ORIGINAL ARTICLE

Medicoeconomic evaluation of total disc replacement based on French National Health Care System data

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KEYWORDS
Economic study; Total Disc Replacement; French National Health System

Summary
Introduction: Total disc replacement (TDR) has existed since 1984 but is not covered by the French national healthcare system (Sécurité Sociale). The present study assessed clinical outcomes, and also pre-, peri- and postoperative treatment costs.

Hypothesis: Surgical management of low back pain (LBP) provides medical and economic benefit.

Materials and methods: A prospective study recruited 19 patients in the Nice University Hospital Center (France); mean age, 41 years; 15 female. Inclusion criteria were: age less than 60 years; chronic low back pain (LBP) with single-segment discopathy; work-related injuries and patients not covered under the General provision of the Sécurité Sociale were excluded. VAS, Oswestry and SF36 scores and return to work capability were analyzed. The local national health insurance branch office (Caisse Primaire d’Assurance Maladie [CPAM]) provided detailed coverage data for a 39-month period around the operation.

Results: Revision surgery was required for one instance of vertebral fracture. Preoperative follow-up was 14 months, postoperative FU 21 months and the perioperative period 4 months. LBP and quality of life showed improvement. Seventy-nine percent of patients reported satisfaction, 59% returned to work, and 84% had leisure activity. Total CPAM payout (reimbursement) was €399,082. Daily sickness benefit and disability compensation were the main cost items. Mean TDR cost per patient was €6833. Mean reimbursements were 19% lower post- than preoperatively. Pre- and postoperative clinical results did not correlate, while pre- and postoperative reimbursement costs did, as did cost and postoperative clinical status (r = −0.72). Preoperative cost was a predictive factor for postoperative clinical result.

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Introduction

There is no medical consensus of the management of low back pain (LBP). Surgically, the reference attitude is fusion. For the last 20 years, an alternative, in the form of total disc replacement (TDR), has been available. Long-term clinical results in TDR are encouraging, according to the series reported by Lemaire et al. [1] and David [2].

The possible economic impact of TDR is not well determined. At the same time, the financial context of health care is a matter of heated debate, as expenditure is restricted. The cost of surgical management thus needs to be established, and also the size of the costs incurred postoperatively.

A prospective series of patients was followed up, and the real long-term costs of national health insurance scheme (Sécurité Sociale) coverage (reimbursements) were determined.

The aim of the study was to assess the cost of medicosurgical management before, during and after TDR and the relation between cost and clinical and radiological parameters. The cost of the implant, with a unit price of about €3,000, for which insurance coverage is an issue, was also taken into account. Is LBP improved, both medically and economically, by TDR?

The study was conducted with the help of the Provence-Alpes-Côte-d’Azur-Corse Regional Health Insurance Medical Department Authority (Direction Régionale du Service Médical: DRSM) and the Alpes-Maritimes area Health Insurance Office (Caisse Primaire d’Assurance Maladie: CPAM) who provided financial data on the exact amounts paid out (in the form of reimbursements) by the Sécurité Sociale.

Materials and methods

A continuous prospective descriptive study was run, with inclusion from July 2004 to May 2006 and clinical and economic follow-up until September 2007. Surgery was performed in two departments (Orthopedics and Neurosurgery) of the Nice University Hospital Center (France). Economic data were provided by the CPAM. Medicoeconomic and statistical analysis was performed by an independent observer with the help of the hospital’s Medical IT Department. The reliability of the data made this procedure seem preferable to the interview-based economic data collection approach used during the first year of the study.

Materials

Inclusion criteria
The diagnostic inclusion criterion was degenerative discopathy with chronic (>6 months) single-segment (L4L5 or L5S1) LBP. The age criterion was 20–60 years. Discography was performed in case of dual-disc involvement. Sciintigraphy and biological assessment for infection were performed for previously operated patients. Thirty patients meeting these criteria were operated on between July 2004 and May 2006.

Medical exclusion criteria
These include work accidents and occupational diseases; > 20° frontal or sagittal curvature abnormality; grade 3 or 4 posterior osteoarthritides; history of disc surgery of less than 6 months; compressive disc herniation with neurological deficit or sequestration.

Economic exclusion criteria
These include patients not covered by the General Scheme of the Sécurité Sociale and those resident outside of France or of the local administrative département.

Ten patients were excluded on economic criteria: four were resident in a different administrative département and one in a different country (Monaco). Four self-employed workers were covered by a different social health insurance scheme, limiting access to economic data. For one patient, although covered under the General provision, data were not available. Finally, one patient, considered an outlier for requiring very costly complication related revision, was excluded from the economic analysis, and will be reported elsewhere. Nineteen patients thus met economic inclusion criteria.

The series
The medicoeconomic series comprised 19 patients: five male and 14 female patients, with a mean age of 41 years (range, 24–53 yrs). Only three patients had history of disc surgery in the form of discectomy of the involved segment. Mean clinical follow-up was 25 months (range, 14–35 months). All patients received single-segment TDR: L5S1 in 11 cases, L4L5 in eight. Four types of implant were used: eight SB Charité III (®Link-Depuy), six MÖBIDISC (®LDR), three OMAV (®Sofamor Danek-Medtronic) and two PRODISC (®Aesculap-Synthes).

Methods

Clinical assessment
Pain was assessed on a visual analog scale (VAS) and quality of life (QoL) on self-administered questionnaires (Oswestry and SF36). Satisfaction scores and ability to return to occupational and personal (household, sports or else leisure) activity were recorded.

Economic assessment
TDR implants are not covered by the French Sécurité Sociale scheme, and were purchased using a dedicated €63,000 budget approved by the hospital’s Innovation Commission. The patients’ written informed consent to the economic study was obtained and the administrative departments concerned with national health insurance payouts were contacted; agreements were signed with the regional DRSM and the local CPAM.
Agreement was obtained from the French Information protection Agency (Commission Nationale de l’Informatique et des Libertés [CNIL]) to establish a medical database including personal information. Data covered a 39-month period around surgery for all patients. A data request to the accounts archive of the Sécurité Sociale retrieved the amounts paid out for the patients between March 1st, 2004 and May 23rd, 2007. For each patient, there were three unequal periods of follow-up (Fig. 1) according to their inclusion date, whereas the economic follow-up period was the same for all.

The preoperative period ran from March 1st, 2004 to 1 month before TDR; it lasted a mean 13.2 months (range, 3–24 months), and reflected the costs incurred for a non-operated chronic LBP patient. The perioperative period ran from 1 month preoperatively to 3 months postoperatively; it systematically lasted 4 months and reflected the costs entailed by the decision to operate: preoperative assessment, hospital stay around the operation, postoperative rehabilitation and systematic discharge medication up to month 3. This approximated the real cost of medicsurgical management. The postoperative period ran from the first day of the fourth postoperative month to May 23, 2007, for a mean 21.5 months (range, 11–32 months), and reflected the costs incurred after surgery for a chronic LBP patient operated on by TDR.

Amounts invoiced were subdivided into four cost categories:

- hospital stay, including all acts invoiced with the establishment’s code-number;
- daily sickness benefit paid out during sick leave and, at the end of the period of cover, disability compensation if the patient was entitled to this and did not return to work;
- health care charges, including all services performed by health-care professionals (family doctor, surgeon, radiologist, psychiatrist, nurse, physiotherapist, etc.);
- complementary charges, including pharmaceuticals, transport, biological analysis, orthoses, etc.

The inclusive overall cost incurred by Sécurité Sociale before, during and after TDR was thus displayed for these four main cost categories, as total gross sum and mean sum per patient and per month, so as to enable the costs to be weighted according to the individual period of follow-up. The objective was to compare management costs before and after TDR. Overall, expenditure was also displayed per specialty and per period of follow-up.

Clinical, social and radiological risk factors were explored for.

Statistical analysis used the non-parametric Mann-Whitney test (comparison of means) and Kruskall-Wallis test. When results on the latter were significant, pairwise comparison (Mann-Whitney) was performed with a significance threshold reduced to \( p = 0.01 \).

Quantitative variables were compared on the nonparametric Spearman test, to identify correlations between individual clinical and radiological parameters on the one hand and costs per patient and per month (divided by the individual period of follow-up) on the other. The significance threshold was set at \( p = 0.05 \). Analyses were performed using STATVIEW 5 software (SAS Institute Inc., Cary, NC).

**Results**

**Clinical**

There was one complication, at the beginning of our experience: an L5 posterior wall fracture sustained while...
Table 1  Gross reimbursements by the CPAM per patient over 39 months.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Global cost (€)</th>
<th>Pre-op cost per month (€)</th>
<th>Peri-op cost for 4 months (€)</th>
<th>Postop cost per month (€)</th>
<th>Pre-op FU (Months)</th>
<th>Postop FU (Months)</th>
<th>Post/pre-op gain (%)</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6717</td>
<td>105</td>
<td>4737</td>
<td>40</td>
<td>9.1</td>
<td>25.7</td>
<td>Decrease 62</td>
<td>Very satisfied</td>
</tr>
<tr>
<td>2</td>
<td>7498</td>
<td>133</td>
<td>4860</td>
<td>53</td>
<td>10.1</td>
<td>24.7</td>
<td>Decrease 60</td>
<td>Very satisfied</td>
</tr>
<tr>
<td>3</td>
<td>10,593</td>
<td>196</td>
<td>5656</td>
<td>129</td>
<td>6.6</td>
<td>28.1</td>
<td>Decrease 34</td>
<td>Very satisfied</td>
</tr>
<tr>
<td>4</td>
<td>11,552</td>
<td>271</td>
<td>5613</td>
<td>91</td>
<td>15.4</td>
<td>19.3</td>
<td>Satisfied</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>12,213</td>
<td>114</td>
<td>5832</td>
<td>258</td>
<td>17.9</td>
<td>16.8</td>
<td>Increase 125</td>
<td>Satisfied</td>
</tr>
<tr>
<td>6</td>
<td>12,504</td>
<td>169</td>
<td>6739</td>
<td>162</td>
<td>19.0</td>
<td>15.7</td>
<td>Decrease 4</td>
<td>Very satisfied</td>
</tr>
<tr>
<td>7</td>
<td>12,838</td>
<td>93</td>
<td>8373</td>
<td>140</td>
<td>8.5</td>
<td>26.3</td>
<td>Increase 51</td>
<td>Satisfied</td>
</tr>
<tr>
<td>8</td>
<td>14,039</td>
<td>287</td>
<td>6229</td>
<td>197</td>
<td>10.9</td>
<td>23.8</td>
<td>Increase 31</td>
<td>Very satisfied</td>
</tr>
<tr>
<td>9</td>
<td>14,105</td>
<td>116</td>
<td>4877</td>
<td>314</td>
<td>8.5</td>
<td>26.3</td>
<td>Increase 171</td>
<td>Satisfied</td>
</tr>
<tr>
<td>10</td>
<td>15,052</td>
<td>381</td>
<td>4416</td>
<td>208</td>
<td>19.8</td>
<td>15.0</td>
<td>Decrease 45</td>
<td>Disappointed</td>
</tr>
<tr>
<td>11</td>
<td>15,178</td>
<td>859</td>
<td>7467</td>
<td>157</td>
<td>3.2</td>
<td>31.5</td>
<td>Satisfied</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>22,076</td>
<td>747</td>
<td>5216</td>
<td>282</td>
<td>15.2</td>
<td>19.5</td>
<td>Decrease 62</td>
<td>Very disappointed (invalidity)</td>
</tr>
<tr>
<td>13</td>
<td>23,340</td>
<td>545</td>
<td>6788</td>
<td>393</td>
<td>19.0</td>
<td>15.7</td>
<td>Decrease 28</td>
<td>Satisfied</td>
</tr>
<tr>
<td>14</td>
<td>23,763</td>
<td>314</td>
<td>6438</td>
<td>742</td>
<td>19.7</td>
<td>15.0</td>
<td>Increase 137</td>
<td>Satisfied</td>
</tr>
<tr>
<td>15</td>
<td>29,639</td>
<td>1945</td>
<td>7267</td>
<td>324</td>
<td>6.9</td>
<td>27.9</td>
<td>Decrease 83</td>
<td>Very satisfied</td>
</tr>
<tr>
<td>16</td>
<td>32,788</td>
<td>1137</td>
<td>9120</td>
<td>579</td>
<td>6.4</td>
<td>28.3</td>
<td>Decrease 49</td>
<td>Very satisfied (invalidity)</td>
</tr>
<tr>
<td>17</td>
<td>38,164</td>
<td>367</td>
<td>11282</td>
<td>1652</td>
<td>23.7</td>
<td>11.0</td>
<td>Increase 350</td>
<td>Satisfied</td>
</tr>
<tr>
<td>18</td>
<td>41,013</td>
<td>836</td>
<td>6851</td>
<td>1056</td>
<td>11.4</td>
<td>23.3</td>
<td>Increase 26</td>
<td>Disappointed (invalidity)</td>
</tr>
<tr>
<td>19</td>
<td>56,009</td>
<td>1079</td>
<td>12057</td>
<td>1517</td>
<td>20.0</td>
<td>14.8</td>
<td>Increase 41</td>
<td>Disappointed (invalidity)</td>
</tr>
</tbody>
</table>

The bold characters shows which patients are with invalidity, meaning secondary benefits.
introducing the implant. The patient showed a neurological deficit, and surgical revision with decompression was performed on a posterior approach. At 2 years’ follow-up, neurological recovery remained incomplete, with disabling low back pain. Radiography at 2 years’ FU found an implant impacted in the L5 body with absence of spontaneous intervertebral fusion. The patient was, at the time of writing, suing the Nice University Hospital Center and refusing any

Table 2  Distribution of total expenditure for the 3 follow-up periods.

<table>
<thead>
<tr>
<th>In Euros</th>
<th>Total over 39 months’ FU</th>
<th>Pre-op over a mean 13.2 months’ FU</th>
<th>Peri-op over a mean 4 months’ FU</th>
<th>Postop over a mean 21.5 months’ FU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number and cumulative time of economic FU</td>
<td>n = 19; 736 months’ FU</td>
<td>n = 19; 251 months’ FU</td>
<td>n = 19; 76 months’ FU</td>
<td>n = 19; 409 months’ FU</td>
</tr>
<tr>
<td>Daily benefit and disability compensation</td>
<td>153,466</td>
<td>61,533</td>
<td>16,082</td>
<td>75,851</td>
</tr>
<tr>
<td>Hospital stay</td>
<td>130,024</td>
<td>13,506</td>
<td>91,104</td>
<td>25,414</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>42,900</td>
<td>17,145</td>
<td>5875</td>
<td>19,880</td>
</tr>
<tr>
<td>Radiology</td>
<td>17,072</td>
<td>5009</td>
<td>3943</td>
<td>8120</td>
</tr>
<tr>
<td>Physiotherapy</td>
<td>14,186</td>
<td>5969</td>
<td>2013</td>
<td>6203</td>
</tr>
<tr>
<td>General medicine</td>
<td>13,183</td>
<td>4811</td>
<td>1751</td>
<td>6621</td>
</tr>
<tr>
<td>Laboratory</td>
<td>11,497</td>
<td>4206</td>
<td>2817</td>
<td>4474</td>
</tr>
<tr>
<td>Ambulances</td>
<td>4240</td>
<td>817</td>
<td>2025</td>
<td>1398</td>
</tr>
<tr>
<td>Psychiatry</td>
<td>2231</td>
<td>1307</td>
<td>251</td>
<td>673</td>
</tr>
<tr>
<td>Orthopedic surgery</td>
<td>1862</td>
<td>249</td>
<td>1320</td>
<td>293</td>
</tr>
<tr>
<td>Physical medicine</td>
<td>1626</td>
<td>44</td>
<td>810</td>
<td>772</td>
</tr>
<tr>
<td>Nuclear medicine</td>
<td>1575</td>
<td>598</td>
<td>0</td>
<td>978</td>
</tr>
<tr>
<td>Nursing</td>
<td>1514</td>
<td>138</td>
<td>1101</td>
<td>276</td>
</tr>
<tr>
<td>Misc. Suppliers</td>
<td>1279</td>
<td>236</td>
<td>311</td>
<td>732</td>
</tr>
<tr>
<td>Anesthesiology</td>
<td>904</td>
<td>207</td>
<td>130</td>
<td>567</td>
</tr>
<tr>
<td>Rheumatology</td>
<td>777</td>
<td>661</td>
<td>23</td>
<td>93</td>
</tr>
<tr>
<td>Neurology</td>
<td>574</td>
<td>0</td>
<td>241</td>
<td>333</td>
</tr>
<tr>
<td>Neurosurgery</td>
<td>173</td>
<td>129</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>399,082</td>
<td>116,565</td>
<td>129,818</td>
<td>152,699</td>
</tr>
<tr>
<td>Cost per patient per month</td>
<td>542</td>
<td>464</td>
<td>1708</td>
<td>373</td>
</tr>
<tr>
<td>Post-/pre-op gain</td>
<td>—19%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The bold characters show the most important numbers, the one to remember.

Figure 2  Cost distribution by category and period of FU.

surgical revision. This case was excluded from the economic analysis.

Pain as assessed on the VAS fell from a mean 7.5 (± 2) preoperatively to 3.9 (± 3) at 3 months’ FU and 3.6 (± 3) at end of follow-up (2 years postoperatively).

Mean Oswestry score fell from 46.6 (± 12) preoperatively to 28.8 (± 20) at 3 months’ FU and 25.2 (± 21) at end of follow-up; in mean global SF-36 score rose from 34.1 (± 10) preoperatively to 64.5 (± 27) at 3 months’ FU and 67.7 (± 26) at end of follow-up (2 years postoperatively).

Eleven patients (59%) returned to work (including two to a lower activity level job) and eight (41%) did not (4 on disability compensation, one unemployed and three with persistent pain).

Sixteen patients (84%) resumed sports activity (seven without restriction and nine patients at a lower level than hoped) and three patients were unable to.

Fifteen patients (79%) resumed their household activity (including four at a lower level) and four did not.

Fifteen patients (79%) declared themselves very satisfied (n = 8) or satisfied (n = 7) with the operation; three were disappointed and one very disappointed.

Four patients received disability compensation following TDR; three of them were disappointed and one was very satisfied with the result of the operation as compared to his preoperative condition. None of the dissatisfied patients agreed to surgical revision by posterior fusion.

**Economic**

The purchase of 19 implants cost €46,959. Over the 39 months of follow-up, the 19 patients totalled costs of €399,082 (excluding implants), or a mean €21,004 per patient (range, €6717–56,009). Table 1 and Fig. 1 present total and period-based costs per patient. Five of the 19 patients accounted for 50% of the total expenditure; three of the five were in receipt of disability compensation. Table 2 and Fig. 2 present results per period and per specialty. Overall, management costs per patient per month fell by 19% between the preoperative (€464/mo/patient) and postoperative periods (€373/mo/patient). The mean cost of TDR over the 4-month perioperative period was €6,833 per patient (range, €4416–€12,057).

Daily benefit was the prime cost in both pre- and postoperative periods. Hospital costs ranked second (except during the perioperative period, when they were the main cost item).

**Statistics**

There was no significant correlation between preoperative clinical status and postoperative clinical result, or between preoperative clinical status and preoperative costs, or between preoperative psychological status (SF-36) and postoperative costs. Nor were there any significant differences according to gender, type of implant or radiological parameters (implant positioning or disc space reconstruction).

There were significant correlations (Table 3) between: postoperative clinical status and postoperative costs; preoperative costs and postoperative clinical status; pre-, peri- and postoperative costs; and age and both post- and perioperative costs.

Satisfied patients showed lower costs than dissatisfied patients.

**Discussion**

The present study concerned a small series at short follow-up, but without loss to follow-up. The data collection methodology is reliable and reproducible, the IT request procedure in the CPAM database being standardized. The exactitude of the economic data thereby retrieved is much greater than would be the case using patient interviews. The cost taken into account is technically a reimbursement, approximating the real cost of the service. The present study was conducted before the so-called “act-based pricing” (Tarification à l’Acte [T2A]) came into force in France, making the present results more rigorous inasmuch as no deductible fixed charges were involved. It is difficult in France to come by reliable data for the real costs involved in a given pathology, and in that context it is interesting to develop a methodology for assessing the real costs associated with a new health-care technique.

One case of vertebral fracture occurred at the beginning of the present experience: the corresponding economic assessment represented not the cost of the TDR but that of the surgical management of a complication. This type of complication is reported elsewhere [3–8], and implant design has since improved so as to limit incidence.

Medicoeconomically, the present results confirm that TDR in our restricted indications achieves both clear clinical benefit and clear cost-saving (19%) on postoperative medical care as compared to the preoperative period.

Analysis of failure found that no patients agreed to revision using posterior fusion. This Patient’s attitude limiting further eventual improvement, cast some doubt on their supposed dissatisfaction.
It is important to identify pre-operative risk factors for poor postoperative clinical and/or economic results with the present procedure. No preoperative clinical or radiological factors emerged as predictive of the postoperative medicoeconomic result.

Preoperative cost, on the other hand, did correlate significantly with postoperative clinical result and with postoperative cost, which in turn correlated with one another. Satisfied patients showed lower postoperative costs and more frequently returned to work. It may be concluded that preoperative economic assessment is a good predictor of postoperative clinical and economic results.

Analysis of the medicoeconomic data further found that older patients had higher peri- and postoperative costs. The older the patient is at surgery, the higher perhaps the risk of posterior osteoarthritis (not necessarily prevented by the interbody arthroplasty), or of anterior osteoarthritis at adjacent levels.

Seventy-five percent of patients with poor clinical results were eligible for disability compensation, and daily benefit and disability compensation were found to predominate in overall costs both pre- and postoperatively. The literature makes it clear that disability compensation is a chronicity factor in chronic LBP, independently of treatment option [9—11]. Moreover, the lack of anatomoclinical correlation with diagnosis, so often reported in vertebral surgery [12], applies equally to treatment inasmuch as financial benefits are reported to induce discrepancy between objective and subjective assessment in chronic LBP patients [13—17]. Work accidents were excluded from the present series, to limit the issue of side-benefits [13—16,18—22]; on the other hand, our methodology, although based on General provision Sécurité Sociale data, did not allow the self-employed (4/30) to be included (this no doubt had the effect of restoring the balance of the series in this regard). Chronic LBP is a pathology in which the various treatment options achieve only limited success, and in which management is often costly, with a high rate of disability compensation paid to young active patients. In this context, it is especially worth looking into a treatment option able to improve quality of life and socio-occupational integration.

The international literature reports wide methodological heterogeneity, with different methods of assessing the cost of medico-surgical management of chronic LBP. A literature search retrieved "market studies" [23], "economic models" [24], "comparative studies" [25], many "cost-effectiveness studies" [26,27], and "cost assessments" [28,29]. It is difficult to make comparisons across health systems and different systems of social insurance and reimbursement. There are in fact "as many methods as authors", making comparison between studies impossible. Indeed, Soegaard et al. [30], in a review of the literature, demonstrated that none of them are scientifically reliable.

We were not able to find any medicoeconomic studies of LBP in the literature that used a methodology comparable to the present one.

In the French-language literature, Haumesser [31], in 2004, followed up 100 chronic LBP patients managed by discectomy, using accountancy data from the Metz CPAM. Mean global cost per patient was €15,679 (range, €1769—47,876). Daily benefits made up more than half of this, and were the main form of reimbursement. The present results were similar, as the target population was similar; disability compensation, however, was not taken into account in Haumesser’s study, limiting the possibilities of direct comparison.

Such medicoeconomic studies can only be interpreted in their own context: in a given country, in a given period. In the present study, performed in 2007 under the French Sécurité Sociale system, TDR represented a cost of €6833 per patient over 4 months of care (to which the cost of the implant itself has to be added). After the third postoperative month, costs varied according to clinical result.

The financial impact of TDR is complex, as the available epidemiological data for LBP are fragmentary, as pointed out in the ANAES [32,33] and HAS [34] reports, which cautiously estimated the potential target population at 600 to 6500 patients per year.

**Conclusion**

Medicoeconomic data are required in assessing our medical practices; it must not, however, be forgotten that the aim of any medical care is above all to improve the patient’s quality of life: a purely economic perspective is to be resisted, as it is all too liable to slip irremediably into abuse.

Surgical management of degenerative lumbar lesions is classically founded on intervertebral fusion; TDR, however, now extends treatment options in restricted indications.

The present study showed that TDR provides favorable medical and economic outcomes, especially in young and active chronic LBP patients.

**Disclosure of interest**

The authors declare that they have no conflicts of interest concerning this article.

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