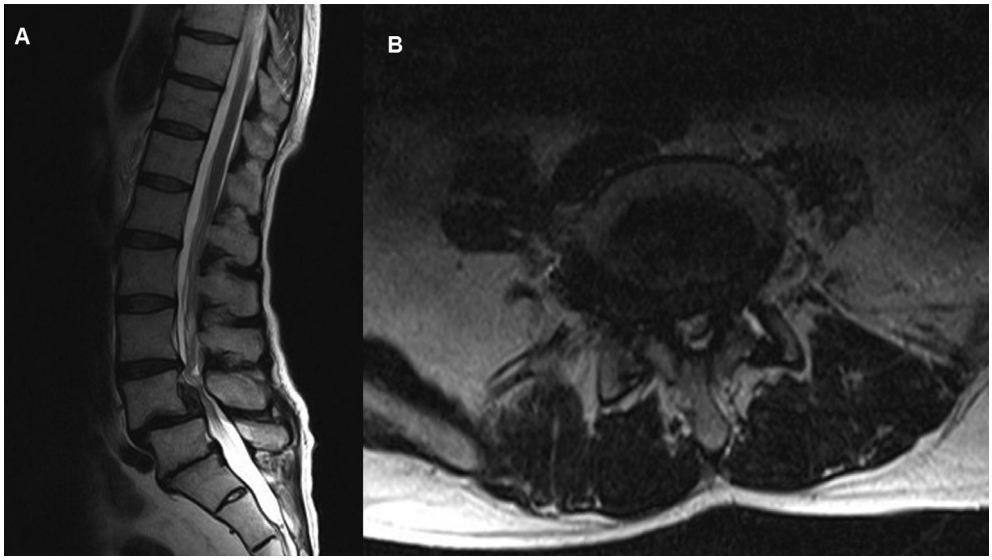

Fig. 1. Preoperative imaging. (A) Sagittal T2-weighted MRI and (B) axial T2-weighted MRI of a patient with severe neurogenic claudication showing degenerative spondylolisthesis and degenerative disc disease.

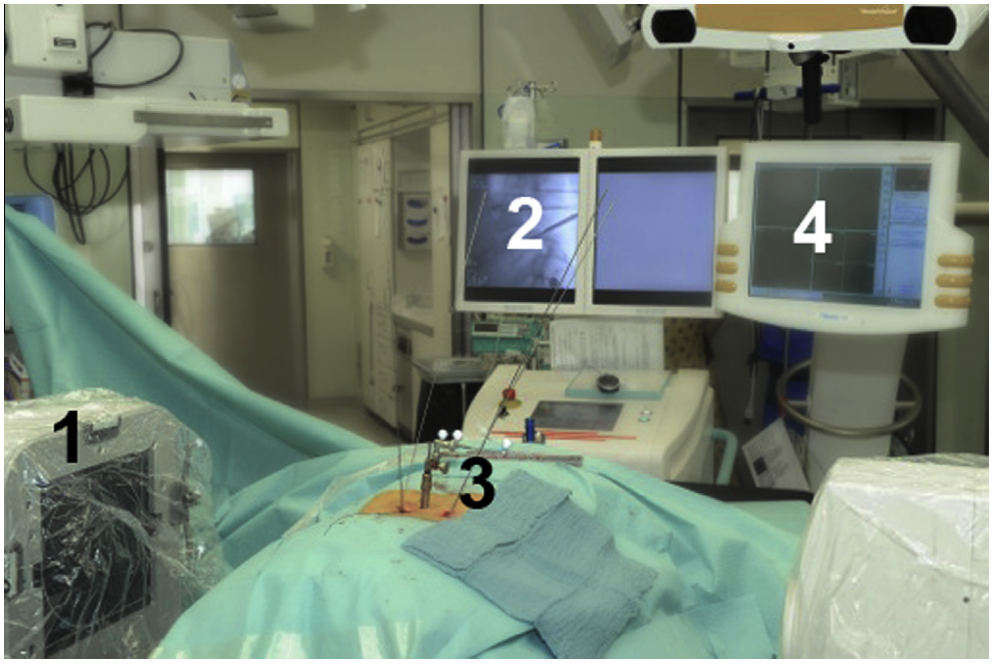

Fig. 2. Intraoperative setup. 1: C-arm, 2: fluoroscopic monitor, 3: reference array, 4: navigation monitor. This figure is available in colour at www.sciencedirect.com.

HLIF by one surgeon (B.R.). Low back and radiating pain were the predominant complaints leading to surgery. Patients underwent at least 6 months of non-operative, conservative management and none had previous surgery at the affected segment. Diagnosis was confirmed by functional radiographs (flexion/normal/extension), MRI and CT scans (Fig. 1). For further information regarding the evaluation of sagittal balance see the discussion and Supp. Figure 1.

2.2. Surgical technique

Surgery was performed with patients in the prone position. The C-arm was placed strictly perpendicular to the spinal axis (Fig. 2). A 30–40 mm posterior midline skin incision was made at the desired level. Microscopic decompression of the more symptomatic (ipsilateral) side was achieved via a laminotomy with additional undercutting for contralateral decompression and optional facetotomy (surgical opening of the facet joint). Ipsilateral partial facetectomy was performed to gain better access to the intervertebral disc space and facilitate cage implantation. Only the medial parts of the ipsilateral facet joint were removed (Fig. 3A). Bone fragments were collected for later bone graft and discectomy was performed. After segmental release, the reference array (Brainlab AG, Munich, Germany) was fixed to the cranial vertebra and a 3D navigation scan was acquired (Fig. 2). Two 5 mm skin incisions were made contralaterally, approximately 30 mm lateral to the midline (Fig. 3D) and guide wires were inserted under navigated and fluoroscopic control in a standard dorsolateral