A cost analysis of three methods of treating femoral shaft fractures in children

A comparison of traction in hospital, traction in hospital/home and external fixation

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Introduction There is no consensus as to which is best treatment of femoral fractures in children.

Patients and methods We performed a cost analysis comparing three treatments of femoral shaft fractures in children aged 3–15 years at 3 hospitals during the same period (1993–2000). The analysis included total medical costs and costs for the care provider and were calculated from the time of injury up to 1 year.

Results At hospital 1, treatment consisted of external fixation and early mobilization. At hospital 2, the treatment was skin or skeletal traction in hospital for 1–2 weeks, followed by home traction. At hospital 3, treatment was skin or skeletal traction in hospital until the fracture healed.

Results The average total costs per patient were EUR 10,000 at hospital 1, EUR 23,000 at hospital 2, and EUR 38,000 at hospital 3.

Interpretation The main factor for determining the cost of treatment was the number of days in hospital, which was lower in children treated with external fixation.

Femoral shaft fractures are common childhood injuries and several treatments are available, such as the immediate application of a cast, various forms of traction in some cases followed by a cast, intramedullary rodding or elastic nails, plate fixation and external fixation. There is no consensus as to which treatment is best (Clinkscales and Peterson 1997, Wright 2000). The cost of the various treatments varies markedly. With the rapidly rising cost of health care, it is important to identify these costs when considering the choice of treatment (Newton and Mubarak 1994).

Several authors have compared the clinical outcome and the financial aspects of various treatments. Early reports showed a difference between traction and/or casting and intramedullary nailing, with the latter being less expensive (Kissel and Miller 1989, Reeves et al. 1990). However, Newton and Mubarak (1994) found no difference when the total medical charges took into account and not only the hospital charges. Henderson et al. (1984) found that early spica cast treatment cost much less than traction, a finding confirmed by Newton and Mubarak (1994). The costs were greatly affected by the number of days in traction before casting.

In-hospital skin or skeletal traction has been the gold standard for the treatment of femoral fractures in children, but it is also the most expensive. The cost can be reduced to almost half with a home-traction program, although it can be demanding for both the physician and care provider (Newton and Mubarak 1994, Boman et al. 1998).

Nork and Hoffinger (1998) compared the costs of external fixation and 90–90 traction with spica casting and found that “external fixation resulted in decreased hospital costs and length of hospitalization, but produced substantially less income for the hospital, when compared with skeletal traction followed by spica casting”. None of the above-mentioned reports contain any data about the social costs in terms of lost wages and other expenses for care providers.

We performed a cost analysis of three standard treatments of femoral shaft fractures in children and adolescents—i.e., external fixation, traction at home and in-hospital traction during the same period (1993–2000). The analysis included total medical costs and costs for the care provider.

Patients and methods

This study was done in 3 county hospitals in Sweden with orthopedic departments of about the same size and a catchment area of 200,000–240,000. The number of children between 0–18 years varied between 55,000 and 67,000. In Sweden, children with fractures are hospitalized in pediatric departments, but are managed by orthopedic surgeons with a special interest in pediatric orthopedics. Usually at least one parent or care provider stays with the child in the department and takes part in the daily care of the child.

We included all children with femoral shaft fractures, aged 3–15 years, treated in any of the 3 study hospitals during the period January 1993–July 2000. Each of the hospitals had a standard treatment for femoral fractures in children. To be included in the study, the child had to be treated with that specific standard method: hospital 1, external fixation and early mobilization for all femoral fractures in children aged 3–15 years; Hospital 2, skin or skeletal traction in hospital for 1–2 weeks, followed by home traction until the fracture healed; hospital 3, skin or skeletal traction in hospital until the fracture healed.

We obtained relevant patient demographic data from medical charts and radiographs. Complications were classified by the method of Zachee et al. (1991) and Gregory et al. (1992). All charts were reviewed by one of the authors (HH).

Duration of treatment was defined as from the operation until removal of the external fixator or the traction. At that time the children with external fixation were fully weight-bearing and had no walking aid while the children who had been treated with traction needed physiotherapy or help from their parents for a couple of weeks before they could walk independently.

Table 1. Unit costs of various parts of the treatment

Type	Cost/unit, Euro
In-patient	
cost per day	706
surgery, cost per minute [a]	12
cost per radiograph	
acute	42
planned	33
Out-patient, cost per visit	131
Parents' salary [b]	
M 18–24	2529
F 18–24	2762
M 25–29	2912
F 25–29	3278
M 30–34	3078
F 30–34	3644
M 35–39	3145
F 35–39	3644
M 40–44	3162
F 40–44	3960
M 45–49	3178
F 45–49	3994
M 50–54	3212
F 50–54	4077

[a] Including costs for anesthesia
[b] M mother, F father and average monthly salary by gender and age classes (years) including social costs

The parents's demographic data were obtained from a questionnaire sent to all parents and from information from the regional social insurance office.

Most health services in Sweden are financed by tax revenue and health care is primarily a public responsibility. The regional political authorities, the county councils, are responsible for health care. Children below the age of 18 years pay no fee for consulting a doctor.

The unit costs (Henriksson et al. 2000) for each part of the treatment in the hospital and out-patient clinic have been calculated by the hospital's finance department (Table 1). The unit costs for a specific part of the treatment may vary between hospitals, although the difference was small and the overall unit costs were about the same since they are calculated in the same way. Cost estimates were based on consumption in previous years. No capital costs were included in these cost estimates. In comparing the costs for each hospital, the prices set at one of the study hospitals, Falun, were used for all calculations. A cost analysis was done by Drummond et al.'s method (1997). All costs were calculated from the time of injury up to 1 year to include not only costs up to healing but also potential costs associated with any complications that might occur during the period after healing. At 1 year, all fractures had healed and no further treatment or visits were planned—i.e., no additional costs were expected.

"Costs of hospital stay" were calculated per day and included "hotel" costs, drugs, personnel costs, radiographs, laboratory costs, tutoring (in hospital), physiotherapy and costs of physicians and surgeons. In Sweden physicians and surgeons are hospital employees on a fixed salary. The only costs not included in the hospital stay were operating costs, since such costs were included in "Costs of anesthesia/operation".

The latter category included all costs in the operating room, such as costs of equipment, personnel, medicine, orthopedic devices, and costs of the surgeon. The traction pins and pins for the external fixator were used only once, although the external fixator was reused, which up to now has been customary in Scandinavian countries. When reused about ten times. the cost of the fixator is about EUR 300 per patient.

The costs of radiographs were calculated only for radiographs taken in the out-patient clinic, because costs of radiographs taken during a hospital stay were included in the costs of hospitalization.

We calculated sick-leave for the providers in two ways: 1. The number of days the parents had stated in the questionnaire, which were the actual days they had been away from work; 2. The number of days recorded at the regional social insurance office as sick-leave for taking care of the child.

To calculate the cost of loss of earnings for taking care of the child, we used the Statistical Yearbook of Salaries and Wages 2000, Statistics Sweden.

Statistics

We used SPSS for the statistical calculations (Version 11.0 for windows, SPSS, Chicago, IL). To compare parameters in the 3 groups, duration of operation, days in hospital, duration of treatment, number of radiographs and visits to the out-patient department, we used the Kruskal-Wallis test and, if statistically significant, the differences were evaluated with the Mann-Whitney U-test. The same analyses were used to compare costs of various parts of the treatment and the total costs.

The distribution of clinical parameters, such as type of injury, was evaluated with the chi-square test. The same test was used to compare the working hours of the parents. To evaluate the differences in age distribution and the effect on costs at the 3 hospitals, we performed a linear regression analysis using dummy variables for hospitals. To evaluate the differences in distribution of injury and its effect on costs, we used the Kruskal-Wallis test.

All tests were two-sided and the chosen level of significance was $p < 0.05$.

Results

Patients

Hospital 1. During the study period, 69 children with femoral fractures were admitted to the hospital. All were treated with external fixation. 15 children were permanent residents in other parts of the country and were transferred to their home hospital after external fixation. 2 children were refugees and were sent back to their home countries before final follow-up. 1 boy with bilateral femoral fractures and other additional injuries was excluded from the study, leaving 51 patients for evaluation.

Hospital 2. During the study, 26 children with femoral fractures were admitted. 6 adolescents were treated with intramedullary nailing. 1 child with a fracture in the trochanteric area and 1 with a fracture in the supracondylar area were fixed internally. 2 children died a couple of years after their femoral fractures due to complications from their congenital neurological disease. 16 children were thus eligible for evaluation.

Hospital 3. During the study period, 33 children with femoral fractures were admitted. 2 children had spinal muscular dystrophy and were treated with immediate casting, 2 children had fractures in the trochanteric area and 2 had fractures in the supracondylar area. All 4 were treated by internal fixation. 3 adolescents were treated by intramedullary nailing or external fixation. 1 child treated in traction died 2 years after the injury as a result of complications from anoxic brain damage sustained before the femoral fracture. 23 patients could therefore be included in our study.

Table 2. Clinical data for patients

Hospital and treatment	No. of patients	Gender male	Gender female	Age, years mean	Age, years range	Injury fall on same level	Injury fall from height	Injury skis and sports	Injury traffic accidents
1a. External fixation [a]	51	37	14	8.2	3–15	11	14	19	7
1b. External fixation [b]	43	31	12	7.0	3–12	11	13	15	4
2. Home-traction	16	12	4	5.9	3–11	5	4	0	7
3. In-hospital traction	23	15	8	6.1	3–12	5	6	4	8

[a] All patients in hospital 1 (age 3–15 years)
[b] Patients in hospital 1, adjusted for age (3–12 years)

Table 3. Results in patients, mean and (range)

Hospital and treatment	Operation time (minutes)	Days in hospital	Number of radiographs	Duration of treatment (days)	Number of visits to out-patient clinic
1a. External fixation [a]	85 (30–155)	7.6 (3–20)	6.5 (4–11)	57 (39–127)	4.4 (2–11)
1b. External fixation [b]	84 (40–155)	7.7 (3–20)	6.4 (4–11)	55 (29–127)	4.2 (2–9)
2. Home-traction	68 (0–170)	23 (10–49)	6.3 (4–12)	43 (26–55)	2.8 (1–6)
3. In-hospital traction	59 (0–125)	44 (27–65)	7.2 (4–11)	38 (27–54)	2.0 (0–4)

[a] All patients in hospital 1 (3–15 years)
[b] Patients in hospital 1, adjusted for age (3–12 years)

The children in hospital 1 were older than those in the other 2 hospitals because of the use of internal fixation in some of the adolescents in hospitals 2 and 3. To match the groups at the different hospitals as much as possible as regards their age, the results from hospital 1 are given both for the group that was treated (3–15 years), but also as a subgroup restricted to the age range 3–12 years (Table 2).

Injuries incurred while skiing or in conjunction with other sport activities were commoner in hospital 1 and traffic accidents were commoner in hospitals 2 and 3. The number of falls from a height or on the same level was about the same in the 3 hospitals (Table 2).

The difference in the average hospital stay at all 3 hospitals was very significant. The duration of treatment was significantly longer at hospital 1, even when adjusted for age, and about the same in the other 2 hospitals. The same number of radiographs was taken. The primary operation and total time spent in the operating room were slightly longer hospitals 1 and 2 than in hospital 3. Hospital 1 had more visits to the out-patient clinic after discharge from the hospital (Table 3).

Parents

All care providers answered the questionnaire. Several children in each group had only one care provider for various reasons. We found no intergroup difference between the ages of the mothers or fathers. Many mothers worked part-time or did not work outside the home, while most fathers worked full-time or for various reasons did not work. It was commoner that the mothers stayed with the child in the hospital or at home. In more than half of the cases treated with traction in hospital, the parents would not have wanted the same treatment for their child and one of four treated with traction at home would not have wanted the same treatment that they had had (Table 4).

Costs

The “costs of hospital stay” differed significantly in the 3 hospitals. The total costs of both primary and secondary operations, including anesthesia, were

Table 4. Results in patients

Hospital and treatment	Days in hospital mother mean (range)	Days in hospital father mean (range)	Days at home mother mean (range)	Days at home father mean (range)	Patients' satisfaction same treatment, n (%) yes	no
1a. External fixation [a]	5.6 (0–20)	2.2 (0–15)	24.3 (0–90)	7.6 (0–60)	47 (92)	4 (8)
1b. External fixation [b]	6.1 (0–20)	2.4 (0–15)	28.3 (0–90)	8.7 (0–60)	40 (93)	3 (7)
2. Home-traction	16 (5–49)	4.6 (0–21)	36 (0–120)	7.8 (0–32)	11 (48)	12 (52)
3. In-hospital traction	30 (0–65)	15 (0–45)	43 (0–84)	16 (0–47)	12 (75)	4 (25)

[a] All patients in hospital 1 (3–15 years)
[b] Patients in hospital 1, adjusted for age (3–12 years)

Table 5. Costs calculated in Euro (EUR) of various parts of medical consumption, costs of parents' sick-leave and total costs of 3 standard treatments of femoral fractures in children, mean and (95% cofidence interval)

Costs	Hospital 1a [a] External fixation	Hospital 1b [b] External fixation	Hospital 2 Home-traction	Hospital 3 In-hospital traction
In-patient days [c]	5330 (4690–5970)	5450 (4710–6190)	16100 (10730–21470)	30750 (27520–33990)
Surgery [d]	1250 (1060–1440)	1200 (1020–1370)	710 (490–940)	750 (580–910)
Radiographs [e]	120 (110–130)	120 (110–130)	60 (50–70)	40 (30–50)
Visit to out-patient clinic	570 (510–630)	550 (500–610)	370 (270–470)	260 (200–330)
Sick-leave 1 [f]	3110 (2340–3750)	3580 (2750–4420)	5730 (4720–6740)	6490 (5520–7470)
Sick-leave 2 [g]	1760 (1260–2270)	1920 (1370–2470)	2530 (1540–3530)	2490 (1690–3290)
Total 1 [h]	10380 (9220–11530)	10900 (9610–12190)	22980 (17430–28530)	38300 (34600–41990)
Total 2 [i]	9030 (8080–9970)	9240 (6160–10320)	19780 (14560–24990)	34280 (30950–37620)

[a] All patients in hospital 1 (age 3–15 years)
[b] Patients in hospital 1, adjusted for age (3–12 years)
[c] Includes all costs except costs of surgery
[d] Includes costs of anesthesia and operation (both primary operations and secondary operations)
[e] Includes costs of radiographs in out-patient clinic (in-patient radiographs are included in in-patient costs)
[f] Costs of days that parents have noted in the questionnaire as sick-leave for taking care of the child because of the fracture
[g] Costs of days recorded in the regional social insurance office as sick-leave for the parents taking care of the child because of the fracture
[h] Total costs, including all medical costs and sick-leave 1
[i] Total costs, including all medical costs and sick-leave 2

about 40% higher in hospital 1 than in the other 2 hospitals (Table 5). The differences were significant between hospital 1 and the other 2 hospitals.

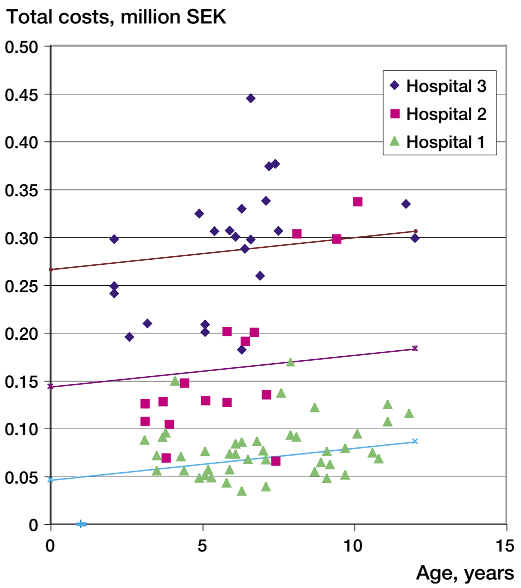
The costs of radiographs taken during the hospital stay were included in the costs of the hospital stay. The costs of radiographs at hospital 1 were 40–60% higher than on the other 2 hospitals.

The costs of visits to the out-patient clinic were 50% higher at hospital 1 than in the other 2 hospitals. This difference was significant (Table 5).

The costs of sick-leave type 1 (i.e., the number of days parents had been away from work) were significantly lower in hospital 1 than in the other 2 hospitals, while there was no difference in the costs of sick-leave type 2 (i.e., number of days recorded in the local social insurance office).

The costs of patients with complications were higher than of those without complications although the difference was not statistically significant. All patients are included in the total costs, even those with complications.

Since the time-to-healing—i.e., duration of treatment—increases with age, there was a positive correlation between the increasing age of the child and the costs of treatment. The average age of children in hospital 1 was slightly greater than in the other 2 hospitals. However, a linear regression analysis showed that even when adjusted for



Linear regression analysis showing the relationship between age and costs of the 3 methods of treatment.

the uneven distribution of age, there were still significant differences in the costs of the 3 methods of treatment (Figure).

The type of injury also affects the costs of treatment. In general, a the severer the injury, the more costly the treatment will be. In the present study, we found a difference in the distributions of the type of injury among the hospitals. However, the differences in costs of the various treatments were still significant when tested within each injury subgroup.

The total average cost per patient was EUR 10,375 in hospital 1 and EUR 10,900 when adjusted for age, EUR 22,980 in hospital 2 and EUR 38,300 in hospital 3 ($p < 0.001$).

Discussion

Many authors have compared the costs of various treatments of femoral shaft fractures in children. Some studies included only hospital charges (Reeves et al. 1990, Clinkscales and Peterson 1997, Greene 1998, Stans et al. 1999), while others also included total medical charges (Newton and Mubarak 1994). None of the previous studies have calculated the social costs as regards lost wages of the parents. In Scandinavian countries most doctors are employed on fixed salaries, therefore whether or not one chooses surgical treatment, there would be no difference in costs for the doctor as would be the case in countries with other remuneration systems (Newton and Mubarak 1994). The costs of various parts of the treatment were calculated in the same way, which permits comparison of the costs in these hospitals. This is not true in other countries (Newton and Mubarak 1994).

The duration of treatment was 1–2 weeks longer in hospital 1, with the definition used in this study—i.e., the time up to removal of the traction or external fixator. A more appropriate definition would be the one used by Stans et al. (1999)—i.e., the time to becoming fully weight-bearing, but as this information was not recorded in the medical charts of the patients treated with traction, we could not use that definition. The time-to-time healing would probably be about the same.

The primary operation took, on average, 15–25 minutes longer for the external fixation than the application of traction. During the second operation, removal of the external fixator was usually done under general anesthesias. This was not always the case with removal of the traction.

The children in hospital 1 were part of a consecutive study of external fixation, which meant more visits to the out-patient clinic. In hospitals 2 and 3, the treatment protocol stated one or two visits after discharge from the hospital. The children were not always seen at the one-year follow-up in hospitals 2 and 3, while in hospital 1, this was included as a scheduled visit.

In studies of costs of the treatment of femoral fractures, the most important factor is the number of days in hospital (Newton and Mubarak 1994, Clinkscales and Peterson 1997, Stans et al. 1999), a finding verified in our study. The most efficient way to cut costs is therefore to use treatments that reduce the number of days spent in hospital. This might also reduce the costs of sick-leave for care providers, except for home traction or spica casts.

When calculating the costs of sick-leave, we used information from the Statistical Yearbook of Salaries and Wages 2000, instead of the actual wages for each parent. The reason was the different number of patients and parents, which could be a potential error if the wages varied too much between individuals. When making an estimate, all parents were calculated as working full-time for the same reasons. In fact, about 40–50% of parents did not work at all at all three hospitals. The reasons included maternity leave, unemployment, parents studying, vacation, illness, etc. This accounts for the difference between sick-leave 1 and sick-leave 2.

Complications add to the total charges (Stans et al. 1999). In our study, the total costs of those with complications were higher than those without complications although the difference was not statistically significant.

Home-traction can reduce the costs of treatment by about 40% when compared with in-hospital traction (Boman et al. 1998), but increases the burden on the family. In this study, the total costs of the home-traction group were about half of the costs of the in-hospital traction group. The costs for the external fixation group were half of the home-traction group and 25% of the in-hospital traction group.

Children in hospital have their education at the hospital while children in home-traction need education at home. Children with external fixation can return to school while still under treatment with their fixator. In the study by Stans et al. (1999) ,none of their children with external fixators returned to school before removal of the fixator although they were fully weight-bearing. This was not the case in our study. On average, children with external fixators returned to school 27 days after the operation.

A potential weakness in our study is that it is retrospective. By collecting data some years after the fracture, data describing, for instance, the time away from work for the care provider, or the time in hospital, may not be reliable, but in Sweden the system of personal identity numbers makes it possible to find all patients and parents. The medical charts and all social insurance documents are based on the same reliable identification system. This means that even if data are collected some years after the treatment, one can obtain reliable information about medical events, demographic data and social insurance costs. In this study, it was possible to obtain all information about patients and parents. At hospital 1, all patients participated in a prospective study and were easy to find. At the other 2 hospitals, some patients could be missing, although the number corresponds to the number expected in that part of the country (Landin 1997). The only data that could be uncertain is the number of days the parents spent at home because of the fracture since this information was obtained in the questionnaire years later.

In this study the savings per patient for hospital 1 and society, as compared to whether the patient had been treated using in-hospital traction were EUR 25,000 and EUR 10,000 if the patients had been treated with home-traction. For parents and society, the savings for sick-leave are EUR 3,400 and EUR 2,600. The total savings were EUR 28,000 per patient in case of external fixation instead of in-hospital traction and EUR 12,600 per patient in case of external fixation instead of home-traction. This means that with an incidence of 10 femoral fractures per year, the savings would be EUR 0.3 million when using external fixation instead of in-hospital traction and EUR 0.13 million when using external fixation instead of home-traction.

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