Cost-effectiveness of posterior lumbar interbody fusion in the Japanese universal health insurance system

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ABSTRACT

Background: Globally, the cost-effectiveness of spinal surgery is becoming increasingly important. However, these data are limited to a few countries. The purpose of our study was to examine the cost/quality adjusted life year (cost/QALY) gained for posterior lumbar interbody fusion (PLIF) in the Japanese universal health insurance system.

Methods: Fifty five patients underwent PLIF for lumbar degenerative spinal canal stenosis between July 2013 and September 2015 was included. Effectiveness was measured using Euro QOL 5-dimension (EQ-5D), Short-Form 8 physical component summary (PCS), and visual analog scale (VAS). The cost was calculated from the perspective of the public healthcare payer. Effectiveness and cost were measured one year after surgery. QALYs were calculated by multiplying the utility value (EQ-5D) and life years. Only direct costs were included on the basis of actual reimbursements. Cost/QALY at a 5-year time horizon with a 2% discount rate was estimated. Sensitivity analysis was performed by varying the time horizon (2 years or 10 years). The exchange rate was defined as US $1 to Japanese 100 yen.

Results: Mean total cost one year after surgery was ¥2,802,900 ($2802.9). Operative cost was ¥1,779,700 ($1779.7). Mean gained score was 0.22 in EQ-5D, 10.3 in PCS, and 44 in VAS. Cost/QALY was ¥2,697,500 ($2697.5). Sensitivity analysis demonstrated that cost/QALY at a 10-year time horizon was ¥1,428,300 ($1428.3) and that cost/QALY at a 2-year time horizon was ¥6,435,400 ($6435.4).

Conclusions: Clinical outcomes after PLIF improved beyond minimum clinical improvement difference. Cost/QALY was below the widely-accepted benchmark (cost/QALY < $50000). PLIF could be regarded as cost-effective interventions.

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1. Introduction

Posterior lumbar interbody fusion (PLIF) provides good decompression for the nerves, stabilization for the spine, and excellent fusion rate [1]. As the fusion procedures become sophisticated and less invasive, the number of spinal fusion increases [2]. However, recently, there will be an additional emphasis on cost-effectiveness and the value of the treatment. In distribution of limited healthcare resources, value-based purchasing or pay for performance models are becoming important [3].

Consequently, increasing numbers of cost-effectiveness studies on spine surgery have been reported [4–7]. However, the cost-effectiveness of an intervention would be changed depending on the health insurance system and the economic situation of the country [8]. Currently, cost-effectiveness data of spine surgery are available only in a few countries.

The universal health insurance system in Japan provides quality healthcare with comparatively low costs [9,10]. To the best of our knowledge, no study has investigated the cost-effectiveness of spinal surgery in Japan. The purpose of this study was to analyze the cost-utility of PLIF.

2. Method

2.1. Study participants and demographics

Our institutional review board approved the study. The study participants were 61 consecutive patients who underwent PLIF in
our hospital between July 2013 and September 2015. The study patients had leg pain or neurogenic claudication due to radiculopathy and/or cauda equina syndrome with or without low back pain. The patients did not respond to conservative treatment like medication and/or epidural blocks and were referred to the hospital. Six patients were excluded for the following reasons: 3 patients for missing score, 2 for loss to follow-up, and 1 for death due to myocardial infarction 6 months after surgery. Finally, 55 patients were included in the study.

Table 1 shows the demographic data of the study participants. Table 2 shows the details of surgery. Mean age was 70 ± 10 years. There were 40 patients with degenerative spondylolisthesis, 6 patients with isthmic spondylolisthesis, 3 patients with foraminal stenosis, 3 patients with spinal deformity, 2 patients with post laminectomy syndrome, and 1 patient with massive central disc herniation with a posterior opening of the disc on a flexion lateral radiograph. There were 37 patients with 1-level PLIF, 12 patients with 1-level PLIF + laminctomy on the other levels, 2 patients with 1-level PLIF + posterolateral fusion on the other levels, 2 patients with 2-level PLIF, one patient with 2-level PLIF + fenestration on the other levels, and one patient with 2-level PLIF + posterolateral fusion on the other levels. Mean hospital stay was 34 days (SD, 20; median, 28; range, 13 to 121). Three patients returned to the operating room: 2 due to hematoma and one due to spinal leakage. These patients had the longest hospital stays and highest costs. One patient with iatrogenic drop foot was transferred to a rehabilitation institute 65 days after surgery. This cost in the rehabilitation institute was not included in this study. All the other patients returned directly to their homes.

2.2. Costs

Direct costs were calculated from the perspective of the public health care payer. Indirect costs were excluded because there was no definite method for estimating them [11].

Our hospital employs the Diagnosis Procedure Combination/Per-Diem Payment System (DPC/PDPS) [12]. In DPC/PDPS, provider reimbursement for inpatient medical care was calculated by adding reimbursement from a diagnosis-related group prospective payment system and reimbursement from a fee-for-service system (Fig. 1). Reimbursement in the prospective payment system was calculated by multiplying a 3-staged flat-rate per-diem fee (Fig. 2), length of hospital stay, and coefficient set for each hospital (1.3222 for our hospital). Only operation and outpatient care costs were reimbursed based on a fee-for-service. In Japan, 66% of large hospitals (beds > 200) use this payment system, corresponding to 53.1% of general beds [12].

Operative costs included everything involved in the surgery: surgical procedures, anesthesia, spinal implants, medicine, blood transfusion, intraoperative blood salvage, etc. In DPC/PDPS, no items except for operation, rehabilitation, meals, procedures over ¥ 10,000, or procedures that were specially approved were reimbursed. For example, blood tests, imaging tests, or medications in inpatient care were not reimbursed because they were regarded as included in the per-diem cost. Preoperative outpatient care cost included the consultation fee, blood test, imaging test (radiography, magnetic resonance imaging, computed tomography [CT]), cardiorespiratory test, autologous blood donation, etc. Postoperative outpatient care cost mainly comprised the consultation fee and imaging test.

2.3. Effectiveness

The utility value was measured using the Euro QOL 5-dimensional (EQ-5D)-3L Japanese version with value-set (1 = perfect health, 0 = death). Physical component summary (PCS) of the Short Form 8 (Larger = better), visual analog scale (VAS) for the buttocks and lower limbs (100 = worst pain, 0 = no pain), and VAS for the low back were used as secondary outcomes. Outcomes were collected prior to surgery and 1-year postsurgery via self-administered questionnaires. The quality-adjusted life years (QALYs) were calculated by multiplying the utility value and life years. The primary endpoint was the necessary cost to gain 1 QALY (cost/QALY).

2.4. Time horizon, discount rate, currency, and sensitivity analysis

We assumed that the gained utility value one year after surgery lasted in the 5 years time horizon [13], in accordance with previous cost-effectiveness studies [6,14,15]. After the second year of operation, we assumed that patients visited annually for follow-up. This future cost was estimated ¥ 6000/year based on the reimbursement system.

The utility value and cost were discounted at an annual rate of 2% based on the Japanese guideline [11]. All costs were expressed in Japanese yen. To compare the previous cost-effectiveness studies in other countries, the exchange rate was defined as US $1 to Japanese 100 yen.

One-way sensitivity analyses were conducted to determine how uncertain data affects the results. We varied the time horizon (2 years, or 10 years), discount rate (0% or 4%), and the cost of spinal implants (half-price or double price).

3. Results

Table 3 shows the costs and the breakdowns. Mean total cost one year after surgery was ¥ 2,802,900 (SD, ¥ 517,700; median, ¥ 2,673,800; range, ¥ 2,200,300 to ¥ 4,802,500). Operative cost was ¥ 1,779,700 (SD, ¥ 2,79,500; median, ¥ 1,690,600; range, ¥ 1,542,400 to ¥ 3,030,700) and DPC/PDPS cost was ¥ 717,800 (SD, ¥ 148,700; median, ¥ 714,000; range, ¥ 389,000 to ¥ 1,122,200). Operative cost included ¥ 417,700 for technical fee, ¥ 169,500 for bone graft, ¥ 921,300 for spinal implant, ¥ 185,600 for anesthesia, ¥ 69,000 for intraoperative blood salvage or autologous blood transfusion, and ¥ 20,600 for other consumable supplies. Outpatient fee for preoperative examination was ¥ 55,400 and outpatient fee for postoperative examination was ¥ 45,300. Lumbar orthosis was ¥ 26,100.

Table 1  Demographic data.a

<table>
<thead>
<tr>
<th>N</th>
<th>Women, n</th>
<th>Age, year</th>
<th>Hospital stay, day</th>
</tr>
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<tbody>
<tr>
<td>55</td>
<td>27 (55%)</td>
<td>70 ± 10</td>
<td>34 ± 20</td>
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</table>

Table 2  Details of surgical procedures and levels.

<table>
<thead>
<tr>
<th>n</th>
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<tbody>
<tr>
<td>1-level PLIF</td>
</tr>
<tr>
<td>1-level PLIF + fenestration on the other levels</td>
</tr>
<tr>
<td>1-level PLIF + posterolateral fusion on the other levels</td>
</tr>
<tr>
<td>2-level PLIF</td>
</tr>
<tr>
<td>2-level PLIF + fenestration on the other levels</td>
</tr>
<tr>
<td>2-level PLIF + posterolateral fusion on the other levels</td>
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</tbody>
</table>

* Data are presented as mean values ± SD (standard deviation).
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