Cost-Utility study for operative methods in spinal surgery

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AIM: The purpose of the present study is to evaluate the quality of life (QoL) of patients with spinal problems before and after surgery with the use of the EQ-5D-5L health status questionnaire.

MATERIALS - METHODS: The research is based on primary data collection of 314 patients who completed the questionnaires at three different times: a) preoperatively; that is, after completion of conservative treatment which involved medication, physiotherapy, etc., b) ten days postoperatively and c) immediately after the first post-operative month.

RESULTS: Out of the 314 patients, aged between 34 and 79 years (mean age 52±15,07) who participated in this study, 172 were males (54,8%) and 142 females (45,2%). 77,71% of the patients suffered from a herniated intervertebral disc and 22,29% from spondylolisthesis in the lumbar region.
Total improvement of the quality of life (QoL) in our study was on average 0,59 QALYs at 10 days and 0,82 QALYs at 30 days. The total average direct cost of these surgical interventions amounted to 9341,86±4042,53 euro while the index of cost-utility for the sample population was estimated to be 15870,16 euro/ QALY at 10 days. This index decreased considerably to 11867,14 euro/ QALY at 30 days after the surgical intervention since the average benefit in QALYs increased and the QoL improved.

CONCLUSIONS: The evaluation of the data of this study was highlighted the high degree of effectiveness of each surgery applied to treat the symptomatology of patients . All the statistical tests applied to the sample showed a very significant improvement of all variables used by the questionnaire for all intervals evaluated after surgery. Lastly, there has also been a very large improvement in the overall QoL of patients.

KEY WORDS: Utility, Cost, Quality of Life, Spinal Column.

INTRODUCTION

Cost and utility are increasingly important elements of the health care debate. Despite the plethora of cost-utility analyses in many medical specialties, there has been little research on spinal procedures. This shortage is significant because this specialty represents one of the most expensive areas of medicine. In this context many articles deal with the general principles of cost-utility analyses and research related to cost and efficacy in neurosurgical units to date. The need to standardise the measurement of costs and usefulness in the context of neurosurgery is underlined and a set of measurements is defined for this purpose.

Neurosurgeons, in addition to surgeries that save patients' lives from death, often also operate on conditions aimed primarily at relieving the patient's pain. Unfortunately, where resources are limited, these surgical operations are considered of lesser importance and are not covered by private insurances. The result of this policy is the prolonged suffering and inability to work of patients with conditions of good long-term prognosis. However, when the effective treatment of spinal diseases is postponed, these, in the long run, can lead into permanent disability. This is particularly true in cases of black disc or lumbar stenosis (Räsänen et al., 2006).

According to the Centers for Disease Control and Prevention, in the United States in 2010, about 1.2 million neurosurgical operations were performed. The cost of lumbar laminectomies alone exceeded $2 billion, while spinal fusions nationwide in 2011 cost $12.8 billion (Zygourakis & Kahn, 2015).

Spinal surgeons were among the first to enter the cost-benefit sector due to the high cost of their operations, the importance of QoL in these conditions and the requests of insurance companies to justify their surgical interventions.

One of the first studies, published in 2005, was a prospective study that investigated whether EuroQol-5D can also be used in waist operations. The sample consisted of 326 patients who had surgery on the lumbar spine. The validity and response of EuroQol-5D with the valid Oswestry Disability Index ODI was tested, which is the indicator used by clinicians and researchers to quantify disability in lumbar diseases. The results showed that EQ-5D can be used to assess the health status of operated patients in the lumbar spine because it provided valid results (Solberg et al., 2005). This study was the beginning of the use of cost-utility analysis in spinal diseases.

The following year, a cost-usefulness analysis study of neurosurgery was conducted in a sample of 270 patients. The 15-dimensional HRQOL was used as a tool and QALYs as a unit of measurement. The results of the study showed that the cost / QALY amounted to 2774 for

neck operations, while for lumbar surgery it amounted to 1738. Notable was also the fact that the delayed surgeries, for various reasons, had the twice cost / QALY (Räsänen et al., 2006).
Three years later, in 2009, came the researchers' next concern, with a more theoretical study, which dealt with the impact of financial evaluation on quality management in spinal surgery. In addition to the cost-utility analysis, where no data were available, all financial evaluations in neurosurgery were studied and concluded that there was a research gap, stressing the need for its coverage. They called for a health care reform to reduce the cost of surgeries, as it was required by market law, but also to increase the quality of life of patients (Boos, 2009).
Also, in 2011 the application of Transforaminal Longitudinal Interbody vertebral Fusion (TLIF) for grade I degenerative spondylolisthesis was investigated and it was found that the cost-utility ratio, during the 2 postoperative years , it was $42,854/QALY that was earned, while the same relationship for recurrent lumbar stenosis (at the same or at an adjacent level),also during the 2 post-operative years, it was $80,594/QALY that was earned (Adogwa et al., 2011).
In the same year, Van den Akker et al. (van den Akker et al., 2011), compared open microdiscectomy with minimally invasive microdiscectomy. A cost-utility analysis was carried out on 325 patients from 7 Dutch Hospitals. The results showed that minimally invasive microdiscectomy is of greater use but there were no significant differences in cost and QALYs between these two methods. Therefore, Minimally Invasive Microdiscectomy has little chance of being more cost-effective than the conventional open method.
With the increasing popularity of Minimally Invasive Spinal Surgery (MISS) many recent Cost-Utility Analyses (CUA) have focused on determining the cost-usefulness of newer invasive spinal techniques, such as minimally invasive TLIF or tubular (percutaneus) discectomy (transdermal microdiscectomy), compared to traditional open approaches. The results of studies of minimally invasive surgical techniques were mixed, with some studies suggesting that minimally invasive approaches are cost-effective and others presenting an equivalent cost-benefit ratio for minimally invasive and open approaches.
In this article we describe the results of a cost-utility analysis of spinal surgeries in a private clinic in Greece, included some cases of robotic assisted percutaneous lumbar fusion.

MATERIALS - METHODS

The research carried out and the data which will be analysed in this part, aims to assess the QoL of patients who have experienced spinal problems before and after surgery, using the Q-5D-5L questionnaire in patients who were operated on at a private clinic , Metropolitan Hospital, New Faliro, Greece. Concomitantly, the total direct cost of the operations was recorded in order to determine the cost-utility ratio. The primary survey included 314 patients. The data was collected by patients using a questionnaire and the measurements was carried out at three different times; the first one immediately preoperatively (i.e., after procedures of medication and physiotherapy had been applied), the second one ten days postoperatively and the last one at the end of the first postoperative month .

People who formed the sample of the survey, were asked to complete the Greek version of the questionnaire EQ-5D-5L, with the help of the trainer. In addition to the basic questionnaire, a supplementary questionnaire recording patient demographics was completed, which included 18 closed-ended questions. For the assessment of QoL, was used the questionnaire EQ-5D-5L , which was available for the purposes of the study in Greek, free of charge, from the EuroQoL Research Foundation (Yfantopoulos, 2001). The questionnaire contains five questions on QoL with five answers each, as well as a visual proportional scale of 20 cm in length, calibrated from 0 to 100. The combination of the answers to this questionnaire leads to 3125 possible combinations corresponding to possible health situations. The quality of life index (EQ index value) was calculated on the basis of the instructions in the questionnaire user manual, using the algorithm for the population of Spain (van Hout et al., 2012), (Ramos-Goñi et al., 2018) as there is no corresponding algorithm for the Greek population.

For the assessment of compensation and the costing of surgical procedures on the spine of our patients' sample, were requested financial data from the accounting department of the private clinic, while the determination of the cost of conservative treatment was based on international bibliographic data.

Statistical Analysis

In order to determine whether there was statistically significant difference between the responses to the five questions (Mobility, Self-care, Usual activities, Pain/ Discomfort, Anxiety/ Depression) as well as for the overall QoL index (Visual Analogue Scale or VAS score) (with values ranging between 0-100, where 100 corresponds to best health and 0 to worst health) as shown in the self-evaluation questionnaire of the state of health, we used the nonparametric Wilcoxon Signed Rank Test and we compared the patients' mean responses for all variables

(6 in total). More specifically, we compared the patient's state of health in pairs (three pairs at a time) before surgical intervention, at 10 days and at 30 days after surgical intervention for each disease separately. Statistically significant were the results with $p< 0,05$.

RESULTS

Demographics

The study involved 314 patients, aged 34 to 79 (average age 53±15.07 years, median age 53 years) of whom 172 were men (54.8%) and 142 women (45.2%).

77.71% of patients suffered from herniated intervertebral disc, while the remaining 22.29% suffered from spondylolisthesis.

Evaluation of the overall state of patients' health

On the day of the intervention, each patient recorded his perceived state of health on a scale from 0 to 100 (Visual Analogue Scale or VAS score) and then he recorded the number that corresponded to his choice.

The average overall health of 314 patients prior to surgery was 0.08±0.31 units, while the corresponding average 10 days after surgery was 0.59±0.25 units and 30 days postoperatively was 0.82±0.18 units **(Diagram 1)**.

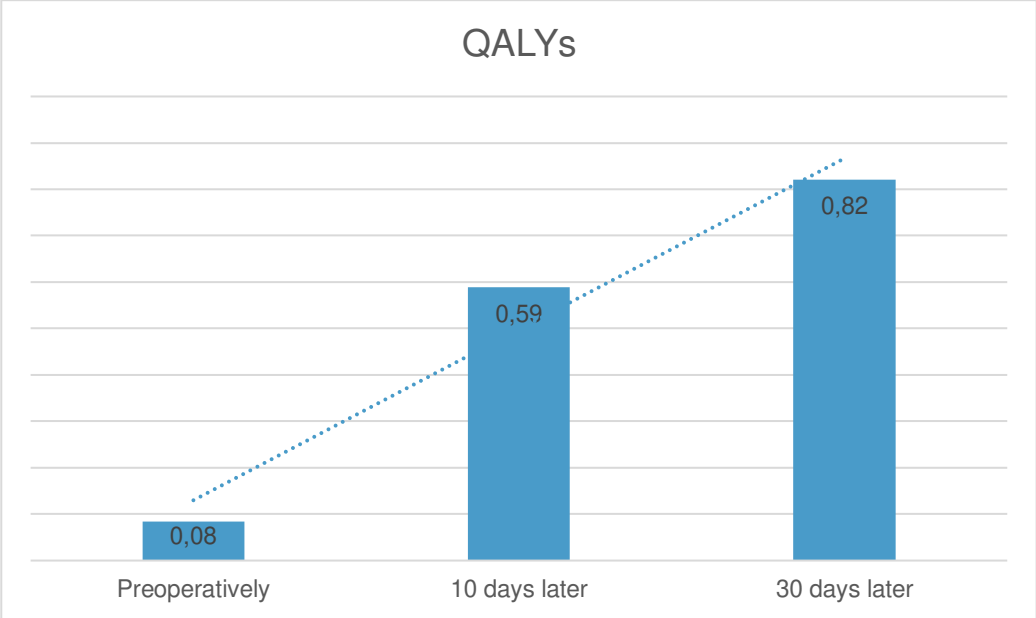

Diagram 1 Quality of life of patients preoperatively, ten days and thirty days after spinal surgery.

The improvement in the quality of life postoperatively was evident in all patients in the sample.

Evaluation of the patients' mobility

The patients selected the appropriate answer choice to the question regarding their mobility not only preoperatively but also at 10 days and 30 days after surgery, as shown in **Table 1** and **Diagram 2** below.

Table 1 Patients' responses to their mobility, preoperatively and postoperatively (at 10 and 30 days).

Mobility Total patients=314	**Preoperative N (%)**	**10 days after surgery N(%)**	**30 days after surgery N (%)**
1.I have no problem walking	26 (8,3)	60 (19,1)	175 (55,7)
2.I have small problems walking	29 (9,2)	139 (44,3)	106 (33,8)
3.I have moderate problems walking	58 (18,5)	94 (29,9)	29 (9,2)
4.I have serious problems walking	176 (56,1)	20 (6,4)	2 (0,6)
5.I am unable to walk	25 (8,0)	1 (0,3)	0

Subsequently, the patients' responses were classified anchored on a scale from 1-5, according to the user guide with 1 corresponding to 'I have no problems in walking about' and 5 corresponding to 'I am unable to walk about'. The median index for the patient cohort was 3,46 units before surgery, whereas the respective one for 10 days after surgery was 2,24 units and for 30 days after surgery 1,54 units.

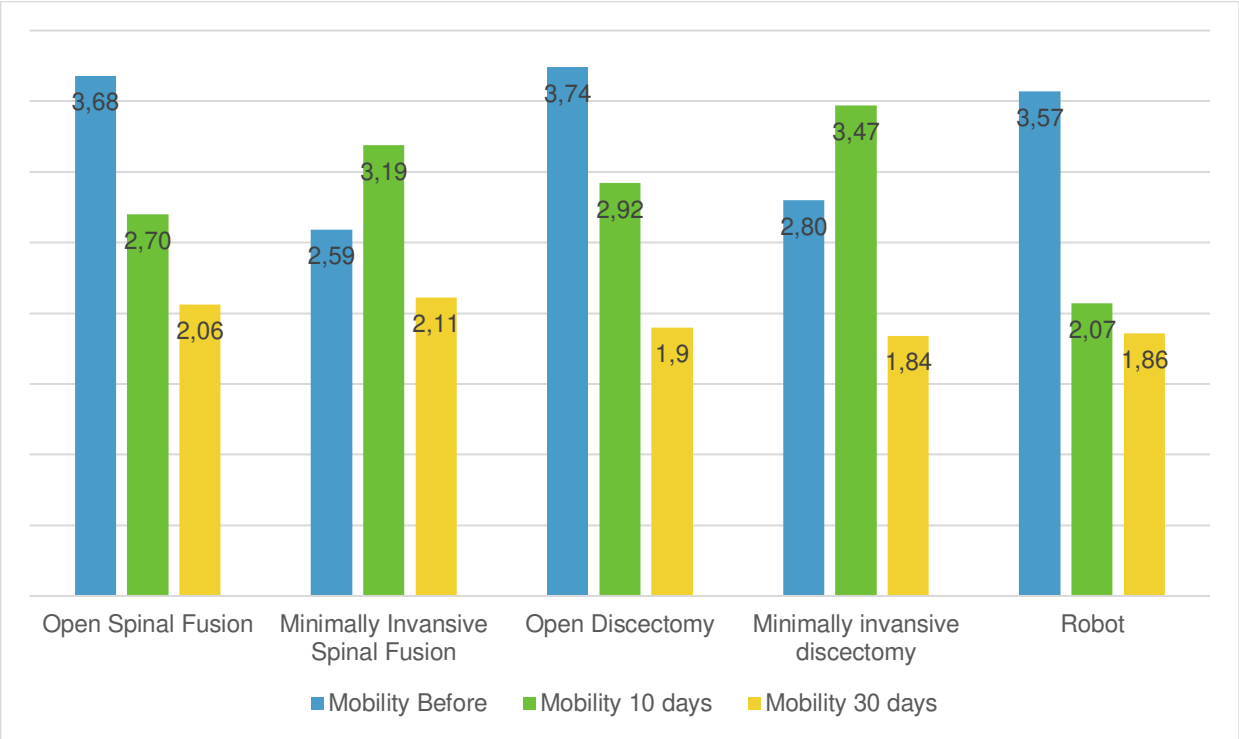

Diagram 2 Average patient mobility, per invasive treatment, at evaluation intervals

Evaluation of the patients' self-care

The patients selected the appropriate answer choice to the question regarding their self-care, not only preoperatively but also at 10 days and 30 days after surgery, as shown in **Table 2** and **Diagram 3** below.

Table 2 Patients' responses to their self-service, preoperatively and postoperatively (at 10 and 30 days).

Self-service Total patients=314	**Preoperative N (%)**	**10 days after surgery N(%)**	**30 days after surgery N (%)**
1. I have no problem washing or dressing alone	57 (18,2)	104 (33,1)	201 (64)
2. I have small problems in washing or dressing	23 (7,3)	102 (80)	80 (25,5)
3.I have moderate problems in washing or dressing	75 (23,9)	87 (27,7)	29 (9,2)
4.I have serious problems washing or dressing	131 (41,7)	14 (4,5)	4 (1,3)
5.I am unable to wash or dress	28 (8,9)	7 (2,2)	0

Subsequently, the patients' responses were classified anchored on a scale from 1-5 according to the user guide, with 1 corresponding to 'I have no problems washing or dressing myself' and 5 corresponding to 'I am unable to wash or dress myself'. The median index for the patient cohort was 3,15 units before surgery, whereas the respective one for 10 days after surgery was 2,10 units and for 30 days after surgery 1,47 units.

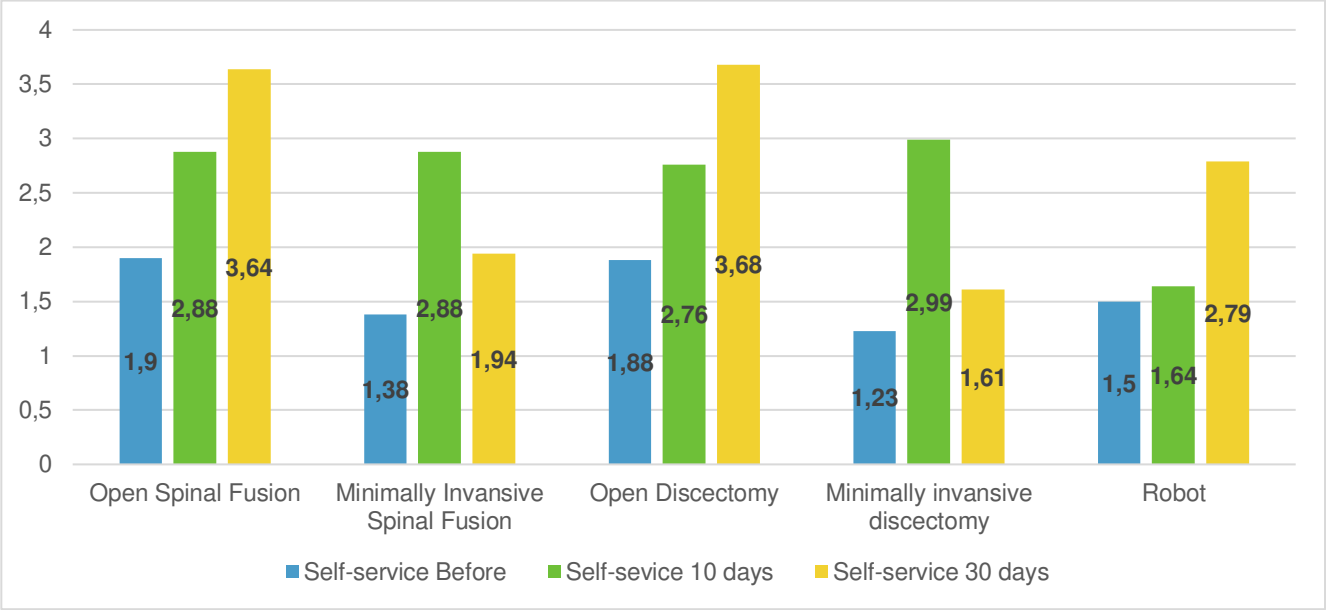

Diagram 3 Average self-service index per operation

Evaluation of the patients' ability to do their usual activities

The patients selected the appropriate answer choice to the question regarding their ability to do their daily activities, not only preoperatively but also at 10 and 30 days after surgery, as shown in **Table 3** and **Diagram 4** below.

Table 3 Patients' responses to the performance of their daily activities, preoperatively and postoperatively (at 10 and 30 days).

USUAL ACTIVITIES Total patients=314	Preoperative N (%)	10 days after surgery N(%)	30 days after surgery N (%)
1.I have no problems doing my usual activities	5 (1,6)	37 (11,8)	149 (47,5)
2. have slight problems doing my usual activities	19 (6,1)	138 (43,9)	128 (40,8)
3. I have moderate problems doing my usual activities	66 (21)	97 (30,9)	30 (9,6)
4. I have severe problems doing my usual activities	167 (53,2)	33 (10,5)	7 (2,2)
5. I am unable to do my usual Activities	57 (18,2)	9 (2,9)	0

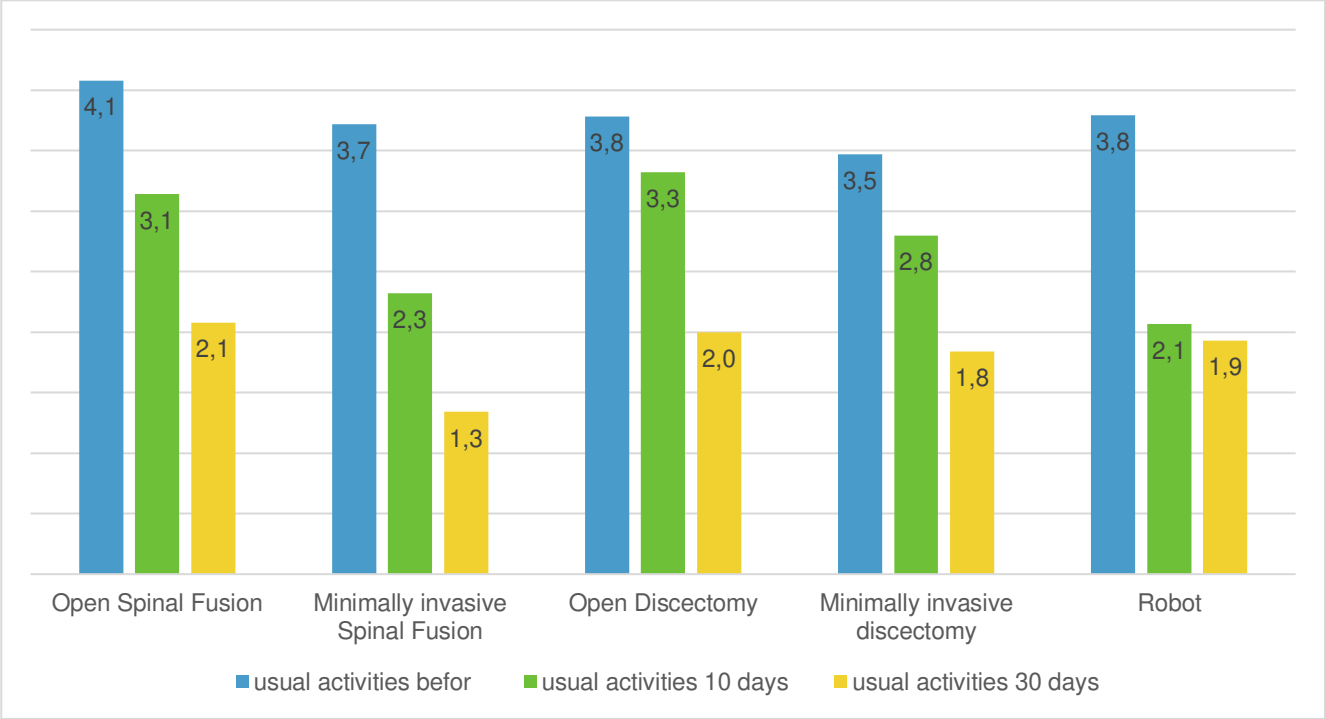

Diagram 4 Average of the daily activity performance index per operation

Subsequently, the patients' responses were classified anchored on a scale from 1-5 according to the user guide with 1 corresponding to 'I have no problems doing my usual activities' and 5

corresponding to ‘I am unable to do my usual activities’. The median index for the patient cohort was 3,8 units before surgery, whereas the respective one at 10 days after surgery was 2,49 units and at 30 days after surgery 1,66 units.

Evaluation of patients’ pain / discomfort

The patients selected the appropriate answer choice to the question regarding pain intensity, not only preoperatively but also at 10 and 30 days after surgery, as shown in **Table 4** and **Diagram 5** below.

Table 4 Patients' responses to the intensity of their pain, preoperatively and postoperatively (at 10 and 30 days).

PAIN/ DISCOMFORT Total number of patients= 314	**Preoperative N (%)**	**10 days after surgery N(%)**	**30 days after surgery N (%)**
1. I have no pain or discomfort	12 (3,8)	56 (17,8)	150 (47,8)
2. I have slight pain or Discomfort	3 (1)	120 (38,2)	111 (35,4)
3. I have moderate pain or Discomfort	43 (14)	117 (37,3)	39 (12,4)
4. I have severe pain or Discomfort	106 (33,8)	21 (6,7)	11 (3,5)
5. I have extreme pain or Discomfort	149 (47,5)	0	3 (1)

Subsequently, the patients’ responses were classified anchored on a scale from 1-5, according to the user guide with 1 corresponding to ‘I have no pain or discomfort’ and 5 corresponding to ‘I have extreme pain or discomfort’. The median index for the patient cohort was 4,2 units before surgery, whereas the respective one at 10 days after surgery was 2,32 units and at 30 days after surgery 1,74 units.

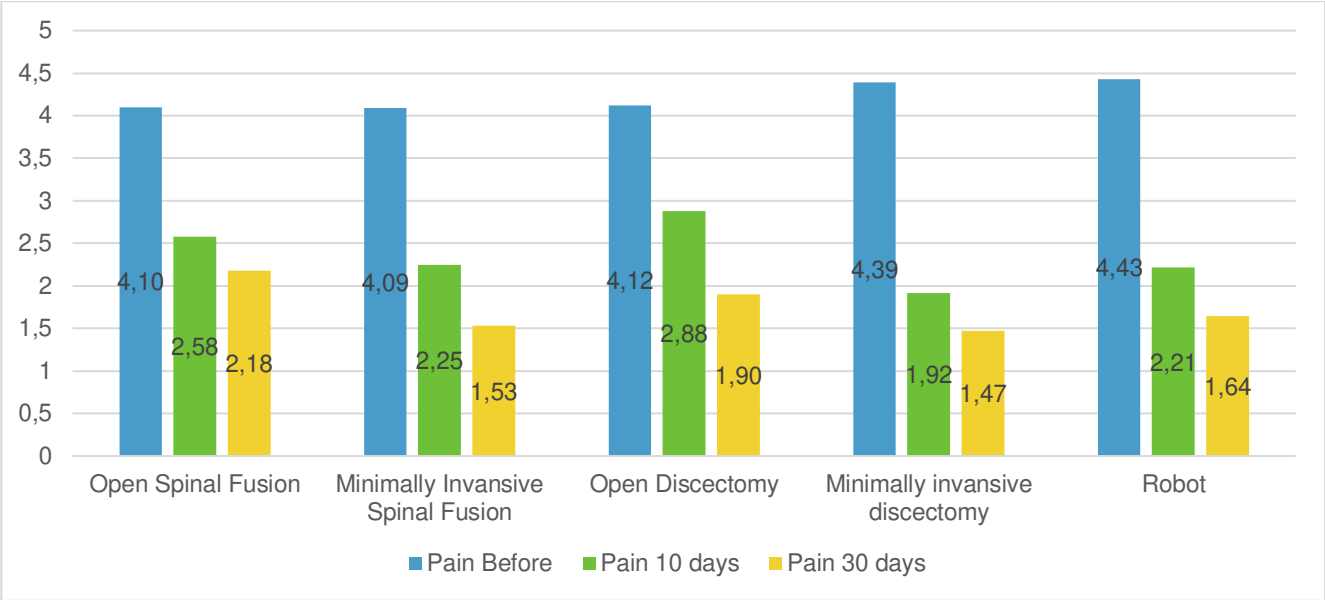

Diagram 5 Average index on pain intensity per operation

Evaluation of the patients' anxiety / depression

The patients selected the appropriate answer choice to the question regarding their anxiety / depression, not only preoperatively but also at 10 and 30 days after surgery, as shown in **Table 5** and **Diagram 6** below.

Table 5 Patients' responses to their anxiety and grief, preoperatively and postoperatively (at 10 and 30 days).

ANXIETY/ DEPRESSION Total number of patients=314	**Preoperative N (%)**	**10 days after surgery N(%)**	**30 days after surgery N (%)**
1. I am not anxious or depressed	43 (13,7)	117 (37,3)	169 (53,8)
2. I am slightly anxious or depressed	32 (10,2)	91 (29)	83 (26,4)
3. I am moderately anxious or depressed	87 (27,7)	65 (20,7)	40 (12,7)
4. I am severely anxious or depressed	61 (19,4)	25 (8)	13 (4,1)
5. I am extremely anxious or depressed	91 (29)	16 (5,1)	9 (2,9)

Subsequently, the patients' responses were classified anchored on a scale from 1-5, according to the user guide with 1 corresponding to 'I am not anxious or depressed' and 5 corresponding to 'I am extremely anxious or depressed'. The median index for the patient cohort was 4,2 units

before surgery, whereas the respective one at 10 days after surgery was 2,39 units and at 30 days after surgery 1,75 units.

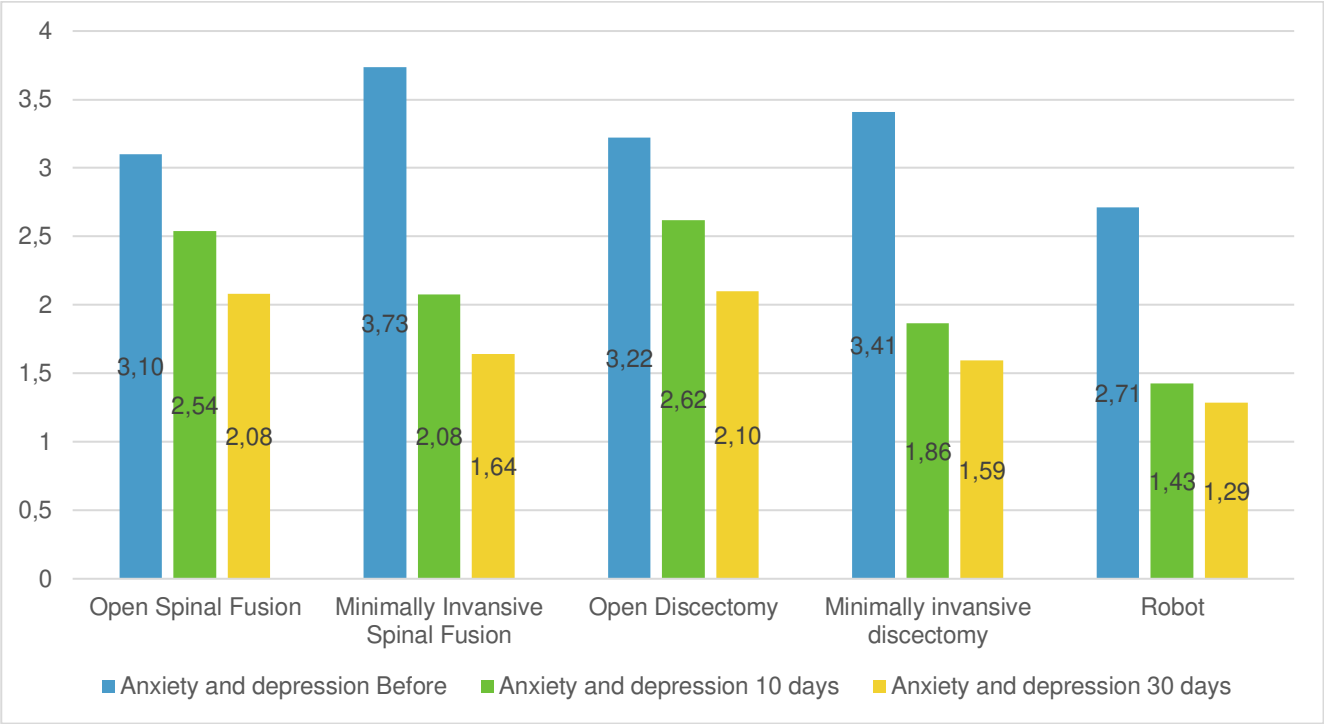

Diagram 6 Patients' responses to their anxiety and grief, preoperatively and postoperatively (at 10 and 30 days).

Assessment of patients' quality of life

The average QoL of the 314 patients before the surgical intervention was 0,085 ± 0,31 units. The median index at 10 days and at 30 days after surgery was 0,59 ± 0,25 and 0,82 ± 0,18. The above-mentioned data are recorded in details in **Table 6** and in **Diagram 7**.

Table 6 Quality of life of patients of the whole sample before, 10 days after and 30 days after spinal surgery.

EQ-5D-5L index value	Patients	Average	Standard deviation	Median	Minimum	Maximum
Preoperative	314	,0845	,30986	0,006	-,65	,83
10 days after surgery	314	,5891	,24970	0,711	-,52	1,00
30 days after surgery	314	,8212	,18120	1	,06	1,00

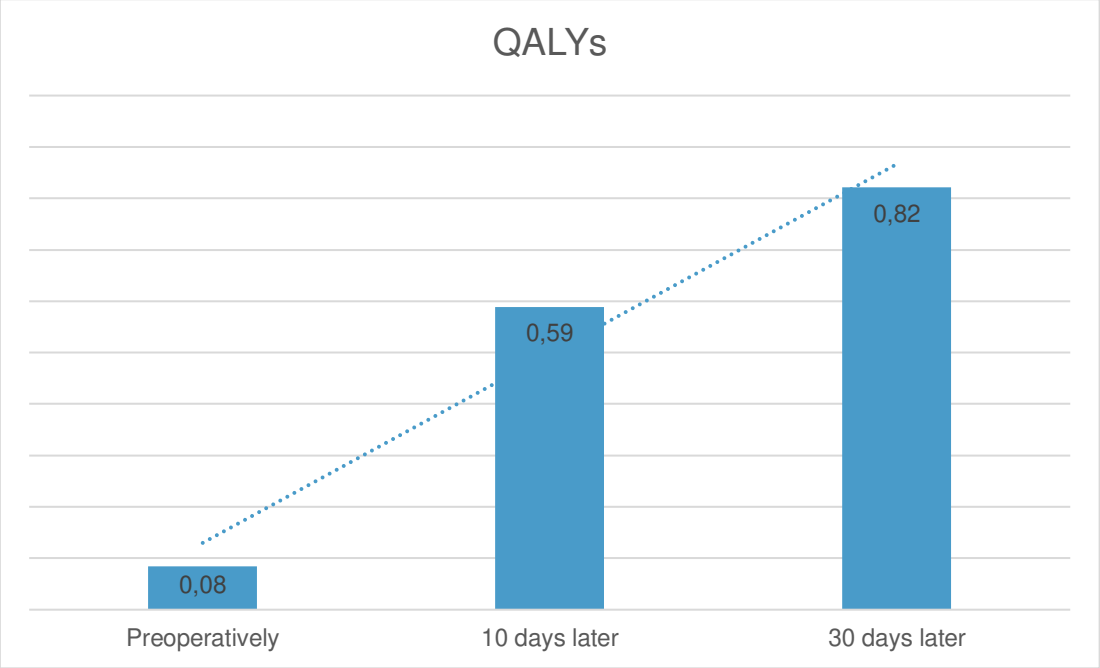

Diagram 7 Average quality of life.

Diagram 8 shows in detail the gain in QALYs as calculated in the sample as a whole and in each subgroup of patients in the study.

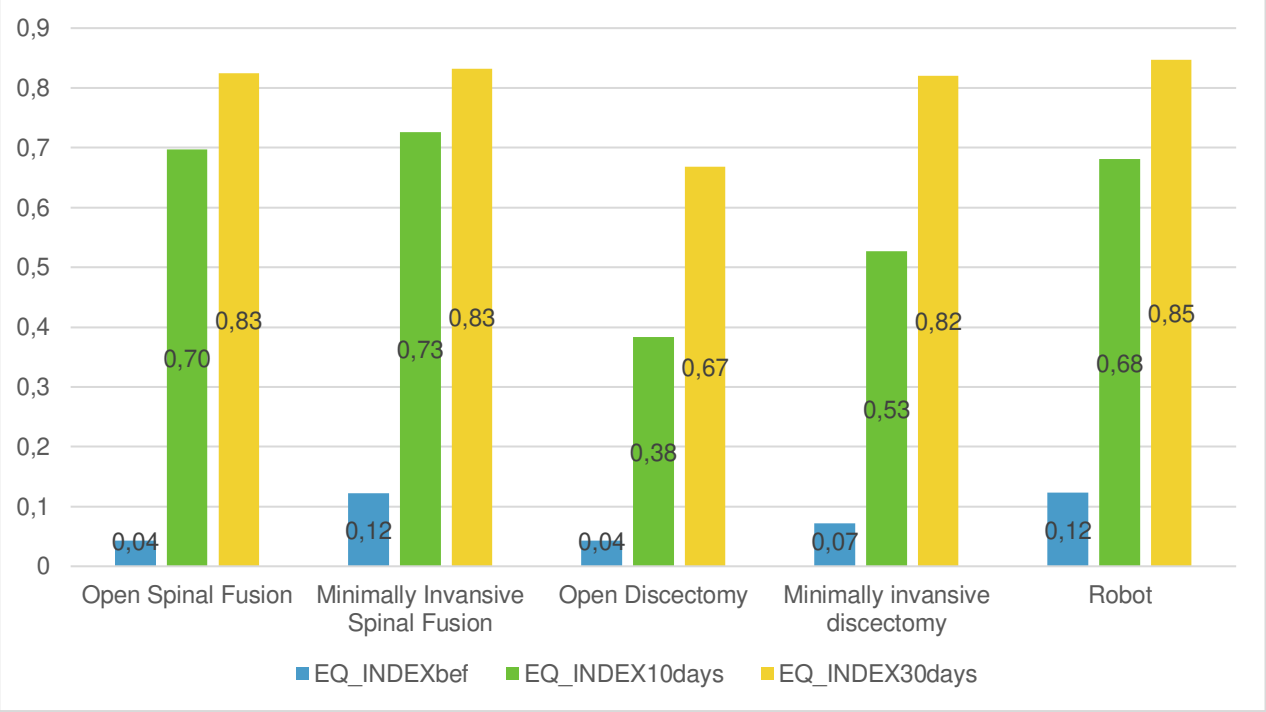

Diagram 8 Average quality of life of patients per surgical treatment.

The improvement in the QoL postoperatively was evident in all patient groups of the sample.

Medical Billing

In 2002 a list of the maximum sums of money that can be allocated to a state hospital for all possible types of hospitalization and treatment was enacted. This list, which is equivalent to the American DRGs (Diagnosis Related Groups), is known in Greek as K.E.N. 'Closed Consolidated Medical Bills' (CCMBs) . This list has been updated and is valid from March 2012 (Government Gazette 946/ 27). Private clinics, like the Metropolitan Hospital, are reimbursed either by the National Organisation for the Provision of Health Care Services (Ε.Ο.Π.Υ.Υ. or NOPHCS) based on the Closed Consolidated Medical Bills (K.E.N or CCMBs) or by private insurance companies with which a contract has been signed, as long as the patient has got a private health insurance policy. When the reimbursement is paid by NOPHCS, then the clinic receives 70% of the sum as per CCMB while the remaining 30% of the sum is paid by the patient himself (out-of-pocket payment). Moreover, the patient who is operated at a private clinic has to pay doctors' fees; namely, the surgeon's and his assistant's fees as well as that of the anesthesiologist.

Table 7 *Total average direct cost per type of surgery on the spine and the sample as a whole, at a private Athens Clinic in 2020.*

Type of surgical procedures	**Number of patients**	**70% KEN Ε.Ο.Π.Υ.Υ**	**Private health insurance (hospitalization + materials)**	**Private payment ***	**Medical fees**	**Total average direct cost at a private clinic in 2018 in euro ±SD**
Robot	14	3511,5	12548,67	6117,73	3459,93	17156,21
Open Discectomy	50	926,05	4627,71	1473	2197,02	6358,43
Minimally invasive discectomy	100	1052,5	4689,22	1453,91	2490,9	6185,02
Minimally invasive Spinal Fusion	50	1794,01	5657,11	3174,19	2592,26	8348,16
Open Spinal Fusion	100	1826,55	7107,64	2850,28	2588,70	8939,7
Total sample	314	1572,012	5839,57	2546,08	2533,94	8069,93

* Under the category of Private Payments are only included the sums paid by patients for hospitalization and materials and not for the medical fees - entered under medical fees - that the patients themselves or their private insurance companies pay.

In the context of this study and during the procedure of compensation determining, the corresponding CCMB was taken into account.

Thus, initially, for open or minimally invasive microdiscectomy, compensation was established on the basis of the cheapest CCMB, by which the costing is made by the NOPHCS using the code M10Xd. The compensation provided in accordance with this code is 1123 euros and the average length of hospitalisation provided is 2 days. Out of this total amount, the respective health provider must pay 70%, i.e., the amount of 786,1 euros and the patient the rest 30% which is corresponding to 336,9 euros. In the cases of open discectomy, the fees that patients or even the private insurances had to pay reached an average of 1473 euros, ranging between 300 and 3000 euros.On the other hand, mean private fees in the case of minimally invasive microdiscectomy amounted to 1453 and fluctuated from 58,95 to 4600 euros. This great variation resulted from the fact that there are different ways of paying medical staff depending on whether the patients have private insurance or not.

Similarly, in order to determine the compensation for instrumantated fusion with robotic system usage, the CCMB with code M06Mγ was taken into account with which is provided average duration of six days hospitalization. Of the total provided amount (8152 euros), the NOPHCS must pay 70% of the total amount, i.e. 5706,4 euros. The patient has to pay the rest 30% of the total amount i.e. 2445,6 euros. The corresponding medical fees and fees for the private insurance ranged from 400 to 21.597 euros. The average amount of fees was 6117 euros.

Similarly, for the determination of compensation in the cases of minimall invasive vertebral fusion the CCMB code M09X was taken into account. The compensation provided is 6000 euros and the average duration of treatment provided is 7 days. The NOPHCS is obliged to pay 70% of the amount, i.e. 4200 euros and the patient the rest 30% of the total amount, which reaches 1800 euros. Patients and their private insurances were burdened with the rest of the cost , which in this case fluctuated from 300 euros to 6000 euros with an average fee of 2850 euros.

Finally, for the method of open vertebral fusion, the CCMB code M09Xb was used, which provided for compensation of 3628 euros and average duration of hospitalization of 3 days. The NOPHCS is obliged in this case to pay 70% of the amount i.e. 2539,6 euros while patients pay the rest of 30% of the total amount i.e. 1088,4 euros . Patients and their private insurances were burdened with the rest of the cost , which in this case fluctuated from 400 to 8000 euros with an average of 3174 euros.

DISCUSSION

The evaluation of the data of this study highlighted the high degree of effectiveness of each surgery was applied to treat the symptomatology of our patients .

All the statistical tests applied to the sample showed a very significant improvement of all the variables which were included in the questionnaire and at all intervals evaluated after surgery. There has also been a very large improvement in the overall QoL of sample patients.

In particular, it was observed a significant improvement in the areas of mobility , self-service, execution of daily activities, pain and anxiety/depression . All the results showed improvement of the overall picture of the patient's health, but in addition statistical significance was observed in mobility improvement through the use of invasive robot therapy, as was as in the case of self-service, pain and anxiety, during the first month after surgery.

On the other hand, the method of open vertebral fusion had no statistical significance in the improvement of pain and anxiety, at the end of the first postoperative month.

In this research, the selection process of all patients was very important. We accomplished to limit the total days of hospitalization of our patients after a detailed medical history obtainement and evaluation of all imaging findings preoperatevily. Also, high efficiency occurred alongside with minimal complications, due to the experience of medical staff and the use of appropriate technology. The tools used for the therapeutic approach of patients and minimally invasive techniques ensured the appearance of minimal complications.

The cost - utility index was calculated for all patients who took part in the survey. This ratio was quite high, with the sample as a whole having a variation from 25.229,73 for robot therapy, to 11.528,48 for open vertebral fusion. Nevertheless, there is a dramatic decrease in this index over the days, which had as the result, at the end of the first postoperative month, the variation ranges from 22.874,95 for the robotic fusion up to 7191,89 for microdiscectomy. The maximum value, calculated for the cost-utility index, was that of robotic fusion that reached 25.229,73 euros at 10 days, while the minimum was that of microdiscectomy that reached 7191,89 euros at 30 days. This index, for the whole sample, decreased significantly and this is mainly explained from the improvement in the QoL of patients during the considered period of time.

The evaluation of the relevant literature it has emerged that the method of vertebral fusion in USA had been linked to a gain of a total of 0.23 QALYs while the corresponding index that defined the cost and utility of the method reached 115,600 euros . These levels were calculated two years after the patient's surgery while at the end of the 4th postoperative year the cost -

utility index was reduced, to 64.300 euros. This resulted due to the improvement in the QoL of patients (Tosteson et al., 2011).

Regarding microdiscectomy method, this was linked to a total gain of 0.21 QALYs, during the same period while in terms of cost - utility index assessment, it was at 34.355 euros (Tosteeson et al., 2008) (Weinstein et al., 2014).

Due to the fact that there is going to be an improvement in the QoL of patients postoperatevily, as mentioned and in a related research, a further reduction is expected in the cost-utility indices calculated in this work after the 30th day.

Comparison between the data of our work and that of the previous study, shows that the cost-utility index, at 30 days, as calculated in the survey, is better than that of the research mentioned above.

Another conclusion drawn from the comparative study among the utility indices for each treatment method is that, although open vertebral fusion takes precedence over microdiscectomy, at the 10th postoperative day, the opposite happens at 30th postoperative day, i.e. the cost-utility index of microdiscectomy excels over all other methods.

Since there was limited time to monitor the course of patients' condition, it was not possible to evaluate the cost-utility index for conservative treatment, in our study. Consequently, no data and information were collected to compare the two methods and therefore it was not possible to benchmark the conservative with the surgical treatment. This is why data was searched to estimate the size of this index. Through a relevant study evaluating the cost-utility index and comparing it with the less invasive methods indices, it has been found that percutaneous infusion, which is a less invasive method, has a lower cost per QALY (460.59 euros) but the effect on the patient is limited in time (Civelek et al., 2012) (D'Orazio et al., 2015).

The process of calculating social costs does not include the wage costs of workers, since in private clinics workers do not have collective agreements and usually their cooperation with clinics varies greatly as well as the number of participants in a spinal surgery.

In the context of this work, the total direct cost of the operations was calculated and compared to this, the size of the wage costs can be considered negligible, since through a survey carried out in 2016, for the private sector and for four medical staff and assistants, it was just amounted to 125 euros per hour (Mazioti, 2016).

In addition, various other categories of direct costs, such as the cost of transporting patients or even the cost of home care, were not taken into account. Also, no difference was calculated in the cost that falls into the category of indirect costs and is related to the reduction of productivity of each patient and their family environment. The cost categories that were taken into account

in the immediate total compensation for each invasive treatment are presented in the table below.

Table 8 Compensation categories and Costs

QALYs / type of surgeon	*10 days after surgeon*	*30 days after surgeon*	*Total average direct cost*	*Cost € /QALYs 10 days*	*Cost € /QALYs 30 days*
Robot	,68	,75	17156,21	25229,73	22874,95
Open Discectomy	,38	,67	6358,42	16732,71	9490,19
Minimally invasive discectomy	,53	,86	6185,02	11669,85	7191,89
Minimally invasive Spinal Fusion	,63	,86	8939,70	14190,01	10395,01
Open Spinal Fusion	,70	,86	8069,93	11528,48	9383,64

Lastly, the gain in QoL level of the whole 314 patients who took part in the survey, for the first follow-up month, was on average 0.59 in the first 10 days postoperatevily and 0.82 for the next 20 days. The QALYs, which patients gained in terms of QoL during the periods corresponding to the surgeries are described in the table 9 . The same table describes the values that reflect the cost-utility index, after its calculation at different time intervals.

Table 9 QALYS won by patients

Descriptive Statistics						
	N	Minimum	Maximum	Sum	Mean	Std. Deviation
EQ_INDEXbef	314	-,65	,83	26,53	,0845	,30986
EQ_INDEX10days	314	-,52	1,00	184,99	,5891	,24970
EQ_INDEX30days	314	,06	1,00	257,86	,8212	,18120

As can be obtained from the evaluation of the data in the table above and also of the diagram showing the cost-utility index , the higher the average gain in all QALYs, the greater the improvement in the QoL of patients.

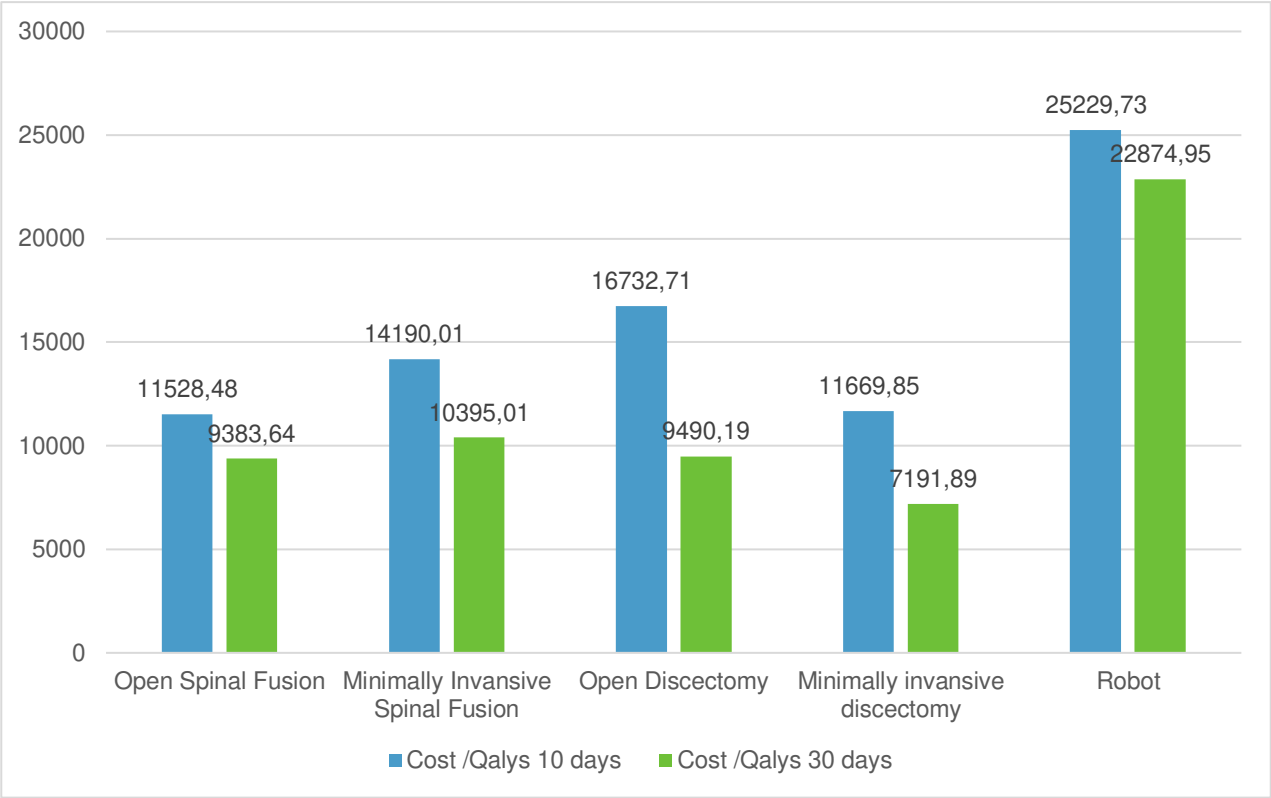

Diagram 9 Cost per QALYs, per operation

CONCLUSIONS

As part of this work, an economic analysis was carried out, covering a total of five categories of spinal surgeries, carried out in a private clinic.

From all the above, and the data evaluated and analyzed in this study, it is concluded that the process of rehabilitation of all patients after surgery on their spine is characterized by great complexity.

One limitation of this study, which may, at the same time, be an object for future research, is the absence of groups of patients to benchmark different types of treatment, such as a method of conservative treatment.

Apart from the others, the method for assessing the results was limited to a short period of time. The subject of future research could be, between others, the assessment of the results one year after surgical treatment.

Another limitation that should be mentioned is that, with regard to the calculation of the total cost of surgery, no account was taken of the direct medical costs which included, for example,

the cost of transporting the patient and the cost of providing assistance from third parties. Also, the indirect costs resulting from the loss of the patient's productivity and family environment were not included. It should be noted that these cost categories may either have a uniform impact on all categories of patients, or are limited if the surgical method used does not require long-term rehabilitation.

The intervention of nurses may have a significant impact, particularly in the area of operational independence, but also on improving the QoL of patients in the long term. Nurses play a particularly important role in the rehabilitation process of each patient who has undergone spinal surgery, since they implement many interventions of immediate care, education, health care and psychosocial support. On the other hand, patients who have undergone such procedures require comprehensive care, so their activities should be planned in order to improve their QoL . Medical and nursing staff, respectively, must work together to understand their role by patients.

Through inpatient training programs, the person who has had spinal surgery should be trained so that he can monitor his individual health and his emotional state. However, the extent to which each patient can participate actively in the process of his rehabilitation is positively correlated with the improvement of his functional abilities. In conclusion, a rehabilitation program that recognizes the needs of the patient and is personalized, should be implemented in the context of the professional and family situation of the patients, aiming at their return to everyday life. In the context described, it is considered necessary to evaluate the cost-utility index, but also to study the QoL index of patients before and after spinal surgery.

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