Prospective comparison of hip fracture treatment

856 cases followed for 4 months in The Netherlands and Sweden

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In a prospective multicenter study 1115 hip fracture patients were registered in Rotterdam (The Netherlands), Sundsvall and Lund (Sweden). The patients had similar background parameters with a mean age of 78 years, about half of them living alone and just above 80 percent coming from independent living.

For cervical fracture, hemiarthroplasty was the predominating treatment in Rotterdam (n 169), whereas osteosynthesis was used in Sundsvall (screws n 135) and Lund (hook-pins n 148). The mean (median) hospitalization time was 32 (20) days in Rotterdam, 16 (12) days in Sundsvall, and 17 (10) days in Lund. Discharge to independent living varied from 53 percent in Lund to 72 percent in Sundsvall. Functional outcome (walking ability and ADL capacity) was at 4 months similar in all groups, but at 2 weeks was lower in Rotterdam. Mortality at 2 weeks / 1 month / 4 months was in Rotterdam 4/9/20, in Sundsvall 2/4/13, and in Lund 0/3/10 percent.

Trochanteric fractures were treated by screw-plate in Rotterdam (n 146) and Lund (n 78), and by Ender nails in Sundsvall (n 117). The mean (median) hospitalization time was in Rotterdam 39 (29) days, in Sundsvall 24 (15) days and in Lund 19 (11) days. Discharge to independent living varied from 41 percent in Lund to 57 percent in Sundsvall. Functional outcome was similar between the groups. Mortality at 2 weeks / 1 month / 4 months was in Rotterdam 2/6/14, in Sundsvall 6/12/19 and in Lund 12/12/18 percent.

Thus, our study has shown that it is possible to perform a prospective multicenter study involving different European countries. The functional outcome after 4 months was very consistent between the centers studied, irrespective of choices made concerning operation method and rehabilitation routines. However, a difference in mortality within these first postoperative months was found, which seems attributable to the operation procedure.

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A prospective multicenter study of operation methods and rehabilitation routines for hip fracture was started in Sweden (Thorngren 1991). Departments in other countries have entered the study. This report describes different approaches to treatment of hip fractures with examples from hospitals in Sweden and The Netherlands. The aim was to compare the effect of treatment on the outcome up to 4 months after fracture.

Patients and methods

During the 1-year period June 1, 1989–May 31, 1990 all hip fractures were registered in 6 hospitals in Rotterdam (Table 1) as well as in the 2 hospitals in Lund and Sundsvall, Sweden. Standardized forms were prospectively filled in with data concerning background factors, hospital stay, patient-resource demands and their quality of life, i.e., information concerning place of living, need for institutional care, consumption of home-help as well as pre-and postoperative ADL and locomotor ability. Functional parameters were followed up to 4 months after the operation. A total of 1115 fractures were studied (Table 2). The background data for the patients in the 3 cities were similar, with a mean age of 78 years. The distributions of fracture types were also similar in the different hospitals, whereas the choice of operation differed considerably. To analyze the outcome of the different choices of treatment, the predominating groups of treatment were separately analyzed (Table 3). As hip fractures are very rare below the age of 50 (in this material 2 percent of the

Table 1. Participants in Rotterdam

Hospital	Coordinating physician
Academisch Ziekenhuis, Dijkzigt	
General surgical	D M K S Kaulesar Sukul
Orthopedic	B A Swierstra
Havenziekenhuis	
General surgical	H W Prillevitz
Ikazia Ziekenhuis	
General surgical	A P Brinkhorst
Orthopedic	A M Vosmaer
St Clara Ziekenhuis	
General surgical	H A Josaputra
IJsselland Ziekenhuis	
General surgical	A Zwaan
Orthopedic	N P J. Setteur
Zuiderziekenhuis	
General surgical	H Boxma

Table 2. Background variables for all hip fracture patients

Hospital	Rotterdam	Sundsvall	Lund
Number of patients	510	295	310
Mean age	78	78	78
Age range	12–102	11–97	22–99
Women (percent)	79	73	74
Living alone (percent)	45	50	56
Admitted from (percent)			
own home	57	66	59
old people's home	29	14	22
independent living	86	80	81
Fracture type (percent)			
Cervical	53	51	52
Basocervical	8	2	4
Trochanteric	34	41	38
Subtrochanteric	5	6	6
Operation type (percent)			
Two screws	0	49	0
Two hook-pins (LIH)	2	0	51
Three screws	8	0	0
Screw-plate	38	2	34
Nail plate	1	1	1
Ender nails	3	45	0
Other osteosynthesis	5	0	13
Hemiarthroplasty	34	1	0
Total hip	2	1	1
Not operated	7	1	0
Days in hospital			
Mean	34	19	18
Median	26	13	12
Discharged to (percent)			
own home	38	51	32
independent living	57	64	46
origin	57	74	57
Mortality within (percent)			
2 weeks	2	5	4
1 month	7	9	6
4 months	15	16	12

total) and as the fracture then usually is caused by a more violent trauma, the present analysis was confined to patients aged 50 years or older. The comparison of cervical fractures thus comprised 63 patients in Rotterdam treated with osteosynthesis and 169 patients with hemiarthroplasty, 135 patients in Sundsvall operated with 2 screws, according to von Bahr, and 148 patients in Lund operated with hook-pin osteosynthesis.

Of the trochanteric fractures 146 patients were operated with screw plate in Rotterdam, 117 patients were operated with Ender nails in Sundsvall and 78 patients with screw plate in Lund.

Chi-square test and multiple stepwise linear regression analysis were used. A probability level of ≤ 0.05 was considered significant.

Results

Cervical fractures

Comparison Rotterdam–Sundsvall–Lund. In Rotterdam hemiarthroplasty was mainly chosen for the displaced fractures whereas there was an almost equal distribution between undisplaced and displaced fractures in the osteosynthesis group. In Sundsvall and Lund practically all cervical fractures were treated with osteosynthesis (Table 3).

The background parameters were all very similar in the Rotterdam hemiarthroplasty group and the osteosynthesis groups in Sundsvall and Lund. However, the osteosynthesis group from Rotterdam had more undisplaced fractures, a lower mean age and more patients coming from their own homes.

The hospitalization time was longer in Rotterdam than in Sundsvall and Lund (Table 3). The discharge pattern differed from 83 percent return back to origin in Sundsvall to 60 percent in the Rotterdam osteosynthesis group. In the 3 major comparison groups the ability to perform activities of daily living was rather similar, as well as the walking ability, while somewhat more patients walked outdoors in Rotterdam. About 1/5 of the patients in all groups regarded their walking ability as equally good at 4 months as before fracture. Pain on weight bearing was fairly similar between the groups, but consumption of analgetics was higher in Sweden than in The Netherlands.

The mortality in the Rotterdam hemiarthroplasty group was higher than in the Swedish osteosynthesis groups, particularly when compared to the 4-month results in Lund ($P< 0.02$).

Osteosynthesis versus hemiarthroplasty. If the 2 osteosynthesis groups from Sweden are combined and compared with the hemiarthroplasty group from Rotterdam, no differences were found concerning

Table 3. Background parameters and outcome for cervical and trochanteric hip fracture patients age ≥50 years, percent

		Cervical fractures				Trochanteric fractures		
Hospital		Rotterdam		Sundsvall	Lund	Rotterdam	Sundsvall	Lund
Operation type		Osteo-synthesis	Hemi-arthroplasty	von Bahr	Hook-pins	Screw-plate	Ender nails	Screw-plate
Number of patients		63	169	135	148	146	117	78
Mean age		73	80	79	80	81	79	80
Age range		51–94	53–94	56–97	53–96	54–102	50–94	51–94
Women		78	80	72	80	87	74	72
Living alone		44	46	52	57	51	48	64
Admitted from	own home	78	56	67	57	45	62	58
	old people's home	10	31	16	22	39	14	23
	independent living	88	87	83	79	84	76	81
Fracture type	Garden I–II	44	6	30	29			
	Garden III–IV	56	94	70	71			
	Two fragment					47	48	63
	Multifragment					53	52	37
Operation type	Two screws (von Bahr)			100				
	Two hook-pins (LIH)	17			100			
	Three screws	63						
	Screw-plate	10				100		100
	Ender						100	
	Hemiarthroplasty		100					
Reoperation during primary admission		6	2	6	4	1	5	0
Days in hospital, mean		25	32	16	17	39	24	19
	median	21	20	12	10	29	15	11
Days admission–operation		2	1	1	1	2	1	1
Discharged to	own home	53	41	55	36	24	46	28
	independent living	63	68	72	53	44	57	41
	origin	60	64	83	65	47	68	47
Home help	before operation	26	29	29	26	35	28	19
	(hours/week)	11	8	10	4	9	10	5
	at 4 months	37	48	51	32	33	45	32
	(hours/ week)	7	7	9	4	6	12	6
Manage ADL	before operation	89	79	70	75	78	71	84
	2 weeks after	63	50	57	66	35	47	56
	4 months after	84	70	65	73	58	58	70
Walking ability outdoors before operation		81	64	62	65	60	63	63
	4 months after	66	53	41	40	35	41	59
Walking ability indoors before operation		98	94	97	96	97	93	93
	4 months after	97	91	88	87	78	82	89
Walking with one cane or better								
	before operation	97	80	70	73	79	68	67
	2 weeks after	6	11	3	6	6	2	0
	4 months after	60	51	46	46	43	38	37
Walking with rollator/walking-frame								
or better	before operation	98	95	98	96	94	91	96
	2 weeks after	77	69	87	89	52	71	79
	4 months after	95	88	85	85	72	82	81
Walking equally well at 4 months								
as before fracture		17	18	23	21	15	20	23
Pain on weight-bearing at 4 months								
	Quite a lot	14	12	17	18	5	10	7
	A little	43	41	50	37	42	41	52
	Not at all	43	47	33	45	53	49	41
Analgesics because of hip pain		9	14	28	35	9	23	33
Mortality within	2 weeks	0	4	2	0	2	6	12
	1 month	0	9	4	3	6	12	12
	4 months	3	20	13	10	14	19	18

gender distribution, age or background factors.

The hospitalization time in Rotterdam was twice that in Sweden. The reoperation rates while in hospital did not differ.

The ADL activity did not differ before fracture or at 4 months postoperatively. However, at 2 weeks postoperatively there was a lower ADL-capacity in the hemiarthroplasty group ($P < 0.02$). The use of

home help did not differ either before fracture, or after 4 months. Walking ability outdoors and indoors, and the use of walking aids did not differ before fracture or at 4 months postoperatively. At 2 weeks postoperatively more patients in the osteosynthesis group could walk with a rollator/walking frame or with fewer walking aids ($P < 0.001$). Thus, function at 2 weeks in the combined Swedish osteosynthesis group was better than in the Rotterdam hemiarthroplasty group. Furthermore, the mortality was higher in the hemiarthroplasty group both at 1 month ($P < 0.05$) and at 4 months ($P < 0.02$).

Multivariate analysis. With stepwise multiple linear regression analysis, different outcome parameters of the 2 osteosynthesis groups from Sweden and the hemiarthroplasty group from Rotterdam were analyzed (Table 4). When analyzing the factors distinguishing the different types of operation, city and fracture type were found to be significant. In the 2 Swedish hospitals the proportion of undisplaced/displaced fractures was the same, whereas in the Rotterdam hemiarthroplasty group there was a higher proportion of displaced fractures. With arthroplasty, the fracture and femoral head are removed, making the 2 fracture types equal. Only if one believes that more fragile persons tend to have a displaced fracture, can the larger number of displaced fractures in the Rotterdam hemiarthroplasty group be regarded as of importance. However, the other background factors demonstrated that this was of no importance. Furthermore, a calculation with only the displaced fractures in each group showed that the city was the only significant factor for choice of treatment of displaced cervical fractures. Since there were no other background factors of importance, the groups are highly comparable.

The time in hospital was dependent on the type of operation (which was longer for hemiarthroplasties in Rotterdam) and whether the patient was living alone before fracture (Table 5). For the return to original place of residence, the city was found to be a significant factor, due to the high return-to-origin in Sundsvall. Thus, tested factors found not to be of significance for return to origin were: age of patient, gender, place of residence before fracture, living alone, type of fracture, type of operation (osteosynthesis or hemiarthroplasty), ability to walk and ADL-capacity before fracture. This indicates that the fracture gives little extra functional burden to the patient after treatment and that the 2 types of treatment allow function good enough for return to origin. This in turn indicates that the rehabilitation routines are most important for the discharge of these patients to origin.

Table 4. Variables used in stepwise regression analysis

Variable	Explanation
City	Rotterdam
	Sundsvall
	Lund
Age	Age of the patient at fracture, years
Gender	Male or female
Admitted from	Own home
	Convalescent home
	Full-service unit with meals/Home for the elderly
	Geriatric department /Rehabilitation clinic
	Long-term care institution/Nursing home
	Acute hospital
	Other
	Not admitted
	Unknown
Living alone before fracture	Yes or No
Fracture type	Cervical
	Undisplaced (Garden I–II)
	Displaced (Garden III–IV)
	Trochanteric
	Two-fragment
	Multi-fragment
Operation type	Cervical
	Osteosynthesis
	Hemiarthroplasty
	Trochanteric
	Screw-plate
	Ender nails
General walking ability before fracture	Could walk alone out of doors
	Could walk out of doors only when accompanied
	Could walk alone indoors but not out of doors
	Could walk indoors only when accompanied
	Could not walk but sat in a chair
	Always bedridden
	Unknown
Walking aids before fracture	No aids
	One stick (crutch or tripod, hemi-walker)
	Two sticks
	One stick+one tripod
	Two tripods
	Rollator/walking-frame
	Wheelchair
	Does not walk
ADL before fracture	Yes or No

With the same variables tested, the ADL-capacity after 2 weeks was in the following order dependent on: the ADL-capacity and general walking ability before fracture, the type of operation, place of residence before fracture and the age of the patient. At 4 months after the operation, the ADL-capacity was dependent on similar functional parameters, but fracture type was included instead of type of operation. This was because more patients with undisplaced fractures were then able to manage their ADL

Table 5. Significant predictors (variables) found for various parameters in stepwise regression analysis

Parameter	Predictors	
	Cervical fractures	Trochanteric fractures
Type of operation	City Fracture type	City
Time in hospital	Type of operation Living alone	City Living alone
Back to origin	City	Age Living alone Type of operation Admitted from
Back to origin 4 months	Admitted from	Living alone City Age
ADL after 2 weeks	ADL before fracture General walking ability Type of operation Admitted from Age	General walking ability Age ADL before fracture City
ADL after 4 months	ADL before fracture Admitted from Fracture type Walking aids before	ADL before fracture Age Admitted from Walking aids before
Walking with 1 cane or better after 2 weeks	Walking aids before City	City
Walking with rollator, walking frame or better after 2 weeks	General walking ability Type of operation Admitted from Age	General walking ability City Admitted from ADL before Age Fracture type
Walking outdoors 4 months after operation	General walking ability Age ADL before	General walking ability Age
Walking indoors 4 months after operation	Walking aids before ADL before	ADL before Walking aids before Admitted from
Walks at 4 months as well as before fracture	Fracture type General walking ability	
Mortality ≤ 2 weeks	General walking ability Admitted from Type of operation	Admitted from City General walking ability
Mortality ≤ 1 month	General walking ability Type of operation	Admitted from
Mortality ≤ 4 months	General walking ability Type of operation	Admitted from Fracture type

($P < 0.01$).

The possibility after 2 weeks to walk with 1 cane or better was dependent on walking aids before fracture and city. This reflects a difference in training ambition in various places. To be able to walk at 2 weeks postoperatively with rollator/walking frame or better was dependent on: general walking ability before fracture, type of operation, place of residence before fracture, and age of the patient.

At 4 months after operation, the walking ability outdoors as well as indoors was dependent on pre-fracture functional variables as well as the age of the patient. The subjective evaluation of the patients as to whether they walked as well at 4 months as they did before fracture was dependent on fracture type (undisplaced fractures positive in 38 percent and displaced in 16 percent), as well as general walking ability before fracture.

Significant factors for mortality within 2 weeks had the following order: general walking ability before fracture, place of residence before fracture, and type of operation (osteosynthesis or hemiarthroplasty). The other factors were thus not significant: city, age, gender, living alone, type of fracture, walking aids and ADL-capacity before fracture. The mortality within 1 month as well as at 4 months depended on the general walking ability before fracture and the type of operation (i.e., hemiarthroplasty).

Trochanteric fractures

Comparison Rotterdam–Sundsvall–Lund. For trochanteric fractures, screw plate predominated in Rotterdam and Lund whereas Ender nails were used in Sundsvall at that time. When patients operated with these methods were compared (Table 3), the background parameters were again similar, with a mean age of about 80 years. The mean and median hospitalization times were higher in Rotterdam than in Sweden. The patterns for the discharge and use of home help were similar to those shown for femoral neck fractures. Reoperations during primary admission were more frequent in Sundsvall, due to renailing of Ender pins. The ADL-capacity and walking ability outdoors and indoors were also mainly similar between the groups. Somewhat more patients walked outdoors in Lund. Again around one fifth of the patients rated their walking ability equally well at 4 months as before fracture. The pain on weight bearing at 4 months was almost equal and again the analgetic consumption was higher in the Swedish areas. The early mortality was higher in Lund than in Rotterdam and Sundsvall, later mortality rates reached the same level. When the Swedish hospitals were compared to Rotterdam, a higher mortality was found in Sweden at 2 weeks ($P < 0.015$) and at 1 month ($P < 0.05$). At 4 months there was no difference in mortality.

Screw-plate versus Ender. The mean time in hospital was lower for the Ender group ($P < 0.025$) but with more reoperations ($P < 0.02$). ADL-activity did not differ before fracture, at 2 weeks or at 4 months. The use of home help did not differ before fracture, but at 4 months there was a greater use of home help in the Ender group ($P < 0.001$).

Walking ability outdoors and indoors and the use of walking aids did not differ either before fracture or postoperatively. The percentage of patients reporting that they walked equally well at 4 months as before fracture did not differ between the osteosynthesis groups. Nor did the percentage of patients reporting pain on weight bearing. The mortality did not differ.

Multivariate analysis. For type of operation, the city was the only significant factor, indicating the active choice of operation method in the various cities (Table 5). The time in hospital depended on the city and whether the patient was living alone before the fracture since patients spent a considerably longer time in hospital in Rotterdam (in spite of having similar background factors and type of operation as in Lund). The return to place of origin from the operating department was dependent on age of the patient, living alone before fracture, type of operation and place of resicence before fracture.

The ADL-activity at 2 weeks depended on the general walking ability before fracture, the age, the ADL-capacity before fracture and the city. Similar functional variables were predictors for the ADL-capacity at 4 months.

To walk with 1 cane or better after 2 weeks was dependent on the city. In addition, more functional variables, as well as fracture type were significant for the ability to walk with at least a rollator. Walking ability outdoors and indoors after 4 months was mainly dominated by functional parameters.

Significant factors for mortality within 2 weeks were in the following order: place of living before fracture, city and general walking ability. The mortality within 1 month depended only on place of residence before fracture. Mortality within 4 months was also dependent on the type of fracture. Thus, for the majority of the outcome parameters after trochanteric fracture, the type of operation was not a significant factor, but the city and functional preoperative variables were of primary importance.

Discussion

People live differently in various countries due to geographic and ethnic differences. There are, however, great similarities between The Netherlands and Sweden in the way of housing and taking care of elderly people. In both countries the importance of elderly people living in their own homes as long as possible is stressed. There might, however, be some differences between the countries, since differences in density of population and climate influence the possibilities for achieving this goal.

The 2 different ways of treating cervical hip fractures in Sweden and The Netherlands reflect differences as regards allowing the patient to bear weight as soon as possible. When osteosynthesis is performed all the fractures are primarily treated as if they would heal, whereas when arthroplasty is performed, all are treated as if they would not heal (Nilsson et al. 1989, Olerud et al. 1991, Strömqvist

et al. 1992). However, the results of the primary hemiarthroplasty are in many cases unsatisfactory as regards pain and hip function and even more so with time (Diercks and Hollander 1985, Jalovaara and Virkunen 1991). In the present study, the postoperative ADL and walking ability were after 2 weeks lower in the hemiarthroplasty group but at 4 months similar to those in the osteosynthesis groups. Thus, in this comparative study, no short-term benefit was found with the more extensive operation. This is even more important in view of the higher mortality after 4 months in the hemiarthroplasty group. The 4-month mortality of 20 percent in the hemiarthroplasty group confirms the mortality of 15–30 percent up to 6 months in some other studies with hemiarthroplasty (Jensen and Holstein 1975, Sikorski and Barrington 1981, Stewart 1984, Jalovaara and Virkunen 1991). In recent osteosynthesis reports, mortality after 4 months was 6–14 percent (Holmberg et al. 1986, Olerud et al. 1991, Herngren et al. 1992). Mortality is usually lower in cervical than in trochanteric fracture patients, who are somewhat older and more fragile (Thorngren et al. 1988, Jarnlo and Thorngren 1993). This was, however, not the case in Rotterdam, where the mortality for the cervical fracture patients treated with hemiarthroplasty was higher compared to the trochanteric patients. The multivariate stepwise regression analysis showed the mortality to be dependent on the operation type: the hemiarthroplasties had a higher mortality. The mortality figures in the literature and the present study thus indicate that increased attention should be paid to the overall outcome when choosing the method of treatment.

Ender nails have previously been shown to result in a large number of complications in spite of efforts to optimize the operation (Berglund-Rödén and Ellene 1992). However, in the present study the patients treated with Ender nails and screw-plate had similar function after 4 months. This shows that the local facilities, the rehabilitation routines and the general condition of the patient influence the overall outcome of the treatment more than the choice of operation.

The similar 4-month functional outcome was reached despite differences in the hospital resources used in The Netherlands and Sweden. In spite of the winter climate in Sweden and less dense population, a considerable fraction of the patients could return home at an early stage after osteosynthesis. Usually a short stay in the operating department is combined with a low percentage of direct discharge to origin (Jalovaara et al. 1992). In Lund and Sundsvall there was an active program to rehabilitate patients directly to their own home as early as possible (Jarnlo et al. 1984). This program is also cost-efficient (Borgqvist et al. 1991, Jalovaara et al. 1992). The present study shows that rehabilitation in Lund has deteriorated somewhat compared to earlier reports (Jarnlo et al. 1984, Borgqvist et al. 1991). Repeated attention to communications with the primary health care and the municipal social workers is necessary.

In conclusion, in spite of different ways to solve the over-all treatment of hip fractures, a rather similar functional outcome was achieved after 4 months. The expenditure on treatment facilities and overall complications differed, however. All the basic data registered in this type of international multicenter hip fracture study increase the possibilities of more refined analyses and better programs for the benefit of both patient and society.

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