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## PRIMARY ARTHROPLASTY IN FEMORAL NECK FRACTURES

*A Review of 269 Consecutive Cases Treated with  
the Christiansen Endoprosthesis*

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The results of the conventional treatment of femoral neck fractures have been disappointing in a high percentage of cases, as reported by Jensenius (1956), Nielsen & Jensen (1964) and Ramstad from this hospital (1966).

This led to a change in the treatment of femoral neck fractures in this hospital in the early 1960's. Since the Christiansen Endoprosthesis was developed in 1965, this prosthesis has been used routinely in the primary treatment of displaced femoral neck fractures in patients 70 years of age and older.

It is the purpose of this article to report our experience with this treatment over an eight-year period (1965-1973) in altogether 269 arthroplasties on 263 patients.

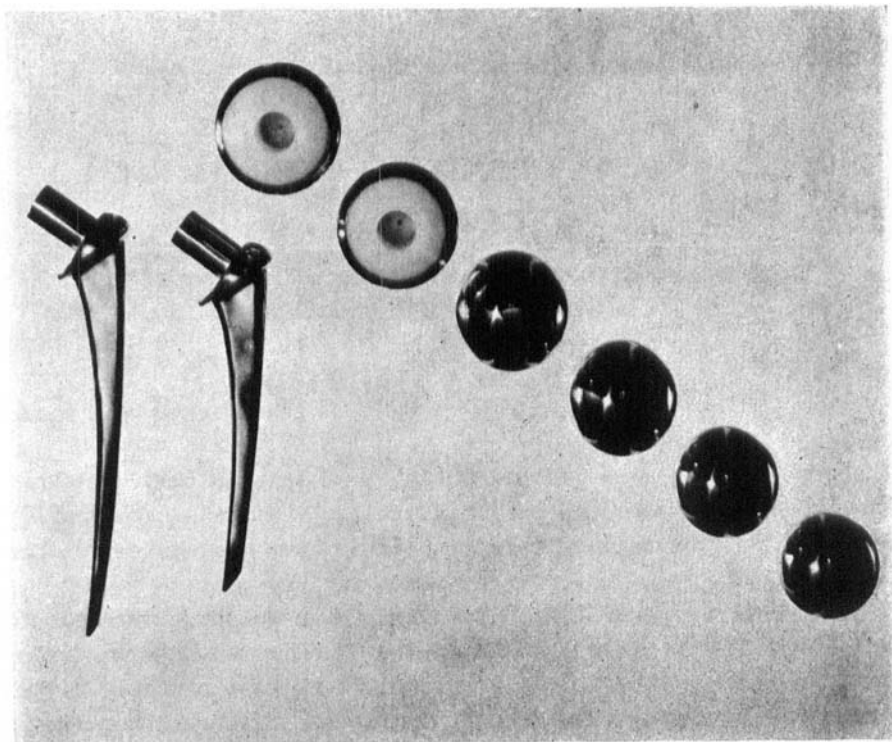
### METHODS AND MATERIAL

#### *Indications*

Arthroplasty has been used as the primary operation for the following indications:

- a) Patients 70 years of age and over with displaced intracapsular femoral neck fractures.
- b) In younger patients with similar fractures when associated medical or mental conditions make early ambulation essential or where avoidance of weightbearing could not be expected.
- c) In younger patients when the fracture could not be reduced under anaesthesia.
- d) In pathological fractures.

Excluded were patients who had not been walking prior to sustaining their fracture or who were moribund at admission. Patients with impacted fractures without displacement were treated by nailing, if at all.



*Figure 1. The Christiansen Endoprosthesis (current model) Two additional shaft pieces are now produced (see text).*

#### *The prosthesis*

The present Christiansen Endoprosthesis (Figure 1) consists of a shaft piece of Francobol produced in two lengths (130 and 160 mm), and now also with a shaft model with a narrow stem and further a special long shaft piece (260 mm). A cylindrical trunnion is integral with the upper end of the shaft-piece, fitting into a corresponding recess in the capitulum. The capitulum is made of Delrin (plastic) fitted with a Francobol cup. The axis of the trunnion with the capitulum and the principal axis of the shaft forms an angle of 115 degrees. The capitulum comes in six sizes from 44 mm diameter with 2 mm increments up to 54 mm.

The shaft-piece is now cemented in place with acrylic cement, used in this series since 1968.

Originally the capitulum was made from Teflon and later from High Density Polyethylene. Since 1968 it has been provided with a metal cap.

#### *Patient material*

269 arthroplasties were carried out on 263 patients with fresh, displaced femoral neck fractures from 1965 up to January 1973. The operation was carried out on males in 42 instances and on females in 227 instances.

The age distribution with mortality rates is shown in Table 1. In the subsequent discussion the patients are divided into two groups:

**Group 1:** Patients who had plastic capitulum inserted and where the shaft-piece was not cemented in place. These operations were carried out from 1965-1968, and the group comprises 115 arthroplasties.

**Group 2:** Patients who had the present model of the prosthesis inserted with a metal capped capitulum and where the shaft was cemented in place with acrylic cement. These operations were carried out from 1968-1973, and this group comprises 154 arthroplasties.

The patients were seen postoperatively at 3-month intervals, later 6-monthly and yearly, each time with clinical and radiological examinations and with a grading of the results. Patients who had not been seen within the previous 3 months by the authors were recalled and personally examined and evaluated. Thus 193 patients were personally examined and evaluated, including patients who had been seen during the 3 last months of their lives.

*Table 1. Age distribution, and mortality rates, at one and six months postoperatively, related to age.*

Age	No. of arthroplasties	Mortality		
		At 1 month	Between 1 and 6 months	Total mortality
60-64	11	0	1	1/11
65-69	32	2	2	4/32
70-74	53	5	1	6/53
75-79	84	8	11	19/84
80-84	51	8	6	14/51
85-89	27	6	6	12/27
90 and older	11	3	3	6/11
<b>Total</b>	<b>269</b>	<b>32</b>	<b>30</b>	<b>62/269</b>

Patients who did not return for examination were asked to complete a questionnaire with enquiries concerning hip mobility, whether they were ambulant and if so what kind of support was needed if any, and finally whether they had any pain on the operated side. Where the patient had died, enquiries were directed to the relatives or to the medical attendant. In 58 instances the evaluation was made based on information from the questions together with the findings at earlier examinations.

In 18 instances no adequate information could be obtained. In those cases the result found when the patient was last examined and the period of observation up to that date were recorded.

### *Management*

As soon as the patient is admitted to the hospital, routine assessment of the general condition of the patient is performed, including blood tests, ECG and chest films. Most patients are put on tibial traction, and operation performed within 24-48 hours of admission, but occasionally later if other medical conditions needing treatment are discovered.

Apart from the first 21 patients in the series where an antero-lateral incision was used, a posterior operative approach has been utilized (modified Osborne). Otherwise the same techniques were used in the two groups, except that no cement was used in the first group.

The femoral head is removed and measured with calipers. The medullary canal is prepared for the shaft piece with an attempt to accommodate the long model (160 mm). The femoral neck is trimmed to allow the shaft piece to rest snugly on the calcar, especially on the medial side. The capitulum is selected according to the measurements of the removed femoral head. The shaft piece is then cemented in place, the capitulum inserted on the trunnion and reduction accomplished. The joint capsule is sutured, a suction drainage placed through a separate stab wound in all patients, and the incision closed. The patients receive local and systemic antibiotics prophylactically, but no routine anticoagulation is given. Postoperative X-rays are obtained on the day of operation.

On the day after surgery physiotherapy is started with gentle active range of movement exercises. Most patients get out of bed on the second or third post-operative day, and ambulation with a walker is usually started on the third day. The patients are encouraged to use full weightbearing from the start; this has been our policy throughout the whole period. They then gradually advance to support with crutches and then sticks. Many use no support at the time of discharge from the hospital, usually around three weeks after the operation. Many patients have had to stay longer, usually because of other medical conditions and for social reasons.

### RESULTS

The results were graded according to Love's classification (1963) as follows:

- Excellent: Good range of movement, occasional or no pain, no support necessary for regular activity.
- Good: Some limitation of movement, slight pain and support with a cane necessary for walking.
- Fair: Considerable limitation of movement, moderate pain and support with a walker or crutches necessary for walking.
- Poor: Bed or wheelchair patient.

The results are shown in Tables 2 and 3.

In 121 instances the arthroplasties were carried out on patients with a concomitant significant medical disorder, which interfered with their

ability to walk without support. Although these medical disorders affected the grading in an adverse direction the result, as far as hip pain and movement is concerned, could be excellent.

*Table 2. Results in group 1: Patients with plastic capitulum pieces and without acrylic cement fixation.*

	Observation period (in years)							Total	
	0-1	1-2	2-3	3-4	4-5	5-6	6-7		7-8
Excellent	2	1	0	0	0	1	0	0	4
Good	9	2	2	0	3	3	7	1	27
Fair	3	7	1	4	2	7	4	1	29
Poor	7	3	5	11	7	5	5	1	44
<b>Total</b>	<b>21</b>	<b>13</b>	<b>8</b>	<b>15</b>	<b>12</b>	<b>16</b>	<b>16</b>	<b>3</b>	<b>104</b>

Excluded from the table are 11 patients who died within the first month after surgery.

*Table 3. Results in group 2: Patients with the present model of the prosthesis with a metal-capped capitulum and acrylic cement fixation.*

	Observation period (in years)					Total
	0-1	1-2	2-3	3-4	4-5	
Excellent	15	12	18	9	8	62
Good	16	4	0	5	3	28
Fair	17	1	5	1	2	26
Poor	11	1	1	4	0	17
<b>Total</b>	<b>59</b>	<b>18</b>	<b>24</b>	<b>19</b>	<b>13</b>	<b>133</b>

Excluded from the table are 21 patients who died within the first month after surgery.

In the first year there was a tendency for the patients to improve their graded results once they gained confidence in their 'new' hip joint. Later, in Group 1, there was a marked tendency for the graded results to drop with the passage of time because of the late complications discussed below.

In Group 2 the graded results have tended to be very stable once the patient gained full confidence in the hip joint. All grade drops have been secondary to a new medical disorder.

## COMPLICATIONS

The complications encountered are listed in Table 4. As would be expected the early complications in the two groups occurred with about the same frequency. It is noted that general complications in the pulmonary and cardiovascular systems were the most frequent. That the incidence of these complications was not even higher is attributed to the policy of early physiotherapy and mobilization.

Table 4. Complications.

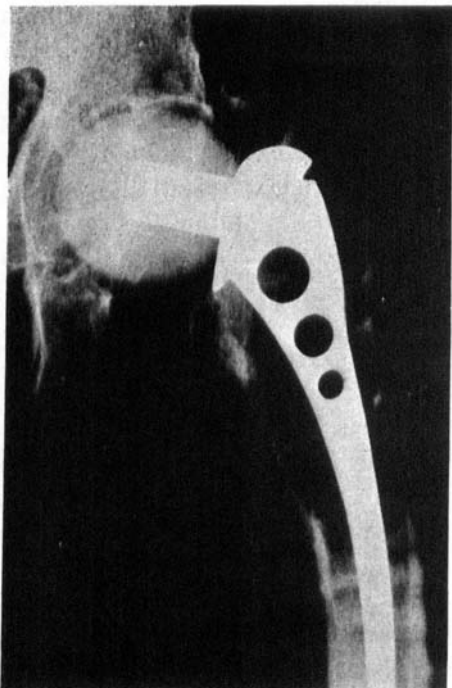
	Group 1	Group 2	Total (with per cent)
<b>General:</b>			
Deep venous thrombosis	8	12	20/269 7 %
Emboli	5	7	12/269 4 %
Bronchopneumonia	8	19	27/269 10%
<b>Local:</b>			
Superficial wound infection	4	4	8/269 3 %
Deep wound infection	6	2	8/269 3 %
Haematoma	5	4	9/269 3 %
Dislocation	3	2	5/269 2 %
<b>Late:</b>			
Soft tissue calcification	18	14	
Osteoporosis, osteolysis	43	2	
Late fractures	23	1	
Late deep infection	1	1	

The incidence of deep venous thrombosis might possibly have been reduced by routine anticoagulation, but it is feared that the incidence of wound haematomas followed by possible infection would then increase.

As regards the local complications, the most feared one is deep infection. To keep the incidence of infections as low as possible strict aseptic techniques are used. As mentioned above both local and systemic antibiotics are used as well as suction drainage for two days.

The use of acrylic cement has not increased the rate of infection. On the contrary deep infection has only been seen in two of the last 154 cases, while it was seen in 6 of 115 cases without cement.

Of the eight patients who sustained deep infections, two were treated successfully with antibiotics, two required removal of the prosthesis, three died from sepsis and one still has a draining sinus associated



*Figure 2. X-ray of patient with the old model with a Teflon capitulum showing marked osteolysis with a working down of the shaft piece into the femur (8 years after insertion).*

with moderate pain in the hip. The eight patients with superficial infections were all treated successfully and have not subsequently shown evidence of a deeper spread.

Dislocation of the prosthesis was seen in 5 instances. Two occurred on the day of operation, one three days postoperatively after a fall, and two later. One of the latter occurred 6 years postoperatively in a patient where the prosthesis had worked down into the femur to a considerable extent. Reduction was accomplished successfully in four patients, in two of them without subsequent dislocation, while in two dislocation recurred repeatedly. The last patient refused attempts at reduction. One of the dislocations occurred following an antero-lateral operative approach. In an attempt to keep the incidence of dislocation as low as possible the femoral neck is left as long as is compatible with reduction without undue difficulty, so as to get a certain tension, and secondly the joint capsule is sutured carefully. Abduction is maintained postoperatively with a special pillow between the knees until muscle tone is completely regained after the anaesthetic.

A marked difference has been noted in the incidence of late complications in the two groups. In the first group an appreciable foreign

body synovitis resulted from the wearing down of the plastic capitulum giving rise to a marked osteolysis. A rotation movement of the shaft piece in the medullary canal probably also contributed to this osteolysis and caused the shaft to work downward into the femur shortening the extremity, and giving the patient pain and reduced range of movement (Figure 2). The osteolysis was so pronounced that at least 23 patients sustained subtrochanteric fractures in relation to the prosthetic shaft, while this complication has only been seen once in Group 2, and in that instance after an adequate trauma.

### *Mortality*

There was an early mortality of 32 patients after the 269 arthroplasties performed (11.7 per cent). Of these 20 died within the first 10 days after the operation, the remainder between the 11th and the 30th days. The causes of death were: Bronchopneumonia in 19 patients, cardio-vascular complications in 10 patients, pulmonary emboli in two patients, and in one patient the cause of death was uncertain.

A further 30 patients died within the first six months after operation, giving an overall mortality rate of 23 per cent in the first six post-operative months. The last 30 deaths were not considered directly related to the operation. The mortality rate in the various age groups is listed in Table 1 and shows as expected a direct relationship to the age of the patient.

### DISCUSSION

There has been a general dissatisfaction with the results of the conventional treatment of femoral neck fractures e.g. Smith-Petersen/Johansson nailing. At this hospital 21 out of 150 patients thus treated during the years 1960-1965 were readmitted because of complications by January 1966 (14 per cent of the total), as reported by Ramstad (1966). Other authors report even higher incidences of complications, as stated by Jensenius (1956) and Hunter (1969).

Ramstad found further that the period of hospitalization was shortened from an average of 40 days in patients treated by nailing to an average of 27 days in the early cases treated by arthroplasty at this hospital.

These considerations led to a change in the treatment of displaced femoral neck fractures in 1965, and from then on the Christiansen Endoprosthesis has been used routinely for the indications outlined above.



*Figure 3. X-ray of patient with prosthesis with metal-capped capitulum and acrylic cement fixation (5 years after insertion).*

Long term follow-up results after femoral head replacement are still few in number, although data are now starting to appear, as reported by Salvati & Wilson (1973) with observation periods of up to 20 years. These data seem to indicate that there is little tendency for the graded results to deteriorate with longer periods of observation, unless caused by other medical conditions. However, only few patients have been followed for such long periods, and large series are difficult to get as most arthroplasties so far have been carried out on patients 70 years of age and above with a short life expectancy and therefore a high percentage of cases are lost to long term follow-up. Because of this uncertainty concerning the long term prognosis, the use of the prosthesis is still limited to patients 70 years and above with the exceptions mentioned. We may well lower this age limit in the future.

Theoretically one would expect that the increased friction between the prosthetic head and the acetabulum would result in a wearing down of the acetabular cartilage followed by arthritic changes and pain. We consider that this wear will be reduced when using the Christiansen Prosthesis, as the main movement—that of walking—in this prosthesis takes place between the prosthetic head and the

trunnion rather than between the head and the acetabulum, as is the case with most other current models (Christiansen 1969). The trunnion has been inspected after up to five years' use with no demonstrable wear.

The early results in the first group operated in the period between 1965 and 1968 were promising as reported by Ramstad (1969). However, subsequent follow-up has shown a steady deterioration in the graded results because of wear and abrasion or cold-migration in the plastic material of the capitulum. The shedding of microscopic particles of the plastic material caused a marked foreign body synovitis with osteolysis, as has also been demonstrated by histologic examination in several of our patients. The osteolysis resulted in late fractures and a shortening of the extremity as mentioned previously. These changes started to appear after an observation period as short as 18-24 months. When the described complications were noted, the capitulum of the prosthesis was equipped with a metal cap, and cementing of the shaft piece was begun, both in 1968.

Comparison of the late results after these alterations were carried out shows a marked difference, even if the follow-up for this group is shorter. Still, after up to five years' observation, late complications similar to those noted in the first group have not been detected (Figure 3).

Some osteoporosis has been seen on two occasions in the second group, while advanced osteolytic changes were apparent in 43 patients in the first group. Only one patient has had a fracture in relation to the prosthesis (after an adequate trauma) in the second group, while this occurred in at least 23 patients in the first group. Soft tissue calcification has been noted in both groups, but more frequently in the first group.

Having eliminated most of the above-mentioned late complications using the present model of the prosthesis with acrylic cement fixation, the follow-up results have improved dramatically with 90 out of 133 patients graded as excellent or good (68 per cent). Of the remaining 43 patients with only fair or poor results 28 had other significant medical disorders, which interfered with their ability to walk without support. Also 13 of the 43 were 80 years of age or older.

If the patients observed less than one year are excluded, 59 out of 74 had excellent or good results (80 per cent), while 14 out of 15 not so classified had another medical disorder interfering with their function.

Altogether 32 patients died in the first postoperative month, giving a mortality rate of 11.7 per cent. A further 30 patients died in the next five months giving a total six-month mortality of 23 per cent, showing what a serious trauma a femoral neck fracture is in the elderly patient. The mortality rate was directly proportional to the age of the patient (Table 1), which has also been recorded by other authors, notably, Reno & Burlington (1958).

In comparison with the early mortality rate of 11.7 per cent Ramstad (1966) reported a mortality rate of 11 per cent at this hospital in the period 1960-1965 in 150 patients 70 years of age or older treated by Smith-Petersen/Johansson nailing. These figures indicate a fairly equal mortality rate with these two operations. Although the arthroplasty is an operation of greater magnitude, the anaesthesia time is probably fairly similar, and with the possibility of earlier mobilization and ambulation in the patients treated by arthroplasty, what may be lost by the greater operative trauma is probably gained in the post-operative period.

The mortality rate in this series compares favourable with that reported by other authors (Greer & Niemann 1971, Nielsen & Jensen 1964 and Reno & Burlington 1958), while Hinchey & Day (1964) report lower mortality rates. It is considered that early operation and early mobilization are extremely important in keeping the mortality rate down.

In conclusion it is felt that primary arthroplasty in displaced intracapsular fractures of the femoral neck has been a significant advance in the treatment using the present prosthesis and acrylic cement fixation. The mortality rate is about the same as with the conventional nailing, the postoperative care is easier, the patient can use full weight-bearing from the start, the period of hospitalization has been shorter, and the late complications are much rarer with the need for secondary procedures just about eliminated. The results in patients followed for more than one year were excellent or good in 80 per cent of cases. However, complications may be severe, notably deep infection, and the long term outlook is still uncertain, although there are observations indicating that the graded results tend to be stable after up to 20 years observation.

#### SUMMARY

A review of the experience in 269 consecutive primary arthroplasties for displaced intracapsular femoral neck fractures using the Christian-

sen Endoprosthesis is reported. The indications for its use are listed and the prosthesis described. The patient material is divided into two groups: Group 1: Patients who had an older model of the prosthesis inserted without cementing of the shaft piece. Group 2: Patients who had the present model of the prosthesis inserted with acrylic cement fixation of the shaft. While the late follow-up results were very disappointing in the first group, those from the second group are considered most encouraging. The early and late complications with mortality are discussed. In conclusion it is felt that primary arthroplasty is a significant advance in the treatment of displaced femoral neck fractures in the elderly patient.

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