The percutaneons compression plate (PCCP) in the treatment of stable intertrochatenic fractures

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Purpose. To assess the results of the PCCP (percutaneous compression plate) in the treatment of stable intertrochanteric fractures.
Materials and methods. Prospective study of 42 patients with a stable intertrochanteric fracture, classified according to the AO/OTA scale, implanted between 2003 and 2005 with a PCCP percutaneous compression plate. There were 12 males and 30 females, with a mean age of 82.3 years. Prior to the fracture, 19 patients were independent walkers, 16 required a walking-stick and 7 required a walking frame or someone's assistance.
Results. Mean OR time was 87 minutes. Fifteen patients required a blood transfusion with a mean of 0.60 concentrates per patient and a mean analgesic consumption period of 3.5 days. Mean hospital stay was 16.9 days. Postoperatively, 73% could ambulate independently. There were five deaths in the first year post-op. No surgical complications were recorded. Radiologically, there were no mechanical complications or material-related failures.
Conclusions. The PCCP percutaneous compression plate comes across as a valid and effective system for the treatment of stable intertrochanteric fractures.

Key words: *hip fracture, intertrochanteric fracture, percutaneous compression plate.*

Placa de compresión percutánea (PCCP) en el tratamiento de las fracturas intertrocantéreas estables

Objetivo. Estudiar los resultados de la placa de compresión percutánea (PCCP) en el tratamiento de las fracturas trocantéreas estables.
Material y método. Estudio prospectivo de 42 pacientes con fractura trocantérea estable, según la clasificación de la AO/OTA, intervenidos entre 2003 y 2005 con placa de compresión percutánea (PCCP, *percutaneous compression plate*). Fueron 12 varones y 30 mujeres, con una edad media de 82,3 años. Previo a la fractura, 19 pacientes presentaban una deambulación independiente, 16 deambulaban con bastones y 7 precisaban la ayuda de un andador o tercera persona.
Resultados. El tiempo quirúrgico medio fue de 87 minutos, 15 pacientes precisaron transfusión sanguínea con una media de 0,60 concentrados por paciente, y tuvieron un consumo medio de analgésicos de 3,5 días. La estancia media fue de 16,9 días. Posoperatoriamente el 73% tenían deambulación por sí mismos. Hubo 5 éxitus en el primer año posoperatorio. No hubo complicaciones quirúrgicas. Radiológicamente no hubo complicaciones mecánicas ni fracasos del material.
Conclusiones. El sistema de placa de compresión percutánea PCCP nos parece válido y eficaz en el tratamiento de las fracturas trocantéreas estables.

Palabras clave: *fractura de cadera, fractura pertrocantérea, placa de compresión percutánea.*

In recent times minimally invasive surgery has gained ever increasing popularity in modern orthopedics; it entails less bleeding and postoperative pain, less postoperative morbidity and a more rapid functional recovery[1]. As the population ages, osteoporotic fractures, and amongst them trochanteric fractures, have become the new orthopedic epidemic lesion[2]. About 90% of the patients who suffer trochanteric fractures are over 65 years of age and have con-

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comitant diseases[3], and therefore consequently present high rates of morbimortality related to their trochanteric fractures.

Currently, classic extramedullary dynamic compression systems are the gold standard for these types of fractures, thanks to their reproducible results[4]. However, these techniques are associated with considerable blood loss, damage to soft tissues and possible de-stabilizing effects on other comorbidities in elderly patients[3]. Due to all this, with the aim of improving results, minimally aggressive internal fixation systems have been developed for the treatment of these fractures. Classical extramedullary dynamic fixation systems have shown multiple failure patterns, the most common being the so-called *screw cut-out*, i.e. the screw migrates superiorly through the upper cortical bone in the femoral head or neck[5,6]. The perforation of the external cortical bone when inserting the head screw creates a zone of tension that may cause a fracture of the external cortical or involuntary detachment of the greater trochanter during surgery. Another possible complication is the excess of slipping with medialization of the distal fragment and collapse when load-bearing is begun[7,8]; this phenomenon is more frequent in unstable posteromedial fractures[9] such as (AO/OTA) type 31.A2.2 fractures.

Many intramedullary implant systems have been used[10-13]. The procedures involved in the use of these systems cause considerable tissue aggression (drilling and medullary canal invasion) with high bleeding and transfusion rates, therefore they cannot be truly considered minimally invasive. These systems are very useful and have shown to possess greatest efficacy in unstable fractures, however, higher rates of femur shaft fractures have been reported; although it is true that the studies performed used the first designs[1,2].

Gotfried[14] developed the percutaneous compression plate (PCCP) (Orthofix, Huntersville, NC, USA) at the end of the '90s. The design of this system makes it possible to implant it using minimally invasive surgery. It only requires the performance of two small incisions, one to insert a plate with a cutting edge and another to insert the screws. The design provides rotational stability by means of the insertion of two screws in the femur neck and lateral cortical support by means of a proximal extension of the plate. It is necessary to perform anatomical or near anatomical reduction of the fracture; this can be achieved by means of traction supplemented by a lower support to elevate the distal fragment.

The aim of this study is to determine the results of the use of Gotfried's percutaneous compression plate (PCCP) in stable trochanteric fractures.

MATERIALS AND METHODS

The PCCP system was introduced in our Hospital towards the end of 2003, and the first 10 patients were considered part of the learning curve, after which a clinical study of 50 selected patients was begun with the following inclusion criteria: over 60 years of age, stable intertrochanteric fracture according to the OA/OTA classification (31.A1, 31.A2.1 and 31.A2.2) capable of closed reduction. The exclusion criteria were: necessity of open reduction, inverted trace or unstable fractures according to AO/OTA classification (31.A2.3 y 31.A.3), pathological fractures, surgery of the ipsilateral lower limb or fracture of the contralateral hip in the last 12 months.

Certain preoperative data of each patient were registered such as: age, sex, fracture side, type of fracture according to the AO/OTA classification, mechanism that caused the fracture, risk of anesthesia according to the American Society of Anesthesiologists (ASA), personal history, use of antiaggregants or anticoagulants and activity prior to the fracture. As to level of activity, four categories were established: independent ambulation, ambulation with walking-sticks, ambulation with a walker or the help of another person and non-ambulation.

Once trochanter fracture was diagnosed, the patient was admitted to Hospital, the corresponding preoperative analysis was performed and standard antithrombotic 6 weeks prophylaxis with Clexane® was begun. As well as the consultation to Anesthesiology, if the patient's comorbid conditions made it necessary, other specialties were consulted. Once the Anesthesiology Service considered the patient suitable for this procedure, surgery was programmed as soon as possible.

Surgical Technique

All the surgical procedures were carried out by the same surgeon, who had received specific training in the use of the material from Dr. Yechiel Gotfried. All fractures were anatomically or almost anatomically reduced, in both projections, on the traction table, using the femur shaft elevator provided with the material when necessary. The plate entrance was located using a spinal #22 needle and a scope, an incision of approximately 2 cm was made, the plate was introduced using the sharp side as a sort of periostotome elevator and the height was checked with the scope. An inferior incision of approximately 3 cm was made, the plate was applied to the femur shaft by means of a reducing hook according to technique, the height was checked and subsequently the screws were placed in the following order: distal cephalic, proximal and distal shaft, proximal cephalic and mid-shaft, all checked by X-rays.

After surgery the patient was allowed to sit up after 24 hours and to ambulate after 48 hours, after the corresponding X-ray control. Painkillers were planned on an increasing scale based on the patient's demand due to the degree of pain, so that they were not administered if not requested. Antibiotic prophylaxis was carried out for 48 hours according to hospital protocol.

Table 1. Distribution by type of fracture according to the AO/OTA classification

	Number	Percentage
A1.1	15	35.6%
A1.2	7	16.7%
A1.3	2	4.8%
A2.1	11	26.2%
A2.2	5	11.9%
A2.3	2	4.8%

Postoperative follow-up

The variables followed included: Preoperative, postoperative and total hospital stay, operation time, material used during surgery, preoperative, postoperative and total transfusions, hemoglobin, hematocrit and red blood cell values at 6 and 48 hours after surgery, day of initial weight-bearing and ambulation, postoperative complications, amount of painkillers taken, destination of the patient on hospital discharge and level of activity 6 months after surgery. Postoperative X-ray measurements were performed: Neck-shaft angle achieved, impaction of the fracture 3 months after surgery and heterotopic calcifications according to Broker's classification.

Eight patients were lost during follow-up: Five due to a move to another health area and 3 abandoned their postoperative checkups for unknown reasons. The study sample was 42 patients, 12 men (28.6%) and 30 women (71.4%), with a mean age of 82.3 years. The most frequent comorbid conditions seen were: 10 patients had hypertension, 7 diabetes mellitus, 10 senile dementia or dementia from other causes, 4 patients had suffered some kind of stroke and 3 suffered from some kind of heart condition. As to ambulation, prior to fracture, 19 patients (46.2%) walked independently, 16 (38.5%) walked with walking-sticks and 7 (15.4%) needed to use a walker or required the help of another person.

In 48.8% of cases the fracture was on the right and in 51.2% on the left. In 95% of cases the fracture was due to a casual fall and in 5% was caused by high-energy trauma. The frequency of each type of fracture can be seen in Table 1, where it is possible to see that 2 type AO/OTA 31.A2.3 fractures were treated that initially had been considered unstable. This was due to the fact that they were detected at the time of reduction and as closed reduction was possible they were considered suitable for treatment by PCCP. As to anesthetic risk: 10 patients were classified as ASA II (23.8%), 15 as ASA III (35.7%) and 5 as ASA IV (11.9%); 12 patients (28.6%) underwent emergency surgery without the Anesthesiology Service performing a preoperative assessment of anesthetic risk.

RESULTS

Mean hospital stay from admittance to surgery was 5.5 days (Standard Deviation [SD]: 2.8). Mean operation time was 87.4 minutes (SD: 28.9). The most frequently used materials were: the 90 mm proximal cephalic screw (47%) followed by the 110 mm one (30%), the 120 mm distal cephalic screw (35.5%) followed by the 110 mm one (23.5%) and the 37 mm shaft screws (54%).

The evolution of blood parameters can be seen in Table 2. Five patients (12.2%) required preoperative transfusions with one red blood cell pack each, which meant an average of 0.1 red blood cell packs per patient (SD 0.4); 13 patients required postoperative transfusions (31.7%) with an average of 0.5 red blood cell packs per patient (SD: 0.8). A total of 15 patients received transfusions (35.7%) with an average of 0.6 red blood cell packs per patient (SD: 0.9).

As to postoperative pain, the patients received painkiller on demand. The patients were given painkillers for 3.5 days (SD: 3.3); the most frequently used painkiller in our Hospital is metimazol (Nolotil ®), the mean consumption during the first 24 hours was 2,410.2 mg (SD: 2,392.0) and during the first 48 hours 1,897.4 mg (SD: 2.510,9). None of the patients required opioids for pain.

As to the beginning of postoperative activity, patients began standing at a mean time of 2.7 days (SD: 1.0) and walking at 5.8 days (SD: 3.0). The mean postoperative hos-

Table 2. Evolution of blood parameters

	Preoperative	6 hours	48 hours	Preoperative decrease 6 hours	Preoperative decrease 48 hours
Hemoglobin					
Mean	12.58	10.07	9.68	2.07	2.78
DE	1.64	1.41	1.15	1.32	1.71
Hematocrit					
Mean	37.04	30.13	29.37	5.74	7.42
DE	4.1	3.94	3.75	3.79	4.71
Red blood cells					
Mean	4.15	3.31	3.24	0.65	0.86
DE	0.52	0.49	0.58	0.41	0.48

SD: Standard Deviation.

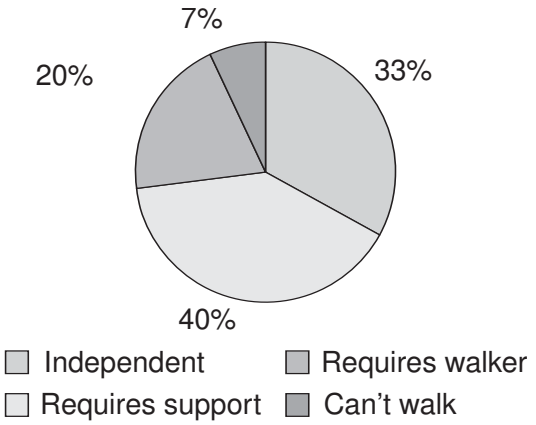

Figure 1. *Postoperative activity at 6 months, excluding deaths.*

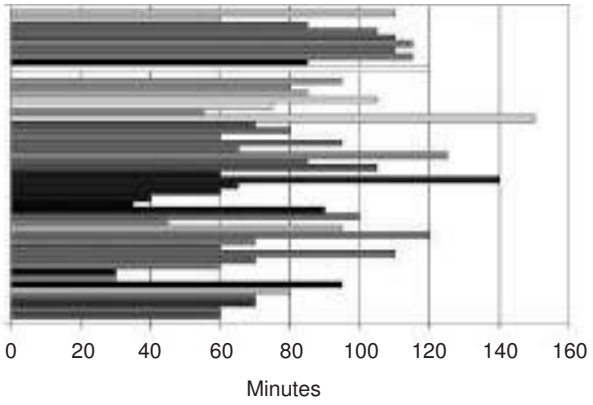

Figure 2. *Evolution of operation time from the first cases (upper) up to the present (lower).*

pital stay was 11.7 days SD: 5.4), which, added to the preoperative hospital stay, comes to a total mean hospital stay of 16.9 days (SD: 7.8). Twenty-three patients (54.8%) were discharged to their homes, whereas 18 patients (42.9%) required discharge to an intermediate rehabilitation facility, one patient (2.4%) died before discharge.

On X-ray measurement, the neck-shaft angle achieved was 133° (SD: 5.0) and at 3 months there was a mean impaction of 3 mm (SD: 7.4). Heterotopic calcifications Broker type I were seen in 8 patients (19%), and type II in 1 patient (2.4%); the remaining 32 patients (76.2%) had no calcifications.

Postoperative activity can be seen in Figure 1. We consider the evolution of activity of more importance than the level of activity itself; 25 patients (59.4%) were able to maintain the same level of activity that they had prior to their fracture, 11 patients (26.1%) descended one degree in their level of activity and 2 patients (4.7%) descended 2 degrees. Five patients (11.9%) died during the postoperative period: 1 at 24 hours, 3 in the first 6 months and 1 between 6 months and 1 year of follow-up.

As to complications, 2 patients (4.7%) had transient ischemia, 2 (4.7%) nosocomial pneumonia, 1 (2.4%) heart failure and 1 suffered disorientation. No material failures or infections were detected.

DISCUSSION

Extramedullary internal fixation systems continue to be considered the gold standard for the treatment of trochanteric fractures, however, they are criticized for their high degree of soft tissue aggression, especially in elderly patients. The percutaneous compression plate (PCCP) is an alternative, since it can be placed with maximum preservation of soft tissues. This study had the aim of determining if this method was applicable in our environment. The first fact that caused us surprise was the prolonged hospital stay, especially during the preoperative period, which was about 5 days. We cannot explain this long stay, since we made every possible effort to perform surgery on these patients as soon as possible with the aim of reducing their morbimortality to a minimum. In spite of this preoperative prolonged hospital stay, postoperative morbidity and mortality were excellent in comparison with other studies in which they were about 16%[3,13].

We wish to highlight the OR times recorded. The source of information for this data was the surgical protocol that is filled in by the Nursing Service after each operation. We were struck by what in our opinion were prolonged operation times; our subjective opinion is that the mean operation time was not beyond 30 minutes. Furthermore, operation time has decreased as we advanced in the learning curve (Figure 2).

We wish to highlight the low rate of transfusions, in spite of the prolonged preoperative hospital stay, the age of the patients and their comorbid conditions. The low rate of painkiller use is interesting, this point is little mentioned in the literature but we consider it is of vital importance. Furthermore, no material failure was seen. This suggests that double axis fixation confers great stability to the fracture and preserves the maximum amount of bone tissue in the femur neck to support weight.

Lastly, we were very happy to see good X-ray results, as also a very satisfactory level of postoperative activity. More than the level of activity itself we thought it was of greater importance that almost 60% of the patients preserved their pre-fracture level of activity.

Gotfried[14] in the year 2000, in a study carried out on 97 patients, published data of a hospital stay of 8.7 days; local complications that were: 2 wound hematomas, 1 deep infection resolved with the use of antibiotics, 8 varus consolidations and 1 screw migration. We detected none of these complications in our study

In a subsequent study Gotfried[15] carried out on 188 patients with pertrochanteric stable fractures and a mean age

of 79 years, no surgical complications were reported, although 3 patients had to be reoperated, 1 due to avascular necrosis of the femur head and 2 to remove the plate that caused discomfort. Independent ambulation was achieved in 83% of the patients.

We consider that the most important studies are those which have compared the PCCP plate with classic systems of internal fixation. Brandt et al[16] carried out a study on 71 patients comparing PCCP with DHS (dynamic hip screw); they found that PCCP had a shorter operation time, lower rate of transfusions and a lower rate of postsurgical hematomas; they found no differences in relation to other complications nor final results. On the other hand, Peyser et al[17] published the results of a study carried out on 263 patients comparing PCCP and CHS (compression hip screw) in the long term. The mean age of the patients, similarly to what we saw in our study, was 80 years of age. They confirmed that the use of a PCCP plate meant a shorter operation time; furthermore, although they found no difference in the rate of transfusions, the number of patients to receive 3 or more red blood cell packs was significantly less in the PCCP group. They also detected less general morbidity, and in particular cardiovascular morbidity, in the PCCP group. Lastly, the failure rate was higher in cases in which CHS was used, and no differences were found in the mortality rate. To summarize, we can say that use of the percutaneous compression plate (PCCP) benefits patients, since it is associated with less bleeding, a lower rate of transfusions[16-19] and complications[17]and less operation time[16-18], without negatively affecting long-term results.

In conclusion, we consider that the percutaneous compression plate (PCCP) system is valid and effective for treatment of stable trochanteric fractures, and, according to the literature, has advantages in comparison with classic systems.

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Conflict of interests

The authors have declared that they have no conflict of interests.