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Percutaneous compression plating (PCCP) versus the dynamic hip screw for pertrochanteric hip fractures: preliminary results

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Abstract

The percutaneous compression plate (PCCP) is a new implant for the minimally invasive treatment of pertrochanteric hip fractures that might reduce blood loss, wound problems and prevent devascularization of bone fragments. A quicker operation with minimal blood loss is better in the older patients. We performed a prospective, randomized clinical trial to compare the PCCP with the well-known dynamic hip screw (DHS). A total of 71 patients with an Evans type 1A–D pertrochanteric hip fractures were included. We measured the operation duration, blood loss, wound healing, complications, fracture healing and functional outcome. In total, 33 PCCP and 38 DHS were implanted. The mean operation times were 69.2 and 46.6 min for DHS and PCCP, respectively ($P = 0.000$). Blood transfusions were given in 24 DHS patients compared with six PCCP patients ($P = 0.000$). There were 27 haematomas in the DHS group and eight in the PCCP group ($P = 0.000$). There were no differences in fracture healing and the functional outcome between the two implants ($P = 0.767$, ns). Although this is a preliminary study with a relatively small number of patients and short follow-up, the PCCP seems similar to the DHS in relation to bone healing and stability, but with significant advantages for blood loss, soft tissue healing and operation time.

1. Introduction

The dynamic or sliding hip screw (DHS) is the most commonly used implant for the pertrochanteric hip fracture. For this open procedure, the lateral vastus muscle must be split by at least 10 cm. Gotfried has developed a new device, the percutaneous compression plate (PCCP, Efratgo Ltd., Israel; Fig. 1), which may be inserted using a minimally invasive technique [1]. This reduces blood loss, wound problems and devascularization of fracture parts, and prevents the loss of fracture haematoma. Gotfried reported good results in his clinical practice and biomechanical data in comparison with the DHS. A pilot study of 20 patients treated with the PCCP was performed before the present randomized, controlled trial to gain further experience with the device [2]; no major technical problems or complications were found in the pilot. Basic variables are presented in Table 1.

2. Patients and methods

We undertook a randomized, controlled trial on patients admitted to the Catholic University Hospital of Leuven from June 1998 to March 1999. Patients over 60 years of age with an Evans [3] type 1A–D pertrochanteric hip fracture (Fig. 2) were included. Patients with severe coxarthrosis of the ipsilateral hip, polytrauma, and reversed or bifocal fractures were excluded. The study was approved by the hospital ethics committee and all patients gave informed consent pre-operatively. Randomization was done by drawing a sealed, opaque, numbered envelope containing the treatment method for each patient. There were 33 patients in the PCCP group and 38 in the DHS group. None of the patients chosen had bilateral hip fractures. The mean age of the PCCP group was 80.1 (range 63–96) years and of the DHS group 81.6 (range 61–97) years. All patients received enoxaparine, a low molecular weight heparin (Rhone–Poulenc–Rorer), post-operatively as prophylaxis against deep-vein thrombosis. Intravenous antibiotics were given once at the onset of surgery (Cefazolin, Lilly, Glaxo Wellcome). The fractures treated with the DHS were fixed with a 135° four- or five-hole plate and an additional anti-rotation screw. In 12 patients, a trochanteric stabilizing plate (according to Regazzoni) was also used. The procedure was performed on a traction table under image-intensifier control, by residents and surgeons with varying experience in hip fracture surgery. All of them had knowledge and experience of the DHS. Patients were immediately mobilized to full weight bearing after the operation. Operation time, intra-, post-operative complications, wound healing,

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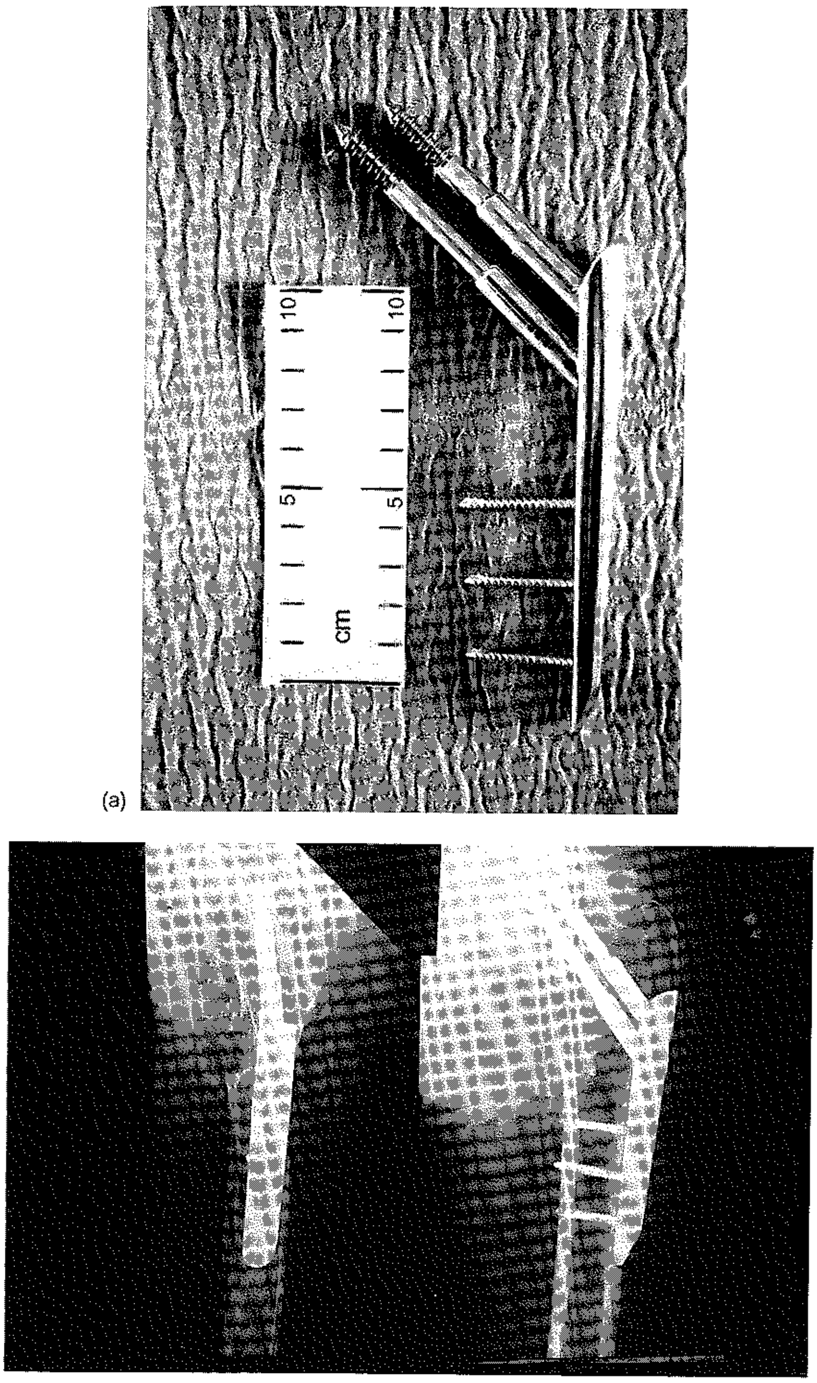

Fig. 1. (a) The PCCP consists of a plate with a knife-like end and two neck screws of 9.3 mm diameter (self-cutting). Dynamization can take place because of the telescopic design. (b) Radiograph of a hip fracture treated with the PCCP.

hospital stay, fracture consolidation and patient rehabilitation were recorded. Statistic analysis was done with the independent samples t-test; α was set at 0.05.

3. Surgical technique for PCCP

The patient is placed supine on the traction table and closed fracture reduction performed. The PCCP is attached to the introducer. A first stab incision is made opposite the proximal border of the lesser trochanter, identified by the image intensifier. An 18-gauge spinal needle is used to locate the anterior and posterior border of the femoral shaft, and a 2–2.5 cm stab incision is made down to bone. Using the knife-like end of the PCCP as a sensor, the plate is introduced at right angles to the femur and dissected down to the bone. On feeling the anterior and posterior borders, the introducer is turned 90° to be parallel to the femoral shaft.

Table 1
Descriptive results of pilot study (20 patients) with the PCCP

One patient died after pre-existing pneumonia
One intra-operative complication of fractured shaft screw; no consequences
Two patients with (conservatively treated) haematoma
Mean hospital stay 14 (range 9–20) days

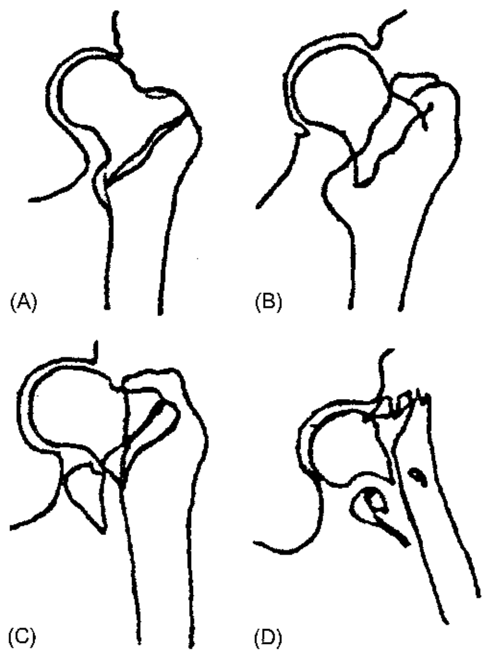

Fig 2 The Evans pertrochanteric hip fracture classification Type 1A and B are stable and types 1C and D unstable fractures

The plate is then slid distally along the lateral border of the femur. The plates position is checked under the image intensifier. A second stab incision (2–2.5 cm) is made through the proximal vertical hole of the introducer (to mark the site for incision) and then, over the introducer itself, continued down to the bone, making sure that the soft tissue is properly dissected, so as not to interfere with the insertion of the fixation hook. The bone hook adaptor is connected to the middle vertical hole of the introducer and checked on a lateral view; corrections are made either by swinging (the bone hook pivots) or, in cases of excessive anteversion, by circum motion (the bone hook glides and maintains the AP position). When the AP and lateral positions are satisfactory, the bone hook is closed firmly.

The main sleeve and trocar are then introduced through the lowest oblique hole of the introducer, and the main sleeve is fastened with a bolt. The guide wire is inserted through the first sleeve and its position confirmed on AP and lateral views.

The butterfly pin is next inserted through the butterfly screw to fix the introducer to the PCCP, and the required length of the first neck screw is measured with the triangular gauge. The guide wire and first sleeve are then withdrawn. The second sleeve is inserted and again screwed into the plate, and then a 7 mm drill-bit is passed. The drill and the second sleeve are withdrawn. A 9.3 mm drill-bit is advanced through the main sleeve and withdrawn. The correctly chosen length of the neck screw is attached to the neck screwdriver as follows. With both the screw and driver in the vertical position (the screw is in its container), the screw sleeve is engaged first. Grip 2 is pushed in with some rotation and the hexagonals engaged (listen for the click). Grip 3 is then pushed down and rotated to engage the threaded ends and the screw picked up out of its container. The screw (grip 2) and screw sleeve (grip 1) are screwed in simultaneously. The marked lines (M) indicate: (1) when the thread is about to engage the plate (first line at the main sleeve aperture); (2) when the thread is all the way in (second line at the main sleeve aperture). The mushroom (grip 4) is then pulled and the neck screw advanced further, under the image intensifier, to its final position at the subchondral bone. Grip 5 is turned counter-clockwise and the fracture gently compressed. In osteoporotic patients, we recommend the use of image-intensifier control at this stage to ensure that the screw is not pulled out. The neck screwdriver and main sleeve are unlocked (turn grip 3 counter-clockwise) and removed.

The shaft sleeve and trocar are then inserted through the proximal vertical hole of the introducer, using a skin retractor. The shaft sleeve is fastened with a bolt and the trocar withdrawn. The shaft is drilled and the correct screw length measured with the depth-gauge (screws from 31 to 43 mm in 3 mm increments). The correct screw is connected to the screw driver by gentle pressure, and using a power tool the first of the screws is inserted. For manual insertion or removal the shaft trocar is used. The bone hook is then removed in exactly the opposite way to its insertion. The other two shaft screws are inserted as described earlier. The butterfly pin is then removed (do not forget this!). The second neck screw is placed as described earlier for the first one. The impactor is introduced through the main sleeve, and turned until it engages the head of the neck-screw sleeve (a slight click is audible), using a light hammer and very gently impacted only once! The impactor and the main sleeve are then removed, as is the introducer after it has been unlocked. Finally, the wound is irrigated, the skin sutured and a dressing applied.

4. Results

All 71 patients were fit for surgery within 24 h of admission. Their characteristics are listed in Table 2. The mean (range) hospital stay of the PCCP and DHS group was 12.5 (6–28) and 13.4 (8–22) days, respectively. The total operation time for the PCCP group ranged from 30 to 90 min (mean 46.6 min) and for the DHS group from 30 to 130 min (mean 69.2 min; Table 3). There was a significant (P = 0.000) mean difference in operation time between the PCCP

Table 2
Patient characteristics

	PCCP	DHS
Number of patients	33	38
Age, mean (range, years)	80 1 (63–96)	81 6 (61–97)
Right:left	16:17	12:26
Evans 1A	10	4
Evans 1B	5	11
Evans 1C	14	19
Evans 1D	4	4
Hospital stay, mean (range, days)	12.5 (6–28)	13 4 (8–22)
Operation time, mean (range min)	46 6 (30–90)	69 2 (30–130)
Blood transfusions	6	24
Haematomas	8	27
Infections	1	2
Complications: implant	2	4
Complications: general	6	10
Died <1 month	0	1
Died 1–2 month	0	2
Follow-up, mean (range, months)	3 (1–8)	3 (1–7)
Follow-up >3 months (patients)	16	21

Table 3
Descriptive statistics

Operation time	Mean	S.D	No	Range
DHS	69 2	22 8	38	30–130
PCCP	46 6	13 7	33	30–90
DHS corrected	63 8	63 8	34	30–95
PCCP corrected	45 3	11 4	32	30–75
DHS + TSP	80.5	18 1	12	50–110
DHS − TSP	64.0	23 1	26	30–130

DHS and PCCP corrected are the results without the outliers TSP is the trochanteric stabilization plate (according to Regazzoni).

and the DHS groups of 22.6 (95% CI, 13.8–31 4). When outliers were omitted, the mean PCCP time was 45.3 min (range 30–65 min; 94% of the patients) and the DHS time 63 8 min (range 30–95 min; 90% of the patients) There remained a significant difference between the PCCP and the DHS group without a trochanteric stabilization plate (Table 4) The distribution of Evans type 1A–D fractures was similar for the PCCP and DHS groups In the PCCP group, there were four intra-operative complications: (1) the device was placed too anteriorly and revised; (2) one of the neck screws was too long and needed to be replaced; (3) the plate fixation bone clamp broke, but this did not affect the fixation and final outcome; (4) there was only enough space for one neck screw, without negative affects. Post-operative general complications (e.g. urinary tract infection, deep-vein thrombosis, respiratory insufficiency, congestion, etc.) occurred in six patients of the PCCP group and 10 patients of the DHS group ($P = 0.13$, ns) In the PCCP group, two implant-related post-operative complications occurred: perforation of the femoral head in two patients by one of the neck screws required revision to a total hip prosthesis in one; the other was asymptomatic. In the DHS group, four implant-related complications occurred In the first, the anti-rotation screw backed out, which was asymptomatic. In the second, the DHS broke out and was revised by use of an unreamed femoral nail with a spiral blade In the third and fourth, the neck screws perforated the femoral head; revision to a total hip prosthesis was necessary with both these patients

In the DHS group, blood transfusion was required in 24 patients as compared with six patients in the PCCP group ($P = 0\ 000$). Blood transfusions were given when the hemoglobin was below 8.9 g/dl or when clinically indicated.

Haematomas were detected by clinical acumen and developed in eight PCCP and 27 DHS patients ($P = 0.000$). Superficial infections were found in one PCCP and two DHS patients ($P = 0.65$, ns). Short antibiotic regimens cleared all three infections.

The mean follow-up period for both groups was 3 months (range 1–7 months in the DHS, 21 of whom had a follow-up >3 months; range 1–8 months in the PCCP group, 16 of whom had a follow-up >3 months). Most patients in both groups were using crutches at 3 months follow-up

Radiographs of the DHS group at 3 months showed secondary fracture dislocation in three patients. This led to varus malunion in two patients and excessive lag-screw sliding with medialization of the distal fracture fragment in the third. This complication delayed healing and caused considerable shortening, which hindered the patients In the PCCP group, there were two with controlled fracture impactions without varus malunion and delayed union, but with a shortened leg, which hindered them ($P = 0\ 767$, ns).

Table 4
Independent samples test: operation time

Comparators	Significance (two-tailed)	95% CI of difference	Mean difference	S.E difference
DHS–PCCP	0 000	13 8–31 4	22 6	4 4
DHS (corrected)–PCCP (corrected)	0 000	11 5–25 6	18 5	3.5
DHS (no TSP)–PCCP	0 005	8 7–28.8	18 7	5.0

DHS and PCCP corrected are the results without the outliers TSP is the trochanteric stabilization plate (according to Regazzoni)

5. Discussion

The DHS is generally accepted as the "gold standard" for the treatment of Evans type 1A–D pertrochanteric hip fractures [4–13]. However, implantation demands wide surgical exposure, especially when the trochanteric stabilizing plate (according to Regazzoni) is used. The hospital stay is prolonged for the older patient, with comorbidity

The Israeli orthopedic surgeon Gotfried developed the PCCP, a device for minimally invasive surgical treatment of pertrochanteric hip fractures in an attempt to reduce comorbidity and create faster rehabilitation. The PCCP can be removed by the same percutaneous route as it had been inserted In our 71 elderly patients, a significant reduction of operation time, blood transfusion and haematoma was found with PCCP in comparable groups of stable and unstable pertrochanteric hip fractures. As indicated by the short, mean and range of operation time, there is almost no "learning curve" with this new device, implanted here by both senior surgeons and residents. When the operation time data were corrected for outliers, the PCCP had a shorter operative time ($P = 0.000$). The mean time for PCCP (45.3 min) is shorter than that reported by others [9,10,14–19], who record operation times ranging from 47 to 81 min for the gamma nail or intra-medullary hip screw. The reported number of intra- and post-operative complications with these implants is also higher [9,10,14–19].

We found significant differences between DHS and PCCP groups in the amount of blood loss and the number of blood transfusions ($P = 0.000$). For blood transfusion, the relative risk reduction of 71% and the absolute risk reduction of 45% represents an important advantage of the PCCP; for every 2.2 patients treated with the PCCP rather than DHS, a blood transfusion may be prevented, which is important considering the rising costs of allogenic blood, potential risks of transfusion reactions, disease transmission and immunomodulation [20–22]. The risk of a serious or fatal transfusion-transmitted disease is approximately 3 in 10,000; the chance of a minor allogenic reaction is 1 in 100 [23]. When looking at blood loss/transfusions in relation to the DHS and gamma nail, significant differences are reported in favor of the DHS by Hoffmann et al. [9] ($P = 0.006$), Watson et al. [13] ($P = 0.0001$) and Guyer et al. [17,18]; and in favor of the gamma nail by Leung et al. [5] ($P = 0.069$ for stable, and $P = 0.04$ for unstable fractures), Baemgaertner et al. [10] ($P = 0.02$) and Park et al. [16] ($P = 0.01$). Most randomized trials [5,7–9,14,15,19] report no significant differences in blood loss or amount of transfusions.

We found no significant difference in hospital stay between the two groups. Comparing the length of hospital stay between studies it is difficult because it is more a reflection of prevailing social/medical/economic conditions, such as the availability of nursing-home care, than a direct result of the implant used. Therefore, a direct comparison is not possible or useful.

We found no other randomized, controlled trials of this device in the literature. The randomized, controlled trials that could be retrieved compared the DHS with the gamma nail and found no significant difference in operation time, hospital stay and wound problems. The percentage of femoral fractures (up to 18%) and number of re-operations was in favor of the DHS [4–8,14–19,24–27].

In two randomized, controlled trials comparing the DHS with the intra-medullary hip screw, the same problems, as seen with the gamma nail [9,10] were described. No randomized, controlled trial comparing the DHS or gamma nail with the proximal femoral nail could be found in the literature.

Meta-analyses by Parker and Pryor [27], of randomized, controlled trials that compare the gamma nail with the DHS or the intra-medullary hip screw with the DHS showed a significantly increased risk of fracture of the femoral shaft and a higher re-operation rate for the gamma nail and intra-medullary hip screw, which still makes the DHS more effective than the nail or screw for the treatment of pertrochanteric hip fractures.

Pitsaer and Samuel's [28] report on the McLaughlin plate showed a high percentage of implant failures (42%) and recommended that this device should not to be used. In two randomized, controlled trials comparing the DHS with the McLaughlin plate, a higher failure rate is described as a result of plate breakage compared with 10% incidence of cutting out of the DHS [11,12,28]. There is only one study comparing the DHS with the Medoff sliding plate; it describes significantly more blood transfusions and longer operation times for the sliding plate [13].

6. Conclusion

Although this is a preliminary study with a relatively small number of patients and short follow-up, the PCCP seems similar to the DHS in relation to bone healing and stability. For blood loss, soft tissue healing and operation time, the PCCP device has significant advantages over the DHS.

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