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Abstract

Introduction

Pelvic fractures requiring surgical fixation are rare injuries but present a great societal impact in terms of disability, as well as economic resources. In the literature, there is no description of these costs. Main aim of this study is to describe the direct and indirect costs of these fractures. Secondary aims were to test if the type of fracture (pelvic ring injury or acetabular fracture) influences these costs (hospitalization, consultation, medication, physiotherapy sessions, job absenteeism).

Materials and methods

We performed a retrospective study on patients with surgically treated acetabular fractures or pelvic ring injuries. Medical records were reviewed in terms of demographic data, follow-up, diagnosis (according to Letournel and Tile classifications for acetabular and pelvic fractures, respectively) and type of surgical treatment. Patients were interviewed about hospitalization length, consultations after discharge, medications, physiotherapy sessions and absenteeism.

Results

The study comprised 203 patients, with a mean age of 49.1 ± 15.6 years, who had undergone surgery for an acetabular fracture or pelvic ring injury. The median treatment costs were 29.425 Euros per patient. Sixty percent of the total costs were attributed to health-related work absence. Median costs (in Euros) were 2.767 for hospitalization from trauma to definitive surgery, 4.530 for surgery, 3.018 for hospitalization in the surgical unit, 1.693 for hospitalization in the rehabilitation unit, 1.920 for physiotherapy after discharge and 402 for consultations after discharge. Total costs for treating pelvic ring injuries were higher than for acetabular fractures, mainly due to the significant higher costs of pelvic injuries regarding hospitalization from trauma to definitive surgery ($p < 0.001$) and hospitalization in the surgical unit ($p = 0.008$).

Conclusions

Pelvic fractures are associated with both high direct costs and substantial productivity loss.

Keywords Pelvic ring injuries, Acetabular fracture, Cost analysis, Morbidity, Work productivity

Introduction

Although acetabular fractures and pelvic ring injuries requiring surgical fixation are rare injuries, they present a high burden of morbidity and complications [1, 2]. The latter have a great societal impact as regards economic resources. Patients with unstable injuries are typically initially treated with a temporary

fixation [3] until definitive surgery can be performed. This is frequently delayed due to a lack of vacancies at the referral centre or due to the patient's general clinical condition (i.e. in polytrauma) [4]. After definitive surgery, hospitalization consists of two stages: the first is the recovery in a surgical unit and the second is the rehabilitation in a physiotherapy unit.

Since this type of trauma often creates a chronic disabling condition [1, 2] and multiple consultations after discharge, long-lasting analgesic therapies and work ability impairment are common. Based on these premises, the societal and economic burden of these fractures is expected to be high, but to our knowledge no studies have tried to estimate these costs yet. Main aim of this study is to describe the direct and indirect costs of acetabular fractures and pelvic ring injuries that were treated with surgical fixation. Secondary aims are to test if the type of fracture (pelvic ring injury or acetabular fracture) influences these costs (hospitalization, consultations, medications, physiotherapy sessions, job absenteeism).

The study was approved by the local ethical committee and all patients consented to the use of their data.

Materials and methods

We performed a retrospective study on patients with a pelvic ring injury or acetabular fracture treated in our referral centre. Only patients who received surgical treatment for pelvic ring injury or an acetabular fracture, between 2008 and 2012 in our referral centre were included. Criteria of exclusion were a follow-up time of less than 9 months or the absence of phone contact in the medical records. Additionally, patients were excluded from the work-related cost analysis if they had retired before the trauma.

All fractures were treated by at least two members of the pelvic surgeon team (three surgeons).

Patients' medical records were retrospectively reviewed to analyse: demographic data, date of hospitalization, definitive surgery, diagnosis (according to the Letournel classification [5] for acetabular fractures and according to the Tile classification [6] for pelvic ring injuries), type of surgical treatment, length of hospitalization in the Intensive Care Unit (ICU), time of surgical theatre occupancy, number of implanted plates, number of screws exceeding the standard configuration of a reconstruction plate, surgical treatment with external fixator at arrival, number of transfused blood units. All data were recorded in a custom made database. Patients who had sustained both an acetabular fracture and an associated lesion of the pelvic ring were classified as pelvic ring injuries.

Patient interviews regarding the time after surgery comprised the number of hospitalization days (in surgical and rehabilitation unit), number of consultations after discharge, number of physiotherapy sessions, type and number of medications on a weekly basis, days of health-related absenteeism from work. Patients were also asked if a subsequent hip arthroplasty had been performed.

Cost analysis

The economic evaluation was performed from a societal perspective. Costs for hospitalization in the ICU [7], surgical and rehabilitation units [8] and for surgical theatre occupancy [9] were retrieved from the literature. Cost assumptions were also derived from the literature to calculate the costs of subsequent total hip replacement procedures [10], blood transfusions [11], specialist consultations [8] and physiotherapy sessions [12]. The costs for plates, screws and external fixator device are specific for costs incurred in our institution and were hence retrieved from our hospital expenses reports. Treatment costs were calculated from the cost assumptions presented in Table 1. To assess the costs of the prescribed pharmacological therapies, units of consumed resources were multiplied by the prices reported in the official Italian price

list [13], taking into account the dosage and duration of the treatment. The monetary value of one lost working day for patients was considered as equal to the gross domestic product per capita/day [14]. Since at the time of analysis only gross domestic product data from 2013 were available, a correction for inflation was performed based on official inflation rates for Italy.

Statistical analysis

Demographic and clinical-related variables are presented with standard descriptive statistics: mean and standard deviation for normally distributed continuous variables, median and interquartile range for non-normally distributed continuous variables, absolute number and frequency distribution for categorical variables. The normality assumption was tested by means of the Kolmogorov–Smirnov test. Since data were not normally distributed, the Mann–Whitney test was used to investigate any possible association of study costs with the type of fracture (acetabular fractures vs. Pelvic ring injuries). The significance level was set at $p < 0.05$. The statistical analysis was conducted using the software Stata, version 12 (Stata Corporation, College Station, Texas, USA).

Results

From the initial sample of 266 patients who were surgically treated for a pelvic ring injury or an acetabular fracture, 203 were included in the statistical analysis; 30 were excluded due to insufficient follow-up and 33 were lost to follow-up. Among the 203 study participants, 135 (66.5 %) had an acetabular fracture whereas 68 (33.5 %) sustained a pelvic ring injury. The distribution of the different types of acetabular fractures and pelvic ring disruptions is shown in Table 2. Main study characteristics of the total sample are presented in Table 3. Then mean age was 49.1 ± 15.6 years and the median follow-up period was 38 months (range 9–77). The vast majority were males (82.8 %). The median period of hospitalization in the surgical unit was 2 weeks. Fifty percent of patients were hospitalized in a rehabilitation unit for a median period of 60 days. A subsequent total hip replacement was performed in 16 patients. Information regarding working status was available for 167 patients. Evaluation of work absence length was not possible for 36 patients due to peculiarity of their job.

The cost distribution is shown in Table 4. The median total cost for the treatment of an acetabular or a pelvic fracture was 29.425 Euros per patient (range 5.583–250.604). Sixty percent of the total cost was attributed to health-related work absence. Median costs (in Euros) were 2.767 for hospitalization from trauma to definitive surgery (preoperative costs), 4.530 for surgery, 3.018 for hospitalization in the surgical unit, 1.693 for hospitalization in the rehabilitation unit, 1.920 for post hospital discharge physiotherapy and 402 for specialist consultation after discharge.

Further on, potential differences in the costs between acetabular and pelvic fractures were investigated (Table 5). In the acetabular fracture group 27 out of 135 (20 %) and 41 out of 68 (60 %) patients with a pelvic ring injury were admitted in ICU at arrival. The total costs for treating pelvic ring injuries were higher than for acetabular fractures although the significance was borderline ($p = 0.058$). Costs for hospitalization from trauma to definitive surgery ($p < 0.001$) and hospitalization in the surgical unit ($p = 0.008$) were significantly higher in patients with pelvic ring injuries than in patients with acetabular fractures. Costs for medications seemed to be slightly higher in pelvic ring injuries compared to acetabular fractures ($p = 0.043$). On the other hand, the costs regarding surgery, consultation after discharge, post hospital discharge physiotherapy, and health-related work absence did not differ significantly between acetabular fractures and pelvic ring injuries.

Discussion

Although acetabular fractures and pelvic ring injuries represent only a small proportion of injuries requiring surgical treatment, they may cause a significant economic burden. In this study, we sought to determine the direct and indirect costs of these fractures and to test how the type of fracture (acetabulum or pelvis) influences these costs.

The majority of our patients (82.8 %) were men. This is in line with the higher prevalence of male patients (56.0 %) reported in large case series for pelvic ring injuries [15] and in a meta-analysis of acetabular fractures (69.4 %) [1]. The mean age of our patients was also comparable with these papers.

To our knowledge, this is the first study reporting on direct and indirect costs of these fractures. We found that the median costs of pelvic ring injuries and acetabular fractures are approximately 29.000 and 34.000 Euros, respectively.

There have been numerous studies evaluating the costs related to various types of trauma [16–18]; however, none specifically looked at direct and indirect costs of pelvic ring injuries and acetabular fractures. Absenteeism covers 60 % of post-discharge expenses, this is due to the long time from trauma to work resumption (180 days). Post-surgery hospitalization covers 26 % of costs and, according to our opinion, should be reduced: the length of hospitalization we saw in both the surgical and in the rehabilitation unit (14 and 60 days, respectively) were higher than reported in other studies [16–18]. On the other hand, the length of hospitalization and the related costs should also be interpreted with caution since vast geographical differences exist. In other European studies (e.g. Pizanis [19]) the mean hospitalization length ranged from 30 to 56 days whereas much shorter mean hospitalization lengths have been reported from the US. For example, Vallier [20] reported a mean time of 9.2 days in surgical wards after pelvic and acetabular fractures. This disparity is likely to be related to the huge difference between hospitalization costs in Europe and in the United States: the World Health Organization estimated 268 [21] and 1944 dollars [21] for a single day of hospitalization in Germany and United States, respectively.

On the other hand, one should appreciate that the economic impact of hospitalization time per se is controversially discussed. Since the last days of hospitalization are usually just for recuperation, the actual resource consumption in this phase is strongly reduced [22].

Our study shows that type of fracture has an important impact on costs. The fact that noticeable changes in direct costs were seen after adjusting for the type of fracture (pelvic ring injury or acetabular fracture) suggests an interaction between these variables and the resulting post-fracture care. Pelvic involvement is likely an indicator of fracture severity, requiring far more extensive healthcare utilization than fractures involving only the acetabulum. Tibbs [23] showed that patients with pelvic ring fractures required longer hospitalization than patients with acetabular fractures. The author attributed this to the worse clinical condition at the time of hospital admission. Our data are in line with these findings: patients with a pelvic ring fracture showed a significantly higher rate of both ICU admission These factors led to significantly higher direct costs for patients with pelvic ring injuries.

Our study has several limitations. Namely the retrospective study design, which is susceptible to biased data collection. Additionally, race, socioeconomic status and anthropometric information were not evaluated. Furthermore, several costs were evaluated not directly but via published references. Additionally, the consumption of further resources (e.g. for assistance with household, nursing and transportation) was not included in our cost estimation and permanent loss of productivity was not taken into account. Finally, this study only included data provided by employees from a single European country. Thus, findings may not be generalizable to other geographical regions. Future research should try to identify the individual factors associated with the costs and potentially with the time required for healing.

Conclusions

The results of this study demonstrate that pelvic fractures are associated with both high direct costs and substantial productivity loss. Costs for hospitalization from trauma to definitive surgery and hospitalization in the surgical unit were lower in fractures involving only the acetabulum than in pelvic ring injuries.

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Tables

Table 1 Costs per unit and references

Variables	Cost per unit (in Euros)	References
One-day hospitalization in ICU	1168	[7]
One-day hospitalization in surgical ward	216	[8]
One-day hospitalization in physiotherapy ward	121	[8]
One minute of surgical theatre occupation	20	[9]
Transfusion of one unit of blood	482	[11]
Specialist consultation	100	[8]
Physiotherapy session	80	[12]
Surgical plate with classic screws configuration	530	Hospital expenses report
One surgical screw	75	Hospital expenses report
External fixator device (disposable)	1200	Hospital expenses report
Total hip arthroplasty procedure	6982	[10]
One-day of work absenteeism	98	[13]

1. *ICU* intensive care unit

Table 2 Distribution of pelvic and acetabular fractures

Fracture type	*N* (%)
Pelvic fracture[a]	68 (33.5)
b1.2	9 (13.2)
b1.3	2 (2.9)
b2.1	1 (1.5)
c1.1	6 (8.9)
c1.2	20 (29.4)
c1.3	11 (16.2)
c2	1 (1.5)
c3.1	3 (4.4)
c3.2	2 (2.9)
c3.3	1 (1.5)
T-type and c1.3	3 (4.4)
Transverse and b1.1	2 (2.9)
Pelvic unclassified	7 (10.3)
Acetabular fracturesb	135 (66.5)
Both column	36 (26.7)
Posterior wall	30 (22.2)
Transverse and posterior wall	23 (17.0)
Transverse	16 (11.8)
Anterior column	10 (7.4)
Posterior column	9 (6.7)
T-type	7 (5.2)
Acetabular unclassified	4 (3.0)

1. [a]According to Tile classification
2. [b]According to Letournel classification

Table 3 Main study characteristics

Variables	
Gender	
Females	35 (17.2)
Males	168 (82.8)
Age (years)	49.1 ± 15.6
Follow up period (months)	38 (21; 58)
Time from trauma to definitive surgery (days)	10 (6; 14)
Admission to ICU upon arrival	
No	132 (65.0)
Yes	71 (35.0)
Time in ICU (days)a	5 (2; 8)
Duration of surgery (min)	130 (90; 180)
Blood transfusion units	
0	59 (37.1)
1	27 (17.0)
2	45 (28.3)
≥3	28 (17.6)
Medication for pain	
None	157 (77.3)
Nonsteroidal anti-inflammatory drugs	35 (17.2)
Opiate	11 (5.5)
Period of hospitalization in surgical unit (days)	14 (9; 25)
Hospitalization in rehabilitation unit	
No	100 (49.3)
Yes	103 (50.7)
Period of hospitalization in rehabilitation unit (days)b	60 (30; 80)
Physiotherapy sessions after discharge	
No	36 (17.7)

Variables	
Yes	167 (82.3)
Number of physiotherapy sessions after dischargec	30 (16; 60)
Patient who worked before trauma	
No	36 (21.6)
Yes	131 (78.4)
Time to work resumption (days)d	180 (120; 240)

1. Data are presented as *N* (%), Mean ± standard deviation, or Median (p25; p75)
2. *ICU* intensive care unit
3. Applicable only for the: [a] 71 patients who admitted to ICU upon arrival, [b] 103 patients who were hospitalized in rehabilitation unit, [c] 167 patients who were submitted to physiotherapy after discharge, [d] 131 patients who belonged to the working population (information on working status was missing for 36 patients)

Table 4 Mean, standard deviation (SD), median, minimum (min), maximum (max), lower quartile (q25) and upper quartile (q75) values of the costs (in Euros) attributed for the treatment of a patient with an acetabular or a pelvic fracture

Type of cost	Mean	SD	Median	Min	Max	q25	q75
Preoperative	4.702	5.788	2.767	216	46.720	1.728	5.785
Surgery	5.288	2.680	4.530	1.025	18.156	3.488	6.144
Hospitalization in surgical unit	4.966	5.953	3.018	647	51.730	1.940	5.389
Hospitalization in rehabilitation unit	4.140	6.789	1.693	0	44.150	0	7.258
Consultation after discharge	407	430	402	0	4.019	201	502
Medications	118	471	0	0	4.344	0	0
Post hospital discharge physiotherapy	3.573	5.951	1.920	0	48.000	720	4.000
Health-related work absence[a]	23.430	21.012	17.719	984	125.757	11.813	23.626
Total cost	38.083	29.676	29.425	5.583	250.604	20.854	42.681

1. [a]Applicable only for the 131 patients who belonged to the working population

Table 5 Median values and interquartile range (q25; q75) of direct and indirect costs (in Euros) according to type of fracture

Type of cost	Acetabular	Pelvic	*p* value[†]	Type of cost	Acetabular	Pelvic	*p* value[†]
Preoperative	2.376	4.104	<0.001	Preoperative	2.376	4.104	<0.001
Surgery	4.480	5.046	0.426	Surgery	4.480	5.046	0.426
Hospitalization in	2.802	3.233	0.008	Hospitalization in	2.802	3.233	0.008
Hospitalization in	0 (0; 4.838)	3.629 (0;	0.069	Hospitalization in	0 (0; 4.838)	3.629 (0;	0.069
Consultation	402 (201;	402 (251;	0.941	Consultation	402 (201;	402 (251;	0.941
Medications	0 (0; 0)	0 (0; 101)	0.043	Medications	0 (0; 0)	0 (0; 101)	0.043
Post hospital	2.000 (800;	1.600	0.811	Post hospital	2.000 (800;	1.600	0.811
Health-related	17.719	17.719	0.156	Health-related	17.719	17.719	0.156
Total cost	28.571	33.710	0.058	Total cost	28.571	33.710	0.058

1. [†]*p* values derived from Mann–Whitney test
2. [a]Applicable only for the 131 patients who belonged to the working population