



Original research

A cost-minimization analysis in minimally invasive spine surgery using a national cost scale method



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HIGHLIGHTS

- Evaluation of cost-effectiveness of percutaneous osteosynthesis in spine surgery.
- Comparison of clinical results and hospitalization costs versus open surgery.
- Methodology based on a national cost scale.
- Clinical outcomes after on 1-year follow-up appears similar.
- Percutaneous osteosynthesis appears more cost-effective.

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ABSTRACT

Introduction: The last decade has seen the emergence of minimally invasive spine surgery. However, there is still no consensus on whether percutaneous osteosynthesis (PO) or open surgery (OS) is more cost-effective in treatment of traumatic fractures and degenerative lesions. The objective of this study is to compare the clinical results and hospitalization costs of OS and PO for degenerative lesions and thoraco-lumbar fractures.

Methods: This cost-minimization study was performed in patients undergoing OS or PO on a 36-month period. Patient data, surgical and clinical results, as well as cost data were collected and analyzed. The financial costs were calculated based on diagnosis related group reimbursement and the French national cost scale, enabling the evaluation of charges for each hospital stay.

Results: 46 patients were included in this cost analysis, 24 patients underwent OS and 22 underwent PO. No significant difference was found between surgical groups in terms of patient's clinical features and outcomes during the patient hospitalization. The use of PO was significantly associated with a decrease in Length Of Stay (LOS). The cost-minimization revealed that PO is associated with decreased hospital charges and shorten LOS for patients, with similar clinical outcomes and medical device cost to OS.

Conclusions: This medico-economic study has led to choose preferentially the use of minimally invasive surgery techniques. This study also illustrates the discrepancy between the national health system reimbursement and real hospital charges. The medico-economic is becoming critical in the current context of sustainable health resource allocation.

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1. Introduction

Spine injuries can be the results of degenerative process and traumatic injuries. The degenerative process of thoraco-lumbar spine includes a broad range of diseases. Accurate estimation of their incidence is difficult due to the consolidation in many

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publications of various diseases under the term of “low back pain” and seems vary from 49 to 70% [1–3]. Traumatic spine fractures mainly concern men, with 50% aged less than 25 years. Spine fracture's incidence is 40–50 cases per million populations per year in Europe [4]. Patient's quality of life seems depend of the therapeutic management for both degenerative and traumatic associated lesions [5]. In fact, this management of such pathologies when unassociated with any neurological deficits has not yet been formalized. The choice between conservative and surgical treatment is based on clinical and radiological examinations.

Conventional surgery using the posterior approach has been widely described and has been shown to be effective for unstable fractures [6,7]. In this context and during the last decade, various new minimally invasive surgery (MIS) techniques have been proposed, including percutaneous osteosynthesis (PO) [8]. Originally aimed to treat degenerative pathologies [9], percutaneous pedicle screwing technique has been progressively introduced for the treatment of thoraco-lumbar fractures. Theoretically, their interest lies in performing surgery with reduced access to the operative site, leading to less muscle trauma and blood loss, in addition to shorter surgery duration, all of which should result in a reduction in postoperative pain. Previous studies have demonstrated earlier mobilization and a decrease in Length Of hospital Stay (LOS) with the same long-term effectiveness as conventional open surgery [10,11]. Many studies confirm the advantages of the MIS: a similar fusion rate and clinical outcomes, a MIS duration significantly shorter [11], reduction in postoperative pain improves patients' quality of life and a lower risk of intraoperative blood loss clearly favors PO [11,12]. Blood transfusion practices vary from one institution to another, and may be correlated with pre-operative patients characteristics [13]. Hematocrit levels have also been shown to be predictive in 30-day post-operative mortality and occurrence of cardiac events in patients undergoing non cardiac-surgery [14].

Despite these clinical benefits, the emergence of minimally invasive techniques appears to have been limited in some countries. Indeed, the value of this innovation by industry increased the price of implants.

Cost savings due to improved early clinical outcomes have been well documented with the emergence of other MIS procedures, such as laparoscopic gastrointestinal surgery [15], minimal access total hip arthroplasty [16], and thoracoscopic surgery [17]. Regarding the aging population evolution, the exponential increases in health care spending and various emerging technologies, clinical efficacy must be correlated with economic value in a context of constrained economic resources. Health care expenditure related to spine pathologies was over 86 billion dollars in 2005 in the United States [18]. Therefore, there is great interest in reducing treatment costs, both in the hospital itself and in terms of outpatient care costs, which include functional re-education fees, drugs, work leave and professional disqualifications.

To date there has been little medico-economic research published concerning PO vs. OS in the treatment of lumbar and thoracolumbar fractures. Moreover, it seems important to assess the economic impact of surgical innovation. Nevertheless these studies are essential to allow insurance agencies to understand as precisely as possible the cost of hospital stays and pathologies.

Currently, such evaluation requires the use of national database if local data appear not sufficient. In France, patient's hospital stay reimbursements have been based on a “rates per activity” system since 2004. All stays are classified according to a diagnosis-related group (DRG) classification (available at: <http://www.atih.sante.fr>). Each DRG corresponds to a rate of reimbursement, which is delimited by lower and upper thresholds of LOS. Each stay can be broken down into expenditure items dependent on LOS and others variables regardless of LOS (Fig. 1). Rate supported by a DRG health

insurance is determined using National Cost Scale (NCS). These NCS gather some hospitals (both general and university hospitals) well able to evaluate the cost of every DRG in non-reducible costs and costs adjustable to day of hospitalization.

2. Objectives

The objective of this retrospective medico-economic was to compare at the hospital point of view the clinical results and hospitalization costs of OS and PO for degenerative lesions and thoraco-lumbar fractures. Firstly, clinical iso-efficiency was controlled between the two therapeutic strategies. Secondly hospitalization costs of both surgical techniques for treatment of traumatic and degenerative lumbar and thoracolumbar fractures using a cost-minimization approach was evaluated. Costs calculated in both surgical groups were compared to “rates per activity” reimbursements in the French health insurance system using the NCS database.

3. Materials and methods

The study design is schematized in Fig. 2.

3.1. Patient population

This retrospective study involved a single-center series of patients at the University Hospital of Nantes, France. Patient recruitment was conducted from January 2009 to December 2011. All vertebral levels implanted extended from T10 to S1. The study was limited to a maximum of three vertebral levels of osteosynthesis in order to obtain uniformized groups.

All admissions of patients were classified using DRG as traumatic fractures or degenerative lesions according to the 10th and 11th French version of DRG. These data were extracted from the medical information system program (MISP). Patients who underwent conventional surgery or PO but classified in others DRG were not included.

Epidemiological and medical data from the Department of Medical Informatics were collected for each patient, including: gender, age, LOS, diagnosis, blood transfusion, American Society of Anaesthesiologists (ASA) score describing patient status before surgery [19], the number of vertebral levels implanted, operative site infection, blood transfusion, pre- and post-operative hematocrit levels, blood loss during procedure, procedure time, occurrence of operative lesions and need for functional re-education after spine surgery.

PO and OS were also compared separately for degenerative lesions and traumatic fractures.

3.2. Operative technique

Three attending surgeons from the Neuro-traumatology department performed all operations.

Open surgery (OS): OS was performed using P.L.U.S System™ instrumentation (Spine Vision, Antony, France) according to industrial recommendations. Briefly, a midline skin incision was used. The fascia was incised and the paravertebral muscles dissected from the spine. Radiographs were used to check the appropriate level. Bilateral pedicle screw-rod constructs were inserted and laminectomy was performed. The wound was copiously irrigated and skin incisions were sutured using separated stitches.

Percutaneous osteosynthesis (PO): PO was performed using Sextant™ (Medtronic, Minneapolis, USA) or Spirit™ instrumentation (Synthes, West Chester, USA) according to industrial

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