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The total costs of a displaced femoral neck fracture: comparison of internal fixation and total hip replacement

A randomised study of 146 hips

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Abstract We randomised 143 patients –age 75 years or older—with displaced femoral neck fracture to either internal fixation or total hip replacement (THR) and compared the socio-economic consequences. In the internal fixation group, 34 of 78 hips underwent secondary surgery. In the THR group, 12 of 68 hips dislocated, the majority in mentally impaired patients. We calculated the total hospital costs for two years after operation. When secondary surgery was included, there was no difference in costs between the internal fixation and THR groups, or between the mentally impaired and lucid subgroups. The costs to the community were calculated comparing the baseline cost before surgery with the average cost per month during the first postoperative year. No difference was found between the treatment groups. The Harris hip scores were higher in the THR group, and pain was more common in the internal fixation group. In lucid patients, THR gives a better clinical result at the same cost.

Résumé Nous avons randomisé 143 malades-âgés de 75 ans ou plus— avec une fracture du col fémoral déplacée traitée par fixation interne ou remplacement totale de la hanche et avons comparé les conséquences socio-économiques. Dans le groupe de la fixation interne, 34/78

hanches ont subi une chirurgie secondaire. Dans le groupe PTH, 12/68 hanches se sont luxées, la majorité chez des malades mentalement affaiblis. Nous avons calculé les coûts totaux d'hospitalisation jusqu'à deux années post-opératoires. Quand la chirurgie secondaire a été incluse, il n'y avait aucune différence dans les coûts entre la fixation interne et le groupe PTH, ou entre les sous-groupes mentalement affaibli et lucides. Les coûts municipaux ont été calculés en comparant le coût de base avant chirurgie avec le coût moyen par mois pendant la première année postopératoire. Aucune différence n'a été trouvée entre les groupes de traitement. Le score de hanche de Harris étaient supérieur dans le groupe PTH et la douleur était plus fréquente dans le groupe de la fixation interne. Chez les malades lucides, la PTH donne un meilleur résultat clinique au même coût.

Introduction

Displaced femoral neck fractures comprise more than one third of all hip fractures. Consensus on the optimal treatment has still not been reached.

As in other Scandinavian countries, closed reduction and internal fixation has long been the preferred treatment in Sweden because it has been considered simple, secure and cheap in comparison with primary arthroplasty. However, this has never been shown in a prospective randomised study with a long-term follow-up.

Patients and methods

Study design

From September 1994 to May 1998, patients 75 years or older who were admitted to the Linköping University Hospital with displaced femoral neck fractures were randomly assigned to either internal fixation or total hip arthroplasty (THR). To be included in the study a patient needed to meet the following criteria: walking ability prior

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to the trauma, no contraindications to major surgery, no important malignancy and no rheumatic joint disease. Mental impairment was not a criterion for exclusion. Randomisation was implemented using sequentially numbered and sealed envelopes. At the time of the study, internal fixation was the standard treatment for all femoral neck fractures and therefore only those patients who were randomly selected for arthroplasty were asked to consent to the treatment, a randomisation procedure proposed by Zelen [19]. Patients with mental impairment were included in the study only after permission was obtained from their legal guardians. The local ethics committee approved the study.

Patients

Originally 157 hips were randomised. Eleven were excluded due to denial by the patient to undergo THR ($n=5$), the patient being thought unfit for THR by the anaesthetist ($n=3$), preoperative stroke ($n=1$) and administrative grounds ($n=2$). A total of 146 hips in 143 patients were followed up for two years. The average age was 84 years (range 75–101), 76% were women, and there were no significant differences between the groups. Of the three patients who suffered bilateral fractures, two were randomised twice to internal fixation and one was randomised twice to arthroplasty. They all fully recovered after the first operation and for each patient the two hips were treated in the material as different cases.

Mental impairment

The mental state of the patients was classified according to the modified Norton scale as 4=fully oriented, 3=occasionally confused, 2=cannot answer adequately or 1=no contact. In this study only grade 4 was deemed normal mental function. When needed, anamnestic data were collected from a close relative or caregiver.

Preoperative and surgical procedures

Internal fixation was performed with two parallel and percutaneously inserted screws (Olmed; Olmed Medical, Uppsala, Sweden) after closed reduction. THR was performed with a cemented prosthesis (Lubinus IP; Link, Hamburg, Germany) using a postero-lateral approach. Surgery was performed on all days of the week by all surgeons that were normally available. Postoperatively, full weight bearing was permitted for both groups, and all patients had physiotherapy.

Clinical outcome

After one year 23% of the patients had died and after two years 29%. There was about the same mortality in the internal fixation and THR groups. The accumulated

mortality was pronounced among the mentally impaired patients; 42% at one year and 55% at two years.

In the internal fixation group, 34/78 patients (44%) underwent secondary surgery (Fig. 1). In the THR group, 12/68 (18%) dislocated. The total number of dislocations, including recurrent dislocations, was 24. The dislocation rate was higher for the mentally impaired patients (Fig. 1).

Cost analyses: hospital costs

The direct costs were calculated in accordance with well-established principles for economic evaluation of medical technologies [3, 17]. The direct costs for surgical procedures, hospital stay, radiographic examinations, home rehabilitation, and emergency and outpatient visits were calculated according to the opportunity cost concept. These costs were collected from the hospital budgets for the year 2000 and are thought to be close approximations of the true costs. The exchange rate from Swedish crowns (SEK) to Euro (€) was 1:9. In order to avoid cost bias due to the use of standard diagnosis-related group (DRG) prices, the costs for different surgical procedures were calculated based on an estimated average time consumption and the number of people needed for the procedure, the cost of the implant or screws, the cost for the anaesthesia and the post-operative surveillance. The set-up cost for anaesthesia and the operating room was estimated at 590€, the variable cost per minute (€): 1.44 for the surgeon, 4 for anaesthesia and 5.11 for the operating room. The average time consumption in minutes was estimated to be 40 for reduction and internal fixation, 100 for THR, 30 for screw removal, 15 for closed reduction of a dislocated THR and 45 for a Girdlestone procedure. These estimates correspond to the normal surgical time at our clinic for each procedure.

The costs in different wards included all standard services including drugs and physiotherapy.

All costs included the overhead costs for the hospital, including those for auxiliary departments. The number of days in the hospital was calculated counting the day of admission but not the day of discharge.

All recorded costs represented the real consumption. For example, only outpatient visits that actually took place

Fig. 1 Clinical outcome with regard to mental function

were counted. Outpatient visits for scientific purposes were not included.

Cost analyses: community services

The average cost for institutional living was 103€ per day. For those living in their own homes, the cost for municipal home aide was 27€ per hour (personal communication from the Linköping Municipal Office). These represent the direct costs for the community. The incremental costs were calculated comparing the baseline cost representing the level of community service consumption immediately before the fracture and the average consumption during the one year postoperatively. When a patient died before one year, the final level of municipal support was extrapolated to one year. The baseline and the accumulated costs during the postoperative year were expressed in average €/month (year 2000).

Statistics

Student's *t*-test was used for analysing parametric data. The Mann–Whitney U-test was used to analyse differences in costs. When testing proportions, the chi-square test and Fisher's exact test were used. *P* values below 0.05 were considered significant.

Results

Hospital costs

Total costs

The total average cost for all patients including complications and reoperations performed at 2 years was 13,000€

Fig. 2 Total hospital costs with regard to surgical method

(range 3,000–58,000). The median cost was 10,800€ (interquartile range 7,900–16,100). These costs were mainly normally distributed, but with a right-hand tail (Fig. 2). There was no difference between internal fixation and primary THR; the mean costs were 13,100€ and 12,800€, respectively. Seventy-three per cent of the total costs were accounted for by the hospital bed-day costs. The total average number of bed-days was 26 (range 4–120).

Mental function and total cost

The average total cost for the lucid patients and for those with mental impairment was 13,100€ and 12,700€ respectively. For the lucid patients, the average cost appeared higher after internal fixation than after THR, but the opposite was found for the patients with mental impairment (Table 1). For the lucid patients, the 95% confidence interval for the comparison between treatment groups ranged from internal fixation being 480€ cheaper to

Table 1 Total costs after internal fixation and THR dichotomised by mental function (€)

Cost factor	Lucid patients		Mental impairment		Average all patients <i>n</i> =146
	Internal fixation <i>n</i> =53	THR <i>n</i> =37	Internal fixation <i>n</i> =25	THR <i>n</i> =31	
Bed-days	27	20	27	30	26
Surgery	2,505	3,013	1,685	3,223	2,646
Care cost	10,226	7,609	8,970	10,201	9,343
Emergency	157	126	147	143	145
Outpatient	129	67	53	60	86
Radiography	227	149	179	202	194
Home rehabilitation	784	935	68	43	542
General comp.	6	10	0	15	8
Total (approx.)	14,000	11,900	11,100	13,900	13,000
CI (95%) €	11,800–19,300	10,700–13,100	8,000–14,200	10,200–17,600	10,700–15,300
Initial treatment (approx.)	8,300	1,130	9,010	10,980	9,740
Initial/total	59%	95%	81%	79%	75%

Each number represents the accumulated average cost including all fracture-related complications, e.g. reoperations and readmissions, within 2 years of the fracture

Table 2 Total hospital costs after internal fixation and THR for patients requiring secondary surgery versus no reoperation (€)

	Internal fixation		THR	
No reoperation	9,000	<i>n</i> =44	11,100	<i>n</i> =57
CI (95%)	7,200–10,900		10,100–12,100	
Secondary surgery	18,300	<i>n</i> =34	21,600	<i>n</i> =11
CI (95%)	16,000–20,700		17,200–25,800	

Secondary surgery is expensive

4,720€ more expensive than a THR. Thus, there is only a 2.5% probability that THR in a lucid patient will be greater than 480€ more expensive than internal fixation, and it will most likely be cheaper. For patients with mental impairment the 95% confidence interval for the comparison between treatment groups ranged from THR being 7,560€ more expensive to 2,100€ cheaper.

Initial versus total cost

The costs for the initial treatment, including primary surgery, hospital stay and one outpatient visit to the hospital, averaged 9,740€, which accounted for 75% of the total costs (Table 1). For the lucid patients the initial treatment costs were lower in the internal fixation group but the secondary costs were higher ($P<0.001$).

Forty-five patients were readmitted to the hospital after the initial treatment: 37 of 78 after internal fixation versus 8 of 68 after THR ($P<0.0001$). Only 2 of 37 lucid patients that had undergone THR were ever readmitted, one due to a wound infection and one due to recurrent dislocations. When secondary surgery was performed, the total costs doubled for both treatment groups (Table 2).

High-cost patients

A dozen patients with the highest costs, seen as the right-sided tail in Fig. 2, were analysed. Eight were patients with internal fixation that was converted to THR (7/8 lucid), three were patients with mental impairment with recurrent dislocations after a primary THR, and one was a patient with mental impairment who had a long rehabilitation period after internal fixation.

Municipality costs

Preoperatively, 45 (31%) of 146 of the patients lived in institutions. All survivors in that group were discharged back to their original institution, thus not adding any additional costs to the municipality. Of the surviving patients who came from independent living, 91 of 100 (91%) could return to their homes (Fig. 3).

During the year of observation, the costs remained unchanged for 83 (58%) of 142 patients. For the 59 patients with incremental costs the mean increase was 1,310€ per month, median 990€ (interquartile range 260–2,230). At the end of the year, 37 (33%) of 113 survivors lived in institutions, whereas 32 (28%) were still living independently without any home help.

There was no difference in the change of average costs per month between the THR and internal fixation groups, nor in the subgroup analysis between lucid and mentally impaired patients in those treatment groups.

Functional outcome (Harris hip score) and pain

Patients whose primary operation was THR had a higher Harris hip score. When the number of patients scoring in the excellent and good categories was compared to the fair

Fig. 3 Types of living before the fracture, after discharge from hospital and at 1 year. Deaths (†) and changes in types of living during the first year are shown. At one year, 76/113 (67%) lived independently

Table 3 Harris hip scores at 3 months, 1 and 2 years

Score	Internal fixation			THR		
	3 months	1 year	2 year	3 months	1 year	2 year
Excellent (90–100)	0	3	3	9	13	8
Good (80–89)	5	3	3	15	11	12
Fair (70–79)	8	8	4	9	9	8
Poor (<69)	51	40	38	21	15	13
(Failures)	(32)	(28)	(26)			
Diseased	7	17	23	3	16	20
Missing	7	7	9	11	4	7

Once a patient scored as “poor” due to a failure, she remained classified as such despite reoperation with a good result. Local pain due to screw ends was not considered a failure

and poor groups, the differences were highly significant at three months and one year ($P<0.0001$) as well as at two years ($P<0.001$) (Table 3).

The prevalence of pain, in relation to the primary treatment, was significantly higher in the internal fixation group. For the mentally impaired patients, the relative prevalence of pain was significantly higher at three months after internal fixation, but not at one and two years.

Discussion

Our results showed almost identical total hospital costs in the internal fixation and THR groups. There was no difference in total costs between the lucid patients and those with mental impairment. However, for the lucid patients there was a tendency towards higher costs after internal fixation despite low initial treatment costs. For the patients with mental impairment the tendency was the opposite. This can be explained by lower reoperation rates in the mental impairment group after internal fixation, which in turn may be due to higher mortality and lower functional demands.

On average, three-quarters of the total hospital costs were derived from the initial treatment and rehabilitation. The difference between initial and total costs was most prominent for the lucid patients treated with internal fixation.

Mainly two types of patients had the highest costs: lucid patients with a failed primary internal fixation and patients with mental impairment and recurrent dislocations of a primary THR. Obviously, these complications should be avoided, not primarily to decrease the costs but to minimise the suffering for these patients.

Our study has a number of weaknesses. First of all, the estimated costs for each procedure and the stay at the hospital should not be extrapolated to other hospitals or countries without careful examination. An alternative would have been to use the DRG system. However, the use of the DRG system is associated with great risks of over- and underestimation of costs and is too inexact for scientific purposes [11, 18].

Our study was characterised by representative surgical quality. Displaced femoral neck fractures (Garden III–IV) show high complication rates after internal fixation. Non-union normally occurs in 20–40% and late segmental collapse in 16% of cases [8]. Our clinical results after

internal fixation correspond well with this study. The 8% dislocation rate after THR in the lucid group may seem high, but this should be compared to an average of around 10% in hip fracture patients in other studies [8, 10]. Almost one-third of the mentally impaired patients with THR in this study dislocated their hips. Such high dislocation numbers have never been published, possibly because this category of patients has not been included in any comparable study.

A majority of the complications that occur after internal fixation are detected within two years and are thus included in this study. Aseptic loosening of a hip prosthesis is usually a long-term complication that we have not seen in this study so far. In a long-term follow-up from the Mayo Clinic, concerning consecutive THR after femoral neck fractures, the probability for survival of the prosthesis without revision at ten years was 94% [7]. Those results, in combination with a natural high mortality rate for this group of elderly patients, indicate that few, if any, future hip revisions will be needed. Thus, we believe that almost all fracture-related complications and hospital costs for both treatment groups have been detected in this study.

We found no difference in incremental costs to the community between the treatment groups. Almost 60% of the patients remained on the same cost consumption level postoperatively. This should not be interpreted as the true consumption of resources. In our study the informal help from relatives, neighbours and friends was not taken into account, nor was the workload for the nurses and attendants at the hospital, in nursing homes or in other institutions studied.

The incremental costs should not automatically be attributed to the fracture. For many elderly patients an event like a hip fracture may call to attention a critical home situation and the incremental costs postoperatively may well be due to other factors such as concomitant disease or incapacity. Thus, we believe that the method of Brainsky et al. [2] and Zethraeus et al. [20], using the difference in total costs between six–12 months before and one year after the fracture to measure the cost for a hip fracture, is methodologically incorrect.

In the literature, only three studies have compared the costs for internal fixation and THR. The one by Søreide et al. was prospective and randomised [15]. They used the basic costs of a hospitalisation day as a unit, and found the total costs, including reoperations, for THR and internal fixation were equivalent to 29.8 and 18.55 days, respec-

tively. At our present cost per day this would correspond to 12,600€ for THR and 7,800€ for internal fixation, figures similar to ours, although internal fixation was cheaper in their study. This, however, may be due to the fact that they followed these patients up for only one year, and the local complication rate was lower for their internal fixation group compared to ours.

The second study, by Iorio et al., that compared internal fixation with THR was based on results collected from the literature, including reoperations within two years [4]. They calculated that the cost of fracture treatment was US\$ 20,000–24,000 and was about the same for internal fixation, hemiarthroplasty and THR. Their costs were higher than ours, which may be explained by the exchange rate and different unit costs. Their results were, however, similar to ours in the sense that the total costs for different treatments did not differ. Their investigation also showed that the benefit of low costs for primary internal fixation is lost when secondary surgery is included in the calculation.

The third study, by Rogmark et al., was a randomised comparison between internal fixation and a variety of hip prostheses. It included 68 relatively healthy patients without mental impairment or institutional living [14]. The study showed that the mean two-year cost after internal fixation was more expensive, US\$ 21,000 versus US\$ 15,000, than after a primary arthroplasty.

The results of the present study, in combination with previously published results concerning clinical outcome and changes of nutritional status, give further strength to the conclusion that primary THR is the treatment of choice for patients with normal mental function and high functional demands [1, 5]. However, there is a need for randomised studies to clarify to what extent hemiarthroplasty should be used. Without doubt, a primary cemented arthroplasty is superior to internal fixation regarding need for secondary surgery, function, pain, nutritional status and quality of life in active and lucid patients [1, 5, 6, 9, 12, 13, 16].

For patients with mental impairment the choice of treatment is not obvious. For patients with limited life expectancy or very low functional demands, internal fixation is probably the treatment of choice.

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