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Department of Orthopedics
De Weezenlanden Ziekenhuis
Groot Weezenland 20
8011 JW Zwolle
The Netherlands

### Acetabular fractures—diagnosis, classification, and indications

*S de Lange*

Department of Traumatology, Westeinde Hospital, the Hague, the Netherlands

Acetabular fractures are rare; some 100 acetabular fractures are operated annually in the Netherlands. Accurate diagnostics, classification and differentiated treatment are difficult owing to the complicated threedimensional configuration of the acetabulum.

Because of the relatively small number of acetabular fractures, only a small group of surgeons in the Netherlands are able to gain adequate experience in the treatment of these injuries.

The diagnosis is based on radiographs in three projections: antero-posterior (AP), oblique obturator view (OOV) and iliac oblique view (IOV). These three projections suffice for classification of the fracture, which does not absolutely require CT and 3D-CT scanning but does require pen, paper and a plastic pelvis.

Letournel's classification is used internationally; there are five elementary types and five associated types of acetabular fractures.

The most frequent forms are:

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| posterior wall | 25% |
| both columns | 22% |
| transverse | 25%. |

Fifteen percent of the patients have a pelvis fracture as well; 20% of the patients are multiple injury cases. Management depends on the classification. Nonsurgical treatment is a correct choice in 10% of the cases. This treatment consists of bed rest, CPM after 14 days, ambulation on crutches until 3 months. Traction is useless: permanent repositioning is not achieved, it is unnecessary in stable fractures, local pin problems may occur.

Indications for nonsurgical treatment are:

1. medical contraindications to surgery;
2. pre-existent coxarthrosis;
3. local infection or skin problems;
4. severe osteoporosis;
5. fractures without dislocation;
6. low transverse fractures;
7. low anterior column fractures
8. posterior wall fractures <1/3 (compare normal side);
9. both column fractures with secondary discongruence;
10. lack of familiarity with the treatment is a contra-indication.

Indications for surgical treatment are: all fractures with dislocation.

Once the decision to operate has been made, the approach has to be selected.

The choices are:

1. the Kocher-Langenbeck approach;
2. the ilio-inguinal approach;
3. the extended ilio-femoral approach.

Operation on the extension table offers major advantages in all cases. A highly specialized instrumentarium is indispensable, as is a large stock of special plates and very long screws. Repositioning and fixation with traction screws, followed by neutralization with plates.

Complications of the surgical treatment are:

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| mortality | 2% (over 70 years 15%) |
| infection | 1% |
| loss of nervous function | 6% |

thromboembolism.

In the Netherlands, some ten specialists are associated in the 'pelvis team'.

Our objective of quality in all injuries of the locomotor system has no place for inexperience. Let us be honest to the patient and to ourselves; consult or refer!

### Movements and forces in the shoulder—a three dimensional approach

*F C T van der Helm*

Department of Man-Machine Systems, Faculty of Mechanical Engineering, Technical University, Delft, the Netherlands

The shoulder may be regarded as consisting of four bony components, viz. the thorax, clavicle, scapula and humerus.

Positioning of the humerus (and the rest of the arm) in space is brought about by simultaneous rotations in the three articulations (sternoclavicular, acromioclavicular and glenohumeral) between these components. Very little quantitative knowledge is available about the movements of these components in relation to one another, and about the forces involved. Insight into the movements and forces can improve the diagnostics and treatment of shoulder dysfunctions. The movements of the scapula are restricted on the one hand by the clavicle, which causes the acromioclavicular joint to move more or less over a spherical surface round the sternoclavicular joint, and on the other by the thorax, which causes the medial edge of the scapula to move along an ellipsoid. This results in a complex pattern of movements.

The three-dimensional (3D) positions of the shoulder are very difficult to measure. 3D roentgen measurements necessitate internal markers, which, however, in healthy test subjects meets with ethical objections. At Delft Technical University a static measuring method has been developed which permits palpation and measurement of bone points. The 3D position can subsequently be reconstructed. Measurements demonstrate among other things that most rotations in general occur in the sternoclavicular and glenohumoral articulations, and only very few in the acromioclavicular articulation. The internal forces exerted during movement of the shoulder cannot be measured directly. For this reason, a computer model of the shoulder has been prepared. Using this model, movements of the bony components can be simulated. In this way, the forces of the various muscles can be calculated. The morphological data for the computer model derive from extensive cadaver measurements. Ninety-five lines of actions are used to represent the 16 muscles of the shoulder. In addition, the extracapsular ligaments and the scapulothoracic sliding surface are modelled. The predictions concerning muscle activation are in good agreement with EMG measurements. Moreover, the model offers insight into the forces that play a part in the shoulder, for instance the function of muscles in stabilizing the articulations, the function of ligaments and the magnitude of the reaction forces in the articulations. So far, the model has been used for a number of standardized measurements, such as abduction and anteflexion, but also for calculation of the shoulder stress during wheelchair riding and for calculation of the effects of a glenohumoral endoprosthesis and of a shoulder arthrodesis.

## Surgical treatment of acetabular fractures

*M de Kleuver[1] and L B Bone[2]*

[1]Department of Orthopaedics, St Maartens Clinic, Nijmegen, the Netherlands
[2]Associate Professor of Orthopaedic Traumatology, State University of New York, USA.

From 1988 to 1992, 42 acetabular fractures were operated in the Erie County Medical Center of New York. In most cases the cause was a high-impact injury, while in 50% of the cases the injured hip was dislocated as well.

After a mean follow-up of 28 months, the clinical results were 'good' or 'excellent' in 55% of the cases, while the postoperative radiographs were judged as 'good' or 'excellent' in 68% of the patients. Anatomical or adequate repositioning (<3 mm dislocation) was achieved 30 times (73%); in 71% of these 30 patients this led to a clinically good or excellent result, which is less than the 91% reported in the literature. The fact that a poor clinical result was recorded in spite of adequate repositioning may be attributable to cartilaginous damage caused by the injury and subsequent avascular necrosis of the head of the femur. In the cases in which the acetabular fracture was combined with dislocation of the hip, the clinical and radiological results were substantially poorer; in 33% of these cases avascular necrosis developed. Periarticular ossifications (PAO) were seen less often in cases of good repositioning than in cases in which repositioning had not been optimal (average grade 0.69 and 1.7, respectively, according to the Brooker classification).

If a posterior approach was selected for the operation, an attempt was made to reduce the risk of PAO by refraining from a trochanteric osteotomy; in addition, most of these patients received after-treatment with a low dose of radiotherapy (1988–1990) and later with indomethacin (1990–1992). These measures resulted on average in PAO degree 0.7, while an average PAO degree of 1.4 was seen in patients not given adjuvant therapy.

The long-term results of acetabular fractures may be improved by good repositioning and adequate prophylaxis against PAO. On the other hand, the violence of the injury, the occurrence of dislocation of the hip and subsequent avascular necrosis are factors that cannot be influenced and that have distinct adverse consequences for the ultimate clinical result.

## Surgical treatment of the unstable supracondylar humerus fracture in children

*P A Nolte, P B Dunki Jacobs, F J Custers and J H Pot*

Departments of Surgery/Traumatology and Orthopaedics, Medical Centre, Alkmaar, the Netherlands

*Introduction:* The treatment of the unstable supracondylar humerus fracture (classification: AO 13A2.3.2/3 and Cartland-Wilkins II A/B and III) in children is controversial. Good results have been reported of conservative treatment by means of (Dunlop) traction, as well as of surgical treatment in the form of closed repositioning (and fixation with plaster or Kirschner wires) or of open repositioning.

*Method:* A retrospective assessment was made of the short-term results of the treatment of children with an unstable supracondylar humerus fracture in Alkmaar Medical Centre. During the period 1987 to 1992, 62 chil-

dren with an unstable supracondylar humerus fracture were admitted for treatment under anaesthesia. Traction treatment was instituted in one case. Closed repositioning and plaster immobilization was opted for in 21 cases (24%); four patients subsequently required reoperation because of redislocation. Twenty patients (32%) underwent closed repositioning of the fracture and fixation with K-wires. Open repositioning and K wire fixation was indicated in 24 patients (39%).

*Results:* Short-term results, scored according to Innocenti, were excellent in 69%, good in 29% and poor in 2%. The two patients with poor results had a radiographical) cubitus varus, but without symptoms and with good function of the elbow.

Postoperative complications were rare; in particular, no Volkmann's ischaemic contracture developed.

*Conclusion:* Traction treatment necessitates a long hospital stay, which is regarded as a major drawback. In Alkmaar, therefore, preference is given to treatment of this (unstable) fracture by repositioning under anaesthesia and fixation with plaster or, depending on the tendency to redislocation, with K wires. If anatomical repositioning is not achieved, if there is an open fracture or if neurovascular damage is present, open repositioning and K wire fixation are resorted to. Neurovascular damage in the authors' opinion occurs at the time of the accident and not during cautious repositioning under anaesthesia. The short-term results are excellent to good in almost 98% of the cases.

## Ankle ligament reconstruction according to the Duquennoy and modified Evans methods—a comparative study of the long-term results

*M R van Liefland, R M Bloem and E J van Langelaan*

Departments of Orthopedics Leiden and Leiderdorp, the Netherlands

A retrospective evaluation was made of the functional and clinical results of treatment of lateral ankle instability by the method of Duquennoy (group 1) in 20 cases and the method of Evans (group 2) in 22 cases. Patients' mean ages were 34 (17–54) and 31 (17–48) years, respectively, with an equal sex distribution; the mean follow-up periods were 8 (2–13) and 7 (2–12) years, respectively. Clinical assessment was made by one independent investigator.

The subjective scores, assigned by the patients, on a scale of 10 were 7.4 in group 1 and 7.8 in group 2. The subjective results, with the criterion whether or not the operated ankle turned, in group 1 was good in 15 and poor in five patients. In group 2, 19 patients scored high and three low. In both groups there were two patients in whom the operation had not had a favourable effect on turning at any time; complaints of turning recurred in group 1 in three patients after 6 to 9.5 years, and in group 2, in one patient after 3 years.

The presence or absence of an anterior drawer phenomenon or the degree of calcaneal tilting (measured externally, by a standardized method, from resting position) both related to the contralateral ankle, displayed no correlation with the clinical results. In case of congenital laxity, the clinical results in both groups were identical, while after surgery for post-traumatic instability poor results were only seen in three cases operated on by the Duquennoy method.

## Results of fixation of stable pertrochanteric fractures with the DHS and of unstable fractures with the Gamma nail in elderly patients—a prospective study

*A J M Janus, A J Verbout[1] and P V M Pahlplatz[2]*

[1]Department of Orthopaedics, University Hospital Utrecht
[2]Department of Surgery, Leyenburg Hospital, the Hague, the Netherlands

*Introduction:* Patients with a pertrochanteric fracture of the femur were treated with a dynamic hip screw or a Gamma nail. If the fracture was stable according to the Evans classification as modified by Jensen, we used a DHS; in case of an unstable fracture, a Gamma nail was used. Purpose of the study was to analyse whether our protocol resulted in faster postoperative mobilization.

*Methods:* We analysed 125 primary pertrochanteric fractures of the proximal femur with adequate fixation and repositioning, with a follow-up of one year after the operation. All patients were encouraged to put weight on the leg as soon as possible after the operation. In many cases this was possible as early as 3 days postoperatively.

*Results:* In spite of the degree of osteoporosis, comminution of the fracture and the patients' advanced age, none of the implants penetrated through the head of the femur. Of the patients who preoperatively functioned highly independently, 71% were capable within 6 weeks to return to their preoperative activities level. 10.5% Of the patients died in the postoperative period. This may be regarded as a fairly low proportion in view of the poor general condition of these patients.

*Conclusion:* Our protocol combines the advantages of two methods of osteosynthesis, with less morbidity and mortality as the result.

## Fractures of the neck of the femur and emboli

*R L Diercks*

Department of Orthopaedics, Martini Hospital, Groningen, the Netherlands

In the department of orthopaedic surgery of the Martini

Hospital, location Van Swieten (then R.C. Hospital) from 1986 through 1988, 66 patients with a medial femoral neck fracture were treated with a cemented head-neck prosthesis or a total hip prosthesis.

Four patients (6%) died on the table or immediately afterward with the picture of hypotension, lowered oxygen saturation and circulatory arrest shortly after the introduction of acrylic cement into the femur. Autopsy in three cases revealed multiple pulmonary emboli, especially lipid emboli, but also clots and particles of cement.

The literature frequently mentions emboli due to intramedullary overpressure during cementing, as well as the toxicity of the methylmethacrylate as the causes of acute death at implantation of a cemented hip prosthesis. The mortality reported in the literature in this respect amounts to 6.8%.

In view of the above-mentioned experience, the preoperative management has been amended; it is now aimed among other things at rapid rehydration. The anaesthetic techniques have been adjusted as well, in particular, lumbar regional anaesthesia techniques are applied less often in unstable circulatory conditions. In the period 1990–1993, all this resulted in a decrease of the number of acute deaths to zero, in a larger group (n=78) of patients with a head-neck prosthesis or a total hip prosthesis.

## How predictable is mortality after a hip fracture?

*J A van der Sluijs[1] and G H I M Walenkamp[2]*

[1]Department of Orthopaedics, University Hospital, Utrecht, the Netherlands
[2]Department of Orthopaedics, University Hospital, Maastricht, the Netherlands

*Introduction:* The mortality of patients with a hip fracture is higher than normal; it returns to normal after approximately one year. Reported risk factors for an increased mortality include age, sex, general condition and type of housing situation.

*Patients and methods:* A prospective study was carried out in 164 successive patients with a hip fracture to determine the degree of predictability of the first-year mortality. To this purpose 12 variables related to the fracture and the social, functional and medical aspects were measured.

*Results and discussion:* Six of the 12 variables were associated with an increased mortality. Cox survival analysis identified advanced age, male sex and a restricted radius of action before the fracture as the principal predictable variables. With the aid of a score based on these three variables, several subgroups could be distinguished. The mortality in the subgroup (n=23) with the poorest score was 57% (confidence interval 35–75).

In consideration of the mean mortality of 33% in the group as a whole, this means that death after a hip fracture is to some extent predictable.

## Posterior dislocation of the hip with ventrocaudal fracture of the head of the femur (Pipkin fracture)

*J J Rondhuis, D G Langevoort, R K J Simmermacher and K J Bongers*

Partnership Surgery/Orthopaedics, Sophia Hospital Zwolle, the Netherlands

The Pipkin fracture is a relatively rare fracture, as appears among other things from the small number of publications, which moreover consists mostly of case reports.

Pipkin (1957) presented the first large series of 25 patients, on the basis of which he subdivided the typical fracture of the head of the femur into four types.

In the period 1984–1993, five patients with a Pipkin fracture were admitted to the Sophia Hospital. Guided by the findings in these cases, a method of treatment was developed in which, in contradistinction to what is indicated in the literature, the emphasis is on early mobilization.

## A new technique for closure of fasciotomy wounds

*H Lacroix*

Department of Orthopaedics, Elkerliek Hospital, Helmond, the Netherlands

The indications for performance of an acute fasciotomy because of excessive intracompartmental pressure are clear. There is less consensus where the method of closing the fasciotomy wound is concerned. Some clinics opt for primary closure of the wound, which in many cases still has to be followed by partial covering with grafts.

Primary application of skin grafts in many clinics also belongs to the standard techniques of closing a fasciotomy wound.

Although wound healing will as a rule give no problems after implantation of grafts, aesthetically the method is far from attractive, while the vulnerability of the healed transplant may still cause difficulties. A technique is now presented which considerably simplifies primary closure of a fasciotomy. Once the swelling of the extremity involved has subsided enough to justify closure of the skin defect, the wound is cleansed under adequate anesthesia. The wound edges are slightly undermined on both sides, following which skin staples are put in symmetrically along both sides of the wound, so that the wound edge is lined by staples. Through the spaces between staples and skin a vessel loop is braided crosswise, like a shoelace in a shoe. When all staples are connected, the vessel loop is tightened step by step so that the wound edges are pulled closer to each other; tension on the wound edges is thus divided evenly from end to end. The procedure is repeated 2–3 days later, and again as long as needed to allow complete closure of the skin. In this way a 'primary' closure can virtually always be brought about.

## Bony synostosis after ankle fractures—a 14-year follow-up

*G H R Albers, A F C C de Kort, C N van Dijk[1] and P R J M Middendorf[2]*

[1]Department of Orthopaedics, Academic Medical Centre, Amsterdam
[2]Department of Orthopaedics, Refaja Hospital, Stadskanaal, the Netherlands

The phenomenon of development of synostoses after ankle fractures has received little attention in the literature. This study focused on the long-term effects of such synostoses. In the AMC between 1975 and 1983, 355 patients with ankle fractures were operated on: 33 of type Weber-A, 176 of type Weber-B and 146 of type Weber-C. Of these 355, the fractures of types B and C were followed up between 1984 and 1986; 128 and 102 patients, respectively, were available for follow-up. A bony synostosis was observed in a total of 15 of these patients (incidence 6.5%), in three cases after a Weber-B and in 12 cases after a Weber-C fracture.

In 13 patients, the synostosis was observed as early as 3 months post-operatively, in the other two distinct calcifications were already visible at this time. For the current follow-up only nine of the 15 patients with a synostosis were available. The study protocol applied comprised anamnestic, clinical and radiographical parameters, resulting in an 'ankle score' with a maximum of 100 points. The mean follow-up was 14 (12–18) years. The mean ankle score was 91, with a range between 71 and 100.

*Conclusion:* Development of bony synostoses after ankle fractures is not rare, especially after Weber-C fractures, and occurs at a relatively early stage. Even in the long term, there are remarkably few symptoms and only slight functional impairment of the ankle joint is observed.

## Experience with the Gamma nail in 163 patients

*H Verburg, J S K Luitse and C P van der Hart*

Departments of Orthopedics and General Surgery, Onze Lieve Vrouwe Gasthuis, Amsterdam, the Netherlands

This retrospective study was carried out to gain insight into the complications observed with Gamma nail fixation of proximal femoral fractures in 163 patients, in the period May 1989 through November 1993. Insufficient data were available for seven patients, so that the study involved the clinical and radiographical findings obtained in 156 patients (114 women and 42 men, mean age 79 years) until the moment of discharge. The fractures were subdivided according to the AO classification (17 times 31A1, 108 times 31A2, 27 times 31A3, once 32A1). Three patients were subjected to preventive fixation because of an imminent fracture. The operations were performed by a total of 36 (!) surgeons; two of these were highly experienced in traumatology and these were present in 28% of the cases. Complications were seen 54 times: 18 at the site of the cervical screw (13 times perforation of the head, 4 times too short, once dorsally to the Gamma nail), 32 times at the site of the distal locking (7 times fracture, 12 times dorsally to the Gamma nail, 3 times medial cortex not perforated, 5 times one screw placed, 3 times drill broken, twice not possible). In one case, the Gamma nail broke, once a subtrochanteric fracture occurred and an infected Gamma nail was seen twice. Among the cases of the two experienced surgeons, complications were seen in 30% as compared with 36% for the less experienced surgeons. Of the first half of the operations (1–78), 33 (42%) entailed complications, of the second half (79–156), 21 (27%).

*Conclusion:* Gamma-nail fixation entails numerous complications which, even in the hands of experienced surgeons, after a learning curve, constitute a constant proportion.

## Late sequelae of sacroiliac dislocations in children

*M Heeg and H J Klasen*

Department of Orthopaedics and Traumatology, University Hospital, Groningen, the Netherlands

A retrospective study was made of the long-term sequelae of sacroiliac dislocations in children. During the period 1970–1987, 18 children aged 10 (2–16) years were treated because of an SI dislocation. All patients displayed an unstable fracture of the pelvic ring, type IV in the classification of Torode and Zieg. Ten patients were treated conservatively, with bed rest and/or traction. Eight patients were operated, with cerclage or plate osteosynthesis of the symphysis (six patients), external fixation (one patient) and osteosynthesis of the SI dislocation (one patient).

*Results:* The follow-up examination was carried out after 12 (6–20) years. In 7 patients, damage to the lumbrosacral plexus had been diagnosed at the time; in 6 of them recovery at the time of follow-up was incomplete, with many sequelae. 13 patients had differences in leg lengths, to a maximum of 2 cm. 4 patients to a slight extent had limited mobility of the lumbar spine. The radiographical follow-up revealed impressive abnormalities. 9 patients displayed complete fusion of the SI joint. 4 patients showed pronounced pelvic asymmetry/deformity with underdevelopment of the ilium. 9 patients were completely symptom-free, the other 9 had slight to moderate residual symptoms.

*Conclusions:* SI dislocations in children may lead to various growth disorders in the pelvis, resulting in fusion of the SI joints, underdevelopment of the ilium and pelvic asymmetry. However, most symptoms and sequelae in the longer run are caused by damage to the lumbosacral plexus.