Direct medical costs after surgical or nonsurgical treatment for degenerative lumbar spinal disease: a nationwide matched cohort study with a 10-year follow-up

Chi Heon Kim
Seoul National University

Chun Kee Chung (chungc@snu.ac.kr)
Seoul National University

Yunhee Choi
Seoul National University Hospital

Juhee Lee
Seoul National University Hospital

Seung Heon Yang
Seoul National University Hospital

Chang Hyun Lee
Seoul National University Bundang Hospital

Sung Bae Park
Boramae Medical Center

John Rhee
Emory University

Moon Soo Park
Hallym University

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Abstract

Demand for degenerative lumbar spinal disease treatments has been increasing, leading to the increased utilization of medical resources. The present study compared the direct costs between surgical and nonsurgical treatment. The national health insurance service sample cohort was used in a matched cohort study comparing surgical treatment (n=2,698) with nonsurgical treatment (n=2,698). Insurance covers both Western and Asian medicine. First, the overall monthly costs were compared between cohorts. Second, the monthly costs were compared at 1, 3, 6, 9, and 12 months after treatment and yearly thereafter for 10 years. The surgery cohort spent $50.84/patient/month, and the nonsurgery cohort spent $29.34/patient/month ($p<0.01$). Surgery cost more ($2,762) than nonsurgical interventions ($180.4) ($p<0.01$). Compared with the nonsurgery cohort, the surgery cohort paid $33/month more for the first 3 months, paid less for the first 12 months, and paid approximately the same over the course of 10 years. Surgery initially cost more than nonsurgical interventions, but the costs incurred during the follow-up period were not higher. The results of the present study should be interpreted in light of the costs of medical services, indirect costs, quality of life and societal willingness to pay.

Introduction

The demand for degenerative spinal disease treatments has been increasing and has led to the increased utilization of medical resources, including surgical treatments and nonsurgical treatments, such as exercise, physical therapy, medication and other interventions.[1-8] Many countries have been trying to provide optimal medical services to their residents, but there is also an issue of how to utilize limited resources, especially in regard to a budget.[9,10] Ideally, from the perspective of the society, we need to understand how the budget is currently being used.[10] A National Health Insurance System (NHIS) is one tool that the government can use to take responsibility in providing medical services to the general population while balancing the efficient use of resources.[11-14] In the Republic of Korea (ROK), all citizens have been beneficiaries of the national health insurance system (NHIS) for more than 20 years, and the NHIS covers both Western and Asian medicine.[11-14] Because the NHIS follows a fee-for-service payment system, all nationwide inpatient and outpatient data on diseases and services (i.e., procedures and operations) are coded and registered in the National Health Insurance Corporation (NHIC) database and the Health Insurance Review & Assessment Service (HIRA) database.[6,11-16] By using the database, the National Health Insurance Service-National Sample Cohort (NHIS-NSC) was identified in 2017 for analysis while maintaining representativeness and protecting personal information.[16] The objective of the present study was to evaluate the utilization of the NHIS for degenerative lumbar spinal disease by comparing the direct medical costs between patients who underwent surgery and patients who did not undergo surgery.

Materials And Methods

Study design

A matched cohort study design was used for the present study. Initially, patients were selected from the NHIS-NSC on the basis of diagnosis and surgery codes. Thereafter, the following factors were considered for matching: the total cost incurred over the past 3 years (which was assumed to be a surrogate for disease severity), age, sex, diagnosis, osteoporosis without fractures and diabetes mellitus. The categorical factors were matched exactly. The continuous variables were matched with a difference of no more than 3 years for age and no more than $73 for the total cost incurred over the past 3 years, which were considered similar enough between matched pairs. This study used NHIS-NSC data (NHIS-3017-2-494) made by National Health Insurance Service (NHIS). The requirement for informed consent was waived because the data were deidentified, and Seoul National University College of Medicine/Seoul National University Hospital Institutional Review Board approved the review and analysis of the data (2010-076-116). **All methods were carried out in accordance with relevant guidelines and regulations**

Data source[17-19]

The National Health Insurance database (NHID) was developed to record the personal information, demographics and medical treatment data for all Korean citizens.[16] The disease codes were standardized based on the 10th version of the International Classification of Diseases (ICD-10), and the procedure codes were standardized to the claim medical fees.[11,13,14,20] The NHIC set guidelines encouraging nonsurgical treatment to be performed for at least 6 weeks before surgery for patients with lumbar disc herniation (LDH) and 3 months for patients with lumbar spinal stenosis with or without spondylolisthesis.[12,13] Nearly all hospitals providing Western medicine and clinics providing Asian Medicine must follow the guidelines to obtain reimbursement. The detailed surgical and nonsurgical methods were determined by the attending physicians.[11,13,20] The NHIS-NSC is a representative sample cohort, and 1,000,000 people (2.1% of the total Korean population) were randomly selected from a total population of 48,438,292 in 2006 (https://nhiss.nhis.or.kr/bd/ab/bdaba021eng.do).[16] Systematic stratified random sampling with proportional allocation within each stratum was conducted.[16] The strata included those for sex, age, location, and health insurance type (insured employees, insured self-employed individuals or medical aid beneficiaries).[16] The resident registration number was replaced with a newly assigned eight-digit personal ID, which enables longitudinal follow-ups to be performed.[16] During the follow-up period, the cohort was updated annually; a representative sample of newborns were included, and the size of the cohort was maintained.[16] The same cohort included any claims from hospitals, pharmacies and Asian medicine clinics. The records for each person in the NHIS-NSC can be traced back to 2002.

Study group

The present study included patients diagnosed with LDH, lumbar spinal stenosis without spondylolisthesis, lumbar spinal stenosis with spondylolisthesis, and spondylolysis, which followed the hierarchical coding algorithm for the diagnosis proposed by Martin et al.[21] The surgery cohort was selected in the following way (Fig 1): initially, patients underwent surgery between 2006 and 2008 were

searched with specific procedure codes (open discectomy N1493; laminectomy, N1499 and N2499; endoscopic lumbar discectomy, N1494; spinal fusion, N0466, N1466, N0469, N2470, N1460 or N1469) and disease codes (LHD, M51-, M472; lumbar spinal stenosis without spondylolisthesis, M4800, M4805-8; lumbar spinal stenosis with spondylolisthesis, M431, M4315-9; spondylolysis, M430, M4306-9), and 4,577 patients were selected. Among them, patients with the following conditions were excluded, and 3,881 patients remained in the surgery cohort: 1) a history of spinal surgery within the past 3 years, 2) a history of using medical services with disease codes for spinal fracture, pathological fracture, spinal infection, any kind of malignancy, or inflammatory joint disease within the past 1 year, 3) a concomitant rare disease such as a metabolic disease, blood disease, or congenital anomaly, 4) admission via the emergency room, and 5) an age less than 18 years.

The nonsurgery cohort was selected in the following way (Fig 1): the patients who visited clinics more than 3 times/year or were admitted to the hospital more than 2 days/year with the same diagnosis as was the surgery cohort were searched, and 63,498 patients were selected. Among them, patients with the following conditions were excluded, and 54,850 patients remained in the nonsurgery cohort: 1) a history of spinal surgery within the past 3 years, 2) a history of using medical services with disease codes of spinal fracture, pathological fracture, spinal infection, any kinds of malignancy, or inflammatory joint disease withing the past 1 year, 3) a concomitant rare disease such as a metabolic disease, blood disease, or congenital anomaly, and 4) an age less than 18 years.

After matching, 2,698 patients remained in each cohort, and each patient was individually followed for 7-10 years with their unique ID (Fig 1). Treatment failure was defined as any kind of lumbar spinal surgery being performed after the initiation of either surgical or nonsurgical treatment.

Statistical analysis

The average monthly cost was compared between the surgery cohort and the nonsurgery cohort (Fig 1). Among the nonsurgery cohort, the monthly cost for patients initially undergoing an intervention (intervention cohort) was separately compared with that of the surgery cohort (Fig 1). The intervention cohort was matched to the surgery cohort to compare the initial costs and average monthly costs at the following times: 1, 3, 6, 9, and 12 months after treatment and yearly thereafter. The initial cost for surgery was defined as the cost incurred during admission for surgery, and the initial cost for the intervention was defined as the cost incurred during the first 1 month after being matched to the surgery cohort. The costs are represented as the mean (SD), and the values were compared with paired t-tests between groups. The reoperation rate (%)was compared between groups using the McNemar test. The Bonferroni method was applied to control the level of type I error for multiple tests. The patient characteristics were summarized as medians (minimums, maximums) for continuous variables and as frequencies (proportions) for categorical variables. The surgical methods included open discectomy, endoscopic discectomy, discectomy and fusion and laminectomy without discectomy for LDH. For the other diagnoses, the surgical methods included decompression only and decompression with fusion. The conservative treatments included the following: injection procedure [KK061-, N1495-]) and medication/physiotherapy

(prescribed medicine, therapeutic exercise [MM101-] and chiropractic [51040]. All analyses were conducted using SAS, version 9.4 (SAS Institute, Cary, NC), and $P < 0.05$ (two-tailed) indicated statistical significance.

Results

The characteristics and matched factors were well balanced between the matched cohorts (Table 1). The median age was 57 years, and females comprised 56% of each cohort. LDH was the most common diagnosis, affecting 45.5% of the cohorts, followed by spinal stenosis without spondylolisthesis (39.3%), spinal stenosis with spondylolisthesis (13.3%) and spondylolysis (2%). Each patient spent $190 over the past 3 years. Osteoporosis was present in 28% of patients, and diabetes mellitus was present in 15% of patients in each cohort. The surgical methods and nonsurgical methods are described in Table 2. Each patient underwent only one surgical treatment but underwent either or both nonsurgical treatments. Open discectomy was the preferred surgical method for LDH. Fusion surgery was performed in 12% of spinal stenosis cases without spondylolisthesis and was performed in 35-39% of spondylolisthesis or spondylolysis cases. Nonsurgical intervention was performed in 51% of LDH cases and in 70% of spinal stenosis cases with or without spondylolisthesis (Table 2). The average monthly cost in the surgery cohort was $50.84/patient/month, while the cost in the nonsurgery cohort was $29.34/patient/month ($p < 0.01$) (Table 3). The average cost of surgery was also significantly higher than that in the intervention cohort ($39.89) ($p < 0.01$) (Table 3). Initially, surgery cost more ($2,761.5) than the nonsurgical intervention did ($180.4) ($p < 0.01$) (Table 4). Compared with the intervention cohort, the surgery cohort paid more by $33/month for the initial 3 months, paid less for 12 months, and paid a similar amount thereafter for 10 years (Table 4, Fig 2). Treatment failure occurred in 15% of the surgery cohort and 9% of the nonsurgery cohort ($p < 0.01$) (Table 5). When the diagnoses were considered separately, the patients with LDH and spinal stenosis without spondylolisthesis showed a higher failure rate after surgery than did the nonsurgery patients, but the patients with spinal stenosis with spondylolisthesis did not have different failure rates, while patients with spondylolysis had lower failure rates.

Discussion

The objective of the present study was to compare the medical costs after treatment for degenerative lumbar conditions between surgery and nonsurgery cohorts. The present study showed that the monthly cost was higher in the surgery cohort than in the nonsurgery cohort and intervention cohort. Initially, surgery was costlier than were the nonsurgery and intervention options. However, the maintenance cost for the surgery cohort was not higher than that of the intervention cohort over 10 years. The results of the present study need to be interpreted with consideration of the cost of medical services, indirect costs, patient quality of life, society's willingness to pay (WTP), and the guidelines of insurance institutes for each society, and these issues will be discussed.[22]

Surgery vs nonsurgery for spinal degenerative disease

Whether surgical or conservative treatments for degenerative spinal disease should be administered has been a controversial issue.[21,23-30] The issue has been addressed by randomized controlled trials (RCTs) and cost-effectiveness analyses.[10,21,23-35] Weinstein JN et al. organized a randomized controlled trial (Spine Patient Outcomes Research Trial, SPORT) to assess the clinical outcomes of surgical and nonsurgical treatments.[28,29] The SPORT study reported more favorable clinical outcomes after surgery than after nonsurgical interventions in patients with spinal stenosis with and without spondylolisthesis.[23,25] Daffiner S et al. analyzed the costs for 30,709 patients with LDH who received nonsurgical care before ultimately undergoing surgery by using a health insurance database.[22] During the preoperative 3 months, $105,799,925 was spent for nonsurgical treatment ($3,445/patient), and the intervention accounted for 32% of the cost. Considering that the cost of surgery was $7,841, the total cost could have been reduced by early surgery. [22] The costs and clinical outcomes were considered together in a cost-effectiveness analysis.[26] Tosteson AN et al. summarized the cost-effectiveness of surgery: Surgery improved quality of life to a greater extent than did nonsurgery and the cost per QALY (quality-adjusted life year) was $20,600 (95% CI: $4,539, $33,088) for LDH, $59,400 (95% CI: $37,059, $125,162) for spinal stenosis without spondylolisthesis, and $64,300 (95% CI: $32,864, $83,117) for spinal stenosis with spondylolisthesis at 4 years.[24] Based on these results, early surgery is recommended as a cost-effective option.[22] Those estimates were based on the medical costs, and they would be higher if indirect costs, 75% of which can be attributed to the costs for low back pain, had been considered simultaneously.[36] However, the recommendation was made on the basis of the high costs of nonsurgical medical services. The present results showed that the cost of surgery was $2761.50 and that the cost of nonsurgical medical services, including injection procedures, was $180.40/patient/month. Therefore, according to the NHIS results, conservative treatments may be cost-effective in the ROK. The cost of medical services and society's WTP vary according to the medical system and economy of each society, which can influence the interpretation of those results.[37-39]

Use of registered health care data for better management

Although RCTs that focus on clinical outcomes can provide robust recommendations for spinal clinical practice,[25,26,28,29] cost-effectiveness is important to physicians, patients and health insurance institutes.[26,30,39,40] These issues are quite serious for spinal disease, considering the recent increase in the number of cases, high cost of surgery/intervention and maintenance cost after treatment.[8,39] Because the coverage policy of insurance influences the practice pattern, safety and cost of spinal surgery, the stakeholders of insurance institutions should know the current utilization of healthcare services.[10,41,42] Although those issues have been analyzed by using medical records, the costs varied among societies to obtain a generalized picture of the utilization of medical services.[24,27,43-48] This issue could be addressed by using registered data to reveal the big picture.[21,24-30,43-48] Recently, claim data have not only been used for accounting but also been used to improve the management of spinal disease.[9,10,20,22,34,42-45,49-54] National population-based data can be utilized to accomplish goals, such as determining the change in the number of surgical cases, average cost for treatment, use of resources and factors influencing

cost.[32,54,55] For example, Martin et al. used claim data to indicate a potential overuse of spinal fusion surgery amid a similar reoperation rate and increased surgical cost.[33] The issues of an increased cancer risk and reduced reoperation rate after using bone morphogenic protein in lumbar fusion surgery were addressed by using claims data.[31,51] Although the analysis of claim data is a retrospective type of analysis, this type of analysis leads to low selection bias by encompassing a large population over a large area and, consequently, providing a robust result.[31,33,51] The current study utilized NHIS-NSC data, which represent the entire population in the ROK, to obtain a comprehensive nationwide picture of health care utilization and to provide a practical estimate.[54] The results can be referenced in the future to make budget plans and modify insurance services.

Strengths And Limitations

To the best of our knowledge, the present study is the first to compare direct medical costs between surgery and nonsurgery under NHIS over a long-term follow-up period.[16,19] However, the present study has several limitations. As mentioned, the claim data lack detailed clinical and radiological information, which limits the direct application of the results to clinical practice.[10,32,33] In addition, claims data do not assess the over/underuse of treatments by physicians or over/underutilization of insurance services by patients. Moreover, the current results cannot be generalized because the thresholds and indications for surgery and the outcomes of treatments are not uniform across doctors and the NHIS influences the indications by enforcing reimbursement restrictions.[10,14,50,53] In the ROK, medical fees for services that are not covered by insurance represent approximately 35% of medical costs, and the actual direct costs can be estimated as the total cost*(100/65).[56] All these factors need to be acknowledged together when the results of claim data analyses are used in clinical practice or policy making. Second, only direct costs were analyzed, and indirect costs, such as missed work and medical fees for noncovered services, were not considered in this study.[19,54,57] In addition, as with most cost-effectiveness studies, specific dollar values might not be equivalent among studies, and the WTP considering the benefits and risks of each surgical method in different countries may lead to different interpretations.[38,44] Regardless of these limitations, the present study provides a picture of how the NHIS is utilized on a nationwide scale, and this information may be helpful for physicians, patients and policy makers for improving the NHIS.

Conclusion

Surgery was initially more costly than was nonsurgical treatment. However, it was not more costly 3 months after treatment for up to 10 years. The results of the present study need to be interpreted with consideration of the costs of medical services, indirect cost, patient quality of life and society’s WTP.

Declarations

Credit author statement

Conceptualization; Kim CH, Choi Y, Chung CK

Data curation; Choi Y, Lee J

Formal analysis; Kim CH, Choi Y, Lee J

Funding acquisition; Kim CH, Chung CK

Methodology; Kim CH, Chung CK, Yang SH, Lee CH, Park SB, Park MS

Project administration; Chung CK

Software; Choi Y, Lee J

Supervision; Rhee JM

Validation; Kim CH, Park MS, Rhee JM

Roles/Writing - original draft; Kim CH, Choi Y

Writing - review & editing; Chung CK, Rhee JM

Conflict of Interest and Source of Funding:

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Tables

Table 1. Characteristics of the cohorts.

Cohorts	Surgery n = 2,698	Nonsurgery n = 2,698
Age (median [min, max])	54.85 (14.19)	54.98 (14.19)]
Sex, n (%)		
Male	1,162 (43.07)	1,162 (43.07)
Female	1,536 (56.93)	1,536 (56.93)
Diagnosis		
Disc herniation	1,229 (45.55)	1,229 (45.55)
Spinal stenosis	1,059 (39.25)	1,059 (39.25)
Spondylolisthesis	360 (13.34)	360 (13.34)
Spondylolysis	50 (1.85)	50 (1.85)
Cost ($) during past 3 years*	366.67 (453.58)	366.47(453.99)
Osteoporosis without fracture, n(%)	763 (28.28)	763 (28.28)
Diabetes Mellitus, n(%)	406 (15.05)	406 (15.05)

*$1 = 1,150 Korean won

Table 2. Details of the treatments

Diagnosis	Methods	Surgery cohort	Nonsurgery cohort
		N=2,698	**N=2,698**
Lumbar disc herniation	Surgery*	**n=1,229**	**n=1,229**
	Open discectomy	1,002 (81.53)	
	Endoscopic discectomy	125 (10.17)	
	Laminectomy	53 (4.31)	
	Discectomy and fusion	49 (3.99)	
	Nonsurgery†		
	Intervention	582 (47.36)	629 (51.18)
	Medication/Physiotherapy	1,213 (98.70)	1,229 (100.00)
Lumbar spinal stenosis without spondylolisthesis	Surgery	**n=1,059**	**n=1,059**
	Decompression	923 (87.16)	
	Instrumentation and fusion	136 (12.84)	
	Nonsurgery		
	Intervention	647 (61.10)	745 (70.35)
	Medication/Physiotherapy	1,052 (99.3)	1,059 (100.00)
Lumbar spinal stenosis with spondylolisthesis	Surgery	**n=360**	**n=360**
	Decompression	233 (64.72)	
	Instrumentation and fusion	127 (35.28)	
	Nonsurgery		
	Intervention	220 (61.11)	259 (71.94)
	Medication/Physiotherapy	360 (100)	360 (100.00)
Spondylolysis	Surgery	**n=50**	**n=50**

	Decompression	31 (62)	
	Instrumentation and fusion	19 (39)	
	Nonsurgery		
	Intervention	24 (48.00)	28 (56)
	Medication/Physiotherapy	50 (100)	50 (100.00)

*Each patient underwent only one surgical method.

†Each patient underwent either or both treatments.

Table 3. The monthly cost for each treatment

		Surgery (N = 2,698)	Nonsurgery (N = 2,698)		P-value*	P-value†
			Intervention (n = 1,661)	Medication/Physiotherapy (n = 2,698)		
Lumbar disc herniation	N	1229	629	1229		
	$	36.29 (45)	26.53 (34.92)	18.33 (38.08)	<.01*	<.01*
Spinal stenosis without spondylolisthesis	N	1059	745	1059		
	$	61.46 (85.96)	47.13 (68.28)	38.53 (61.94)	<.01*	<.01*
Spinal stenosis with spondylolisthesis	N	360	259	360		
	$	68.28 (55.98)	51.9 (89.53)	40.78 (78.47)	<.01*	<.01*
Spondylolysis	N	50	28	50		
	$	57.61 (41.48)	36.3 (42.56)	22.8 (35.43)	<.01*	<.01*
Total	N	2,698	1,661	2,698		
	$	50.84 (66.72)	39.89 (62.77)	29.34 (55.81)	<.01*	<.01*

*surgery vs. med/physiotherapy (total nonsurgery)

†Surgery vs. Intervention

Table 4. The monthly cost after the initiation of treatment during each period (units, US dollar).

	Surgery		Nonsurgery (intervention)		Difference
	mean	SD	mean	SD	Mean
0	2,761.5	1,952.1	180.4	460	2,581.1*
3	89.4	265.5	56.4	162.7	33*
6	43.3	229	50.6	196.9	-7.3
9	28.4	114.3	39.1	148.9	-10.7
12	25.1	114.7	43.8	170	-18.6*
24	31.2	108.2	38.4	101.2	-7.1
36	26.3	120.1	31.2	102.8	-4.9
48	25.6	101.2	32.3	98.7	-6.7
60	25	112.5	28	94.1	-3
72	31.5	133.1	28.9	105	2.6
84	33.5	149.4	26.1	112.3	7.4
96	28.3	118.8	19.9	103.1	8.4
108	14.2	84.5	10.7	95.4	3.5
120	3.2	22.8	2.9	46.7	0.3

*Statistically significant with a 0.0036 (=0.05/14) p value with Bonferroni correction

Table 5. Failure of treatment

	Surgery			Nonsurgery			P-value
	Patients	reoperation	Rate (%)	Patients	reoperation	Rate (%)	
lumbar disc herniation	1,229	195	15.87	1,229	86	7.00	<0.01
Spinal stenosis without spondylolisthesis	1,059	171	16.15	1,059	106	10.01	<0.01
Spinal stenosis with spondylolisthesis	360	42	11.67	360	48	13.33	>0.05
Spondylolysis	50	2	4.00	50	5	10.00	>0.05
total	2,698	410	15.20	2,698	245	9.08	<0.01

Figures

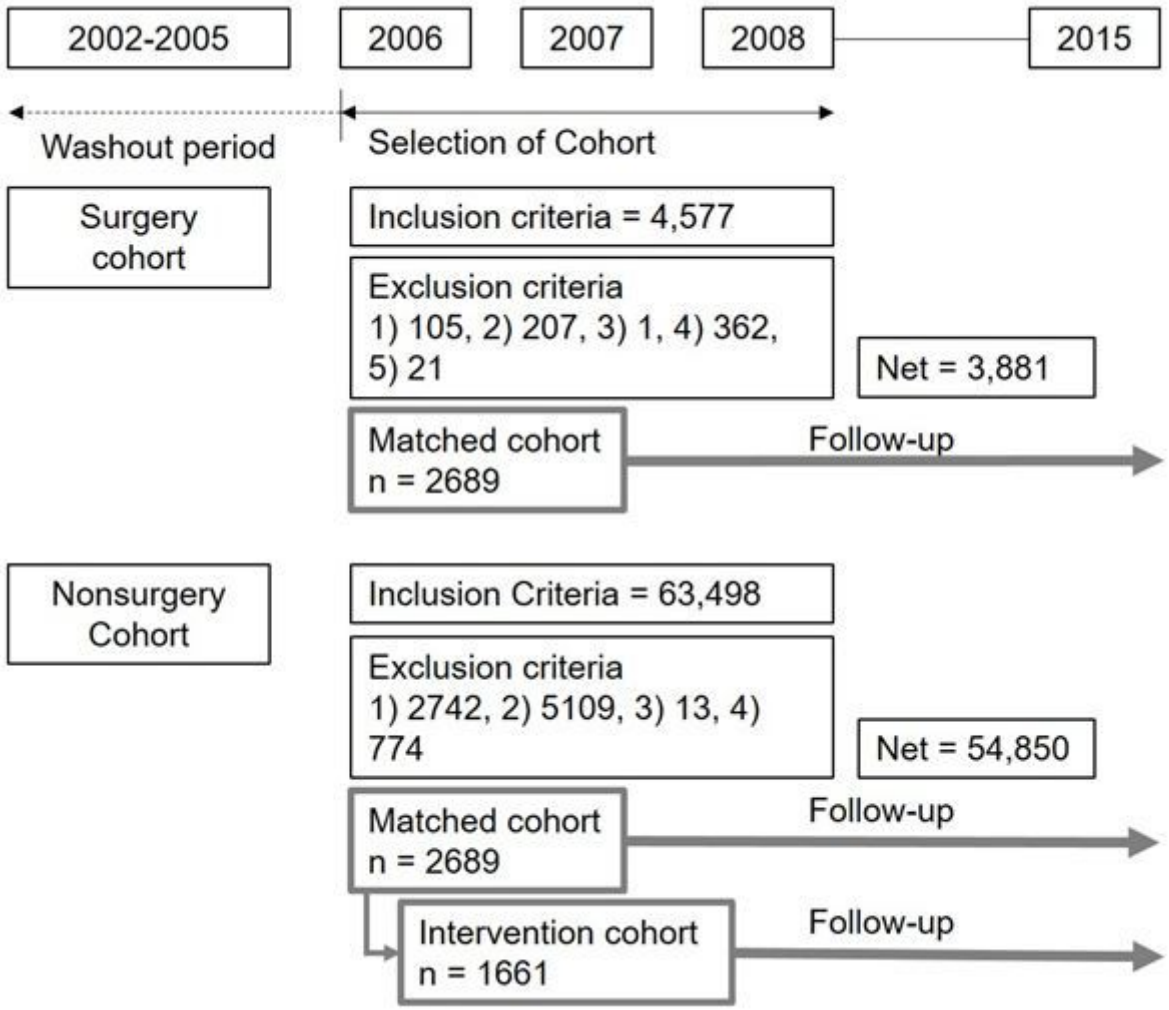

Figure 1

Process of selecting patients.The number of patients were described in the box. The detailed inclusion and exclusion criteria are described in the manuscript. Exclusion criteria in the surgery cohort: 1) a history of spinal surgery within the past 3 years, 2) a history of using medical services with disease codes for spinal fracture, pathological fracture, spinal infection, any kind of malignancy, or inflammatory joint disease within the past 1 year, 3) a concomitant rare disease such as a metabolic disease, blood disease, or congenital anomaly, 4) admission via the emergency room, and 5) an age less than 18 years. Exclusion criteria in the nonsurgery cohort: 1) a history of spinal surgery within the past 3 years, 2) a history of using medical services with disease codes of spinal fracture, pathological fracture, spinal infection, any kinds of malignancy, or inflammatory joint disease withing the past 1 year, 3) a concomitant rare disease such as a metabolic disease, blood disease, or congenital anomaly, and 4) an age less than 18 years.

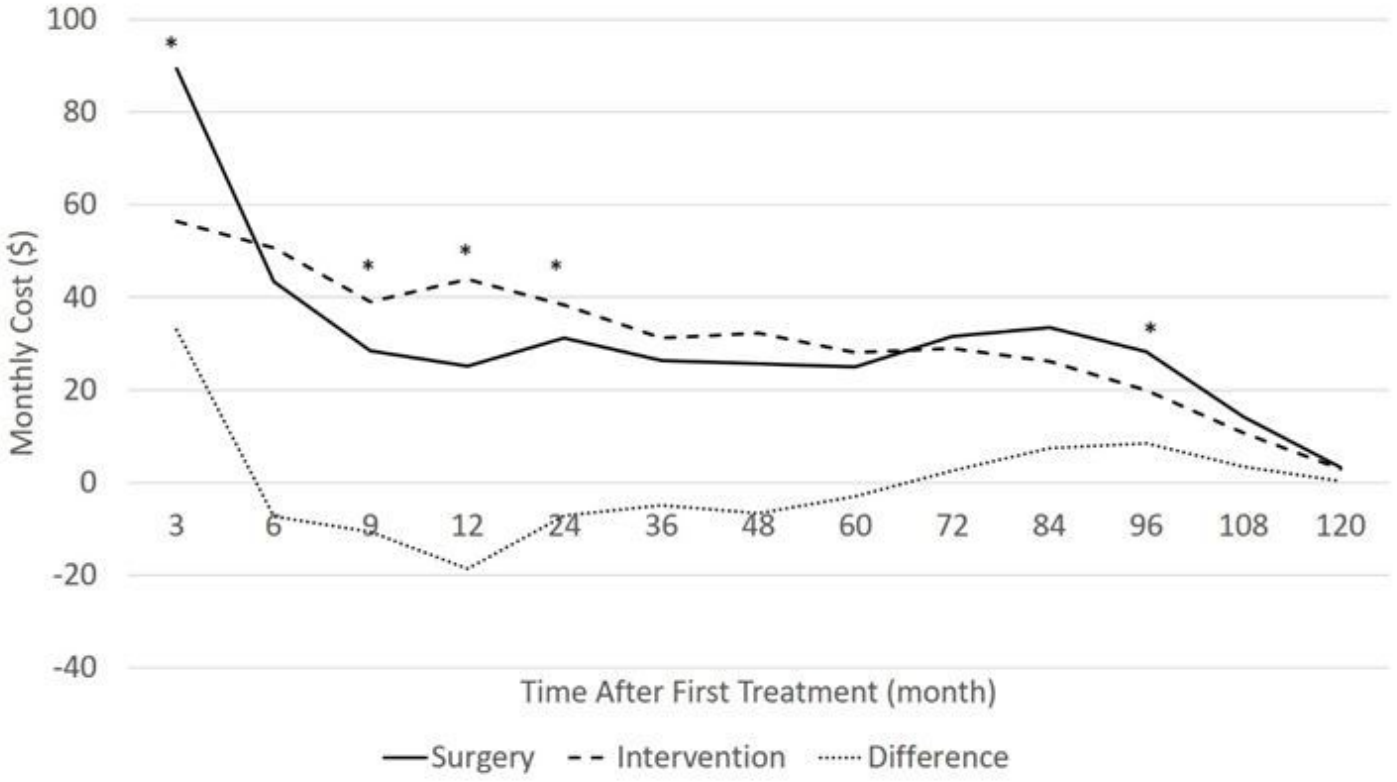

Figure 2

Monthly cost after treatment. The average monthly costs are plotted in the graph. Difference = surgery – intervention. Asterisk (*) implies statistically significant difference between surgery and intervention.