Comparison of inpatient treatment costs after balloon kyphoplasty and non-surgical treatment of vertebral body compression fractures

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Abstract We performed an analysis of following costs after primary conservative or operative treatment with balloon kyphoplasty (BKP) in osteoporotic vertebral fractures. Patients with primary osteoporotic vertebral fractures treated with BKP or conservatively from discharge year 2002–2005 were retrospectively assessed regarding the following hospital treatment in any hospital in Austria from 2002 to 2006. A statistical record linkage between the hospital data and the mortality registry of Statistic Austria was performed. The data search was restricted to ICD-10 and procedures according to the Austrian catalogue of procedures defined as “spine relevant”. Number of readmissions, length of hospital stay and DRG related costs were calculated for the surgical and conservative group separately. 324.5 years (mean 2.93 ± 1.40 , conservative group) and 343.6 (mean 2.56 ± 0.96 , BKP group) of 110 conservative patients and 134 BKP patients were analyzed. There was no statistical difference of the mortality rate with 9 patients (6.7%, BKP) and 11 patients (9.9%, conservative). The number of readmissions was 1.62 times higher ($P = 0.039$), the length of stay 1.09 times higher ($P = 0.046$) in the conservative group. No difference in the DRG scores were found ($P = 0.11$). In conclusion, patients

with osteoporotic vertebral fractures showed in the following years after BKP fewer hospital readmissions and shorter hospital stays but no difference in DRG scores in comparison to conservatively treated patients.

Keywords Balloon kyphoplasty · Vertebral fracture · DRG · Inpatient treatment · Cost analysis

Introduction

Balloon kyphoplasty (BKP) is a well-known technique used since 1998, although first level evidence of its usefulness versus conservative treatment was only established in 2009 [1]. The reimbursement crisis and more stringent laws in addition to first level evidence also warrant economical analysis of surgical techniques. As BKP is a relatively costly procedure, economical studies are needed. The hospital treatment costs of conservative and operative care after osteoporotic fractures have been described. The total hospital costs 2003 was estimated to be 377 mio € in Europe with, for example for Germany 48 mio € for men and 97 mio € for woman per year [2]. Comparative analysis from Switzerland showed conservative hospital costs per case for women 12,739 € and for men 8,923 € in 1997 [3]. A study group from Sweden, published in- and out-patient fracture-related costs 1 year after the event to be 12,500 € per case for a vertebral fracture (primary treatment unknown) and 14,200 € per case for a hip fracture in both genders [4]. However, a comparative analysis of BKP hospital costs compared to conservative care is not yet published. In general, economic studies are focusing on the primary hospital treatment.

We initiated a study looking at the following hospital treatment costs after BKP and conservative treatment in

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patients with osteoporotic fractures after discharge from the primary care centre.

Materials and methods

This study represents a retrospective analysis of patients with a primary osteoporotic fracture treated at Orthopaedic Hospital Speising in Vienna either with BKP or with conservative care as inpatients between 2002 and 2005. Operative treatment in the form of BKP was only available in the hospital after 2002 and the decision tree when to operate patients was developed since 2002 [5]. The patients were primarily admitted due to direct referral from a general practitioner or orthopaedic surgeon to conservative or operative care and all the patients in conservative care were admitted to surgery if they met the inclusion criteria determined in 2002, e.g. collapse of the vertebral body of at least 30%, thoracic kyphosis of at least 15° or lumbar kyphosis of at least 10°, increasing kyphosis during outpatient follow-up or failed conservative treatment for 2 weeks.

Included were only patients with acute osteoporotic fractures of any location or number, excluded were patients with previous vertebroplasty or BKP or metastatic disease.

After discharge, the data of a subsequent hospital or day care centre admissions and treatment in all treatment centres in Austria were recorded and analyzed.

For all these inpatients the full so-called minimum basic dataset (MBDS) of the Austrian DRG-system is available. This includes main diagnosis according to the ICD-10, additional diagnoses according to the ICD-10, procedures according to an Austrian catalogue of procedures, number of procedures, days in an intensive care unit, length of stay (LOS), data of birth, gender and some other administrative data like zip-code. Furthermore, for each admission, the Austrian-DRG-scores are computed. If a patient is a LOS-outlier additional scores are given. The MBDS includes also the day hospital admissions but no ambulatory admissions. There is a special rule for the computation of the day's hospital admissions and for patients with a LOS shorter than the lower limit of the LOS.

Because there is no unique personal identifier in the Austrian MBDS for inpatients a statistical matching has been performed to identify further admissions of these patients in the years 2002–2006. Therefore, a statistical matching based on data of birth, gender and zip-code has been used to identify these patients in the MBDS of the time following the intervention. Using these items a search in the DRG-database between 2002 and 2006 for inpatient admissions was performed.

To calculate the time under observation, a record linkage between the data of the hospital and the mortality

registry of Statistic Austria was performed to find out which patients died until end of 2006.

The data search was restricted as primary study goal to a set of main diagnoses according to ICD-10 and procedures according to the Austrian catalogue of procedures defined as “spine relevant”. Based on the classification in the Austrian DRG-System, a set of 16 case groups has been defined as spine relevant in advance. Out of them ten case groups are based on the main diagnosis and six are based on procedures on the spine. The spine-relevant admissions include fractures and stabilization of the spine, functional interventions in the spine, interventions in the intervertebral disk, syndromes regarding the spine, admission regarding special parts of the nervous system and the musculoskeletal system. Furthermore, also any “non-spine-relevant” admission of these patients was evaluated.

The data have been stored in an ACCESS-database. For the statistical analysis, SPSS 16.0 has been used. $P < 0.05$ has been considered as statistically significant. For the comparison of the two groups the non-parametric Wilcoxon–Mann–Whitney U test has been used, because of the skew distribution of the data and the outliers. For the analysis of correlations Spearman's rank correlation coefficient has been computed.

The access to the national database of hospital admissions was allowed by the Austrian Ministry of Health. All the datasets were anonymized.

Results

Between 2002 and 2005, $N_k = 135$ patients have been treated with BKP and $N_c = 110$ patients with similar diagnoses have been treated by non-surgical methods at the Orthopaedic Hospital Vienna Speising (Table 1).

Then database analysis showed 432 admissions for BKP and 595 admissions for non-surgical patients after the treatment in primary centre. Because of the high specificity of these items it can be assumed that the probability of identifying a “twin” of a patient is very low and

Table 1 Discharge year of the patients

Admission year	Non-surgical	BKP
2002	34	9
2003	33	40
2004	22	52
2005	22	33
Total	110	134

Two patients admitted in 2001 were discharged in 2002, one patient was eliminated because a possible twin (same date of birth, gender, zip-code) was found

furthermore the chance of identifying a twin is the same for both groups.

Six patients with BKP had a second BKP some times later on a different part of the spine. Therefore, these patients' admissions were not used in comparison to have independent samples. Only the data of the first admission were used.

29.1% of the study population are men. More men (29.85%) are in the BKP group than in the non-surgical group (13.46%, $P < 0.05$). The age range is between 37 and 91 years. Men are younger (71.5) than women (73.9). BKP patients (71.0) are younger than non-surgical (74.3) patients (Table 2).

The link with the mortality register revealed a mortality rate of 9 patients (6.7%) in the BKP and 11 (9.9%) in the non-surgical group with an average observation time until death of 0.67 years in the non-surgical and 0.93 years in the surgical group. No statistical difference was found in the mortality per admission year or total mortality.

In total, for non-surgical patients, 324.5 observation years and 343.6 observation years for the BKP group are available for this study. The mean observation time in the non-surgical group is 2.93 ± 1.40 years and 2.56 ± 0.96 years in the BKP group. The significantly shorter mean observation interval in the BKP group is due to the fact that more patients are treated in the year 2003–2005 and only few of them are treated before 2003. There is no

significant correlation between age and observation time ($r_s = 0.036$, $P = 0.573$).

Out of this population 194 spine-relevant in-hospital admissions from 62 patients in the non-surgical and 109 admissions from 57 in the BKP group were found after the treatment until the end of 2006 (Table 3). For 49 patients in the non-surgical group and for 77 patients in the BKP group no further spine-relevant in-hospital admissions were found.

The number of admissions per observation year after the first treatment in the study-hospital was statistically significant lower ($P = 0.039$) in the BKP group compared to non-surgical group (Table 4; Fig. 1). Also, the length of stay per observation year was statistically significant lower ($P = 0.046$) in the BKP group. The DRG scores per observation year are lower in the BKP group, but a value of $P = 0.112$ ($>\alpha = 0.05$) is not considered as significant. On an average, in the BKP group, only 43% of admissions, 31% of inpatient days and 58% of the scores have been observed compared to the non-surgical group.

Because of the skew distribution, as seen in Fig. 1, there is a big difference between mean and median, e.g. the DRG scores of the BKP group include one extreme outlier. Eliminating this outlier for the calculation of the mean value reduces the mean value of the DRG-scores from $1,640 \pm 432$ to $1,267 \pm 218$ (Table 4). But also this difference is not statistically significant.

The non-spine-relevant admissions showed no significant differences between both groups. On an average, only 33% of the admissions, 39% of the length of stay and 45% of the scores have been observed in the BKP group.

Table 2 Description of the patients

Treatment	Gender	Sample size	Gender (%)	Age (mean)	Age (SD)
Non-surgical	M	15	13.51	73.3	10.6
Non-surgical	W	95	86.49	75.8	8.9
BKP	M	40	29.85	69.7	11.6
BKP	W	94	70.15	72.4	8.8

Table 3 Characteristic parameters for the patients after treatment

	Number of patients	Spine relevant admissions	Non-spine relevant admissions
Non-surgical	110	194	398
BKP	134	109	323
Sum	244	303	721
LOS			
Non-surgical		1,456	4,204
BKP		1,287	3,852
Sum		2,743	8,056
Austrian DRG score sum			
Non-surgical		420.099	1.171.819
BKP		440.381	1.214.825
Sum		860.480	2.386.644

Discussion

In a retrospective exploratory study, the use of hospital resources has been compared between patients treated with

Table 4 Characteristic values of spine relevant admissions per observation years for the non-surgical and BKP group

	Non-surgical [min., median, max.]	BKP [min., median, max.]	Significance (<i>P</i>)
Admissions per observation year	0.627 ± 0.116 [0, 0.253, 6.81]	0.388 ± 0.088 [0, 0, 10.33]	0.039
LOS per observation year	5.39 ± 1.08 [0, 0.253, 6.81]	4.96 ± 1.37 [0, 0, 161.84]	0.046
DRG scores per observation year	1,657 ± 297 [0, 621, 16,711]	1,640 ± 432 ^a , 1,267 ± 218 [0, 0, 51,279]	0.112

The values represent mean ± SD

^a There is one big outlier in the BKP group. Elimination of this outlier ($x = 51,279$) reduces the mean value substantially

BKP or conservatively. The study represents a unique and innovative approach to cost analysis for surgical techniques. It is the first time that a surgical treatment was analyzed in a nation-wide analysis and interpretation of hospital-based costs with a 100% patient coverage. In order to do this, we obtained permission from the national authorities in Austria to gain data from all Austrian hospitals and the national death registry.

The decision to allocate the patient treatment to surgery or conservative care was based on the actual knowledge about surgical and conservative treatment during the treatment period and evolved over time following the improvement of data and clinical knowledge. Generally, we tried to choose the individual optimal treatment for the patient without randomization. At the time of the treatment in this hospital there was no discussion about a future evaluation of these therapies.

We did not analyze the clinical effect of BKP regarding height restoration and whether the conservative or operative treatment has reached the desired outcome during the primary hospital stay. This in our eyes is important because we deal with an elderly population with a high prevalence of back pain caused by various degenerative diseases. However, the number of the patients in both groups was large enough that we can expect a mean distribution of prevalent diseases in both groups.

BKP can be performed in Austrian hospitals in special departments such as orthopaedics, trauma surgery or neurosurgery, which need to fulfill special obligations such as a minimum of 50 procedures per year in order to get reimbursement. The reimbursement for this procedure is based on the Austrian DRG-system for inpatients, including day hospital admissions. The Austrian DRG-system was introduced in 1997 for all inpatients in Austrian hospitals and therefore a very complete database is available. A special code for the procedure “BKP” is available in the Austrian DRG-system (MEL 1255) since 2005 and patients are classified according to this procedure. In the years before 2005 no specific DRG existed and BKP was documented as stabilization for spinal fracture like any internal fixation. The lower limit for the length of stay (LOS) in the DRG-model of 2006 was 2 inpatient days, the upper limit was 6 inpatient days and the reimbursement is 5,085

(=4,068 for the procedure component +1,017 for the average day component) scores, which are more or less equivalent 5,085 Euros for the primary treatment.

Because of the completeness of the Austrian DRG-data it can be assumed that all inpatient visits after the spine treatment for these patients are included. Because there is no systematic standardized documentation of ambulatory care in Austria it was not possible to consider also outpatient visits, but 1-day hospital visits are included in this analysis.

Significant differences ($\alpha < 0.05$) between the BKP and the non-surgical group have been found for the number of spine relevant admissions and the length of stay. No significant differences was seen in the DRG scores (Table 4, $P = 0.112$). Due to the standardization of the time under observation, a possible bias caused by different years of the treatment and therefore different years under observation can be excluded. Because there is no correlation between observation time and age also the influence of age on the difference can be excluded.

Furthermore, the significantly lower admission rate and the significantly lower length of stay in hospital is a good indicator for the better quality of life for patients treated with BKP. A recent prospective randomized study comparing BKP to conservative care has demonstrated this effect recently [1].

Interestingly, the patient group with primary conservative treatment continued to produce higher follow-up DRG-points than the operative group over the years, which was not expected.

Whether the observed effect is due to the BKP as potential corrective procedure or pain therapy cannot be proven because, as mentioned above, we did not investigate the clinical success regarding correction of kyphotic deformity. That the correction of the kyphotic deformity with a balloon has any beneficial effect furthermore has not yet been demonstrated in any study. Hence, we presume that the observed effect was due to the stabilization of the vertebral fracture. The benefit of BKP in general reading pain management has been proven in studies [1, 6–10].

The cut-off point with complete amortization of BKP is reached in Austria following the reimbursement system from 2002 to 2006 after ~5 years according to our data depending on the primary hospital-based costs for BKP.

Fig. 1 Number of admissions (a), length of stay (LOS, b) and DRG scores (c) per observation year after the treatment. In each group one outlier is outside the range

It has been shown that patients with persisting kyphosis have an increased mortality due to pulmonary failures [11] but we could not distinguish a significant difference in mortality in our patients.

This study has several limitations besides not being a prospective randomized study. However, a selection bias can be excluded because it primarily was never planned to use this data for a study during the treatment phase, the necessity of this study only emerged during debates of reimbursement issues. It cannot be excluded that there was a treatment bias due to the fact that BKP was newly initiated as operative treatment at the hospital, although the treating surgeon has performed this treatment before in another country and tried to develop stricter guidelines for BKP over the years after 2002. However, all the patients in both groups could be discharged at their respective homes. We furthermore did not evaluate the pain status after discharge, which can be indirectly assessed due to the necessity of further inpatient treatment. However, we think that our approach and the guidelines at the time did not differ from other comparable centers, which offered both BKP and conservative treatment. The other bias against BKP was that the operative treatment was initiated in more severe fractures or fractures where primary treatment did fail, but this bias, in general, has the potential to act against the shown outcome as there was a tendency to operate on more severe fractures and treat less severe fractures conservatively.

We did not investigate whether there were more subsequent vertebral fractures in either group specifically; therefore, we cannot say whether the subsequent hospital treatment was due to a higher subsequent fracture rate after BKP. The above named study [1] showed no significant difference in subsequent fractures after BKP if compared to conservative care.

Finally, we only evaluated patients with osteoporotic vertebral fractures and excluded all metastatic fractures.

This analysis is furthermore incomplete, as the outpatient treatment costs were not accessed. Those treatment costs are stored in separate databases by the reimbursement companies and the group was not able to get permission to perform the analysis from the advising physician managing those databases.

Conclusion

This is the first time that a study looking at follow-up treatment pattern after BKP versus conservative care was performed. We present furthermore a novel way to analyze costs of a surgical versus a conservative procedure.

The study could show significant difference in the number of hospital readmissions and length of stay for the benefit of the surgical procedure compared to a conservative treatment, but not in the DRG Scores. This study can potentially act as a blue print for other studies analyzing treatment effects independently from known clinical scores

having the benefit of a 100% data registration, evaluation of side-effects and calculation of amortization costs in any operative procedure.

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Conflict of interest The study was sponsored by Medtronic Austria.

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