Citieffe/CH-N Trochanteric Fixator

Surgical Technique

Indications – Contraindications

Advantages-Disadvantages-Limitations

N. Christodoulou, MD

Our long-term experience in hip fractures

Significance of endogenic factors in the location of fractures of the proximal femur

N. Christodoulou MD

Thesis- University of Athens, 1985

For ambulatory patient intertrochanteric fractures is severely disabling injury

For non-ambulatory patients with

↓mobilization => death is coming

The bed-bound patients are at ↑risk of complications

- *pneumonia*
- *Pressure sores*
- *Venous thrombosis*
- *Urinary infections*
- *dementia*

Indications for External Fixation

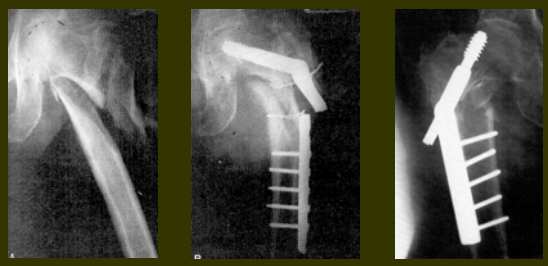
Poor general condition

(it is well known by the literature the complications from delaying the operation until the patient is well under control for open reduction)

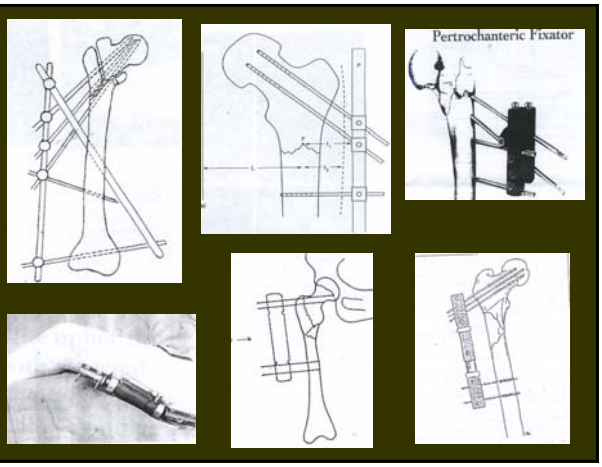
No blood available for transfusion normally required for open surgery (rare blood group)

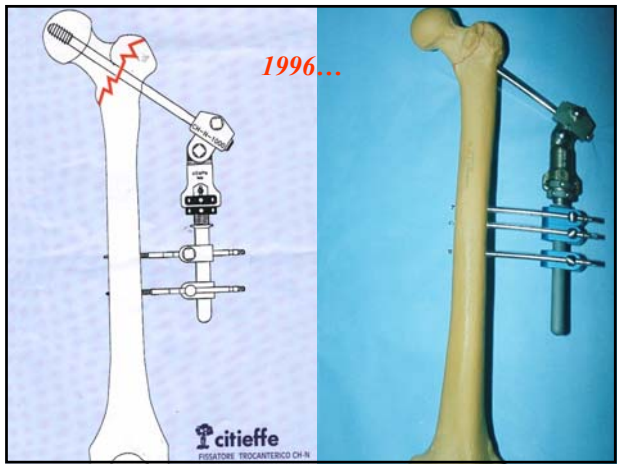
↑ Risk from anaesthesia => Denial of the anaesthetists for an open reduction with blood loss and long duration open surgery

Non ambulatory patients=>Extremely difficult nursing if the fracture is not stabilised by an external fixator



Reoperating patients in this age group for complications of internal fixation is something every surgeon would prefer to avoid



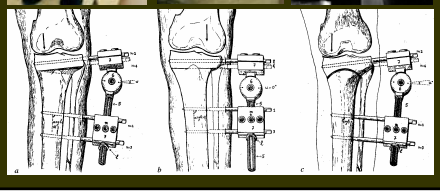


External Fixation of Intertrochanteric or Subtrochanteric Fractures (διεθνείς αναφορές)

- I. Scott –1954 (American Fracture Association)
- Y. Gotfried – 1985 (0rthopedics)
- A. Dhal-1991 (J.B.J.S.)
- JR. Burkley, SM.Caiach 1993 (Injury)
- JK. Barros-1995 (Int. Orhtop.)
- A. Dhal-1996 (Injury)
- D. Pukljak – 1997 (Unfallchirurg.)
- L. Badras, E. Sktetas, ED Vayanos-1997 (Rev Chir Ortop)
- N. Christodoulou, Chr. Sdrenias-2000 (clin Ortop.)
- M. Subasi et al-2001 (Acta Orthop Belg.)
- IC. Vossinakis, Badras LS-2001(Int Orthop.)

Previous External Fixators (CH-N) designed by Dr Christodoulou N.(Ch-N)

1991



1987

Relative literature (N. Christodoulou/CH-N)

The influence of intrinsic factors in the anatomical patern and location of fractures of the proximal femur
N.Christodoulou, Thesis-University of Athens-1985

Ostèosynthèse des ostéotomies tibiales de valgisation par fixateur externe "goniometric" CH-N
N.Christodoulou, Th. Moussas, C. Karaindros, C. Poyatzis, C. Vretos
Revue de Chirurgie Orthopédique, 1996, 82, 331-335

Bilateral non-contemporary fractures of the proximal femur
E. Dretakis, N. Kritsikis, K. Economou, N. Christodoulou
Acta Orthop. Scand. 1981, 52,227-229

Significance of endogenic factors in the location of fractures of the proximal femur
E. Dretakis, N. Christodoulou
Acta Orthop. Scand. 1983, 54, 198-203

Significance of muscular disturbances in the Localization of fractures of the proximal femur
N. Christodoulou, E. Dretakis
Clinical Orthopaedics and Related Research,1984,187,198-203

External Fixation of Select Intertrochanteric Fractures Wirth Single Hip Screw
N. Christodoulou, Ch. Sdrenias
Clinical Orthopaedics and Related Research, 2000,381,204-211

External Fixation Device with Changeable Angle for Trochanteric Fractures N. Christodoulou
European Patent-Int.Cl[6] A61B17/64

Biomechanical Limits of External Fixation in Pertrochanteric Fractures ***F.Giovetti, A.Dovesi, N.Christodoulou, Chr.Sdrenias, A.Perissinoto - 3rd Central European Orthopaedic Congress (EFORT), Portoroz,,Slovenia,6/2000***

I mezzi di sintesi del femore prossimale e la simulazione del loro compartamento duramte il passo ed altre attvita quodidiane. Fissatore Externo CH-N. Pr A.Perissinoto, C.I.O.D. (Italiano Dell Osteosinthesi Dinamica), Vol. 7-Fasc.3,1999

Fissazion esterna di fratture intertrochanteriche in pazienti ad alto rischio chirurgico, mediante vite femorale singola transcefalica
C. Sdrenias, N. Christodoulou, R. Tsiaknis, A. Mavrogenis, A. Sarakiotis
Aggiorn Club Ital Osteosint (2003) 9: 81-88, Springer-Verlag 2003

Biomechanical analysis of External Fixation CH-N for Trochanteric Fractures

Research and Development Division - Citieffe s.r.l.- Bologna

Biomechanic Unit, Venice

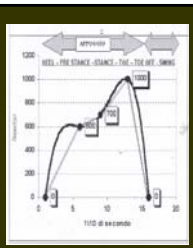
Biomedical School, University of Padua Italy

Med CaD(1) Program

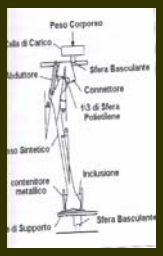
Surfaces/B-Spline generation

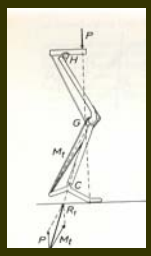
3Dimensional plans

(first used for testing Custom Made arthroplasties and then for new materials of internal or external fixation, like the external fixator for hip fractures Citieffe/CH-N)

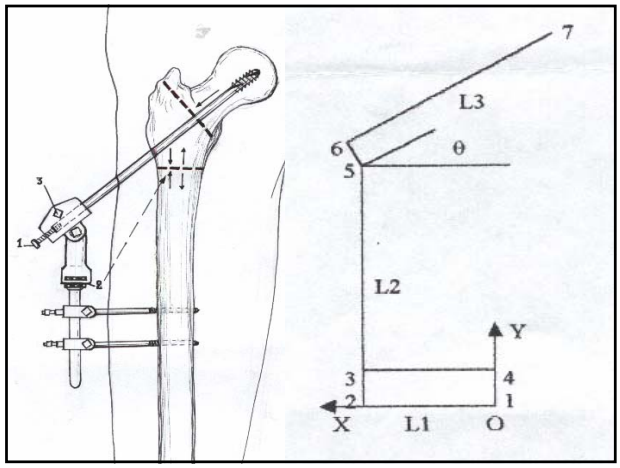


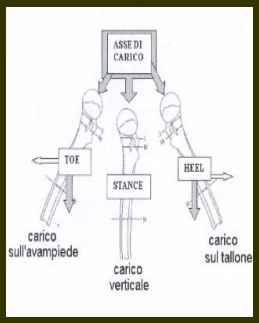
The mechanical combination: Bone-Osteosynthetic material, is subjected to forces that tend to produce varus deformity and anteversion or retroversion of the femoral neck,during walking

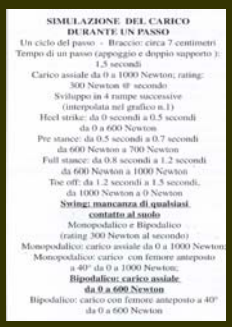




Planning and biomechanical testing of the device were based on models simulating the real walking procedure.







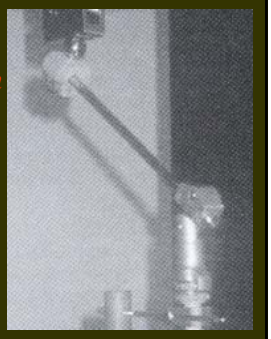
SIMULAZIONE DEL CARICO DURANTE UN PASSO

Un ciclo del passo - Braccio: circa 7 centimetri
Tempo di un passo (appoggio e doppio supporto): 1,5 secondi
Carico assiale da 0 a 1000 Newton; rating: 300 Newton @ secondo
Sviluppo in 4 rampe successive (interpolata nel grafico n.1)
Heel strike: da 0 secondi a 0,5 secondi da 0 a 600 Newton
Pre stance: da 0,5 secondi a 0,7 secondi da 600 Newton a 700 Newton
Full stance: da 0,8 secondi a 1,2 secondi da 600 Newton a 1000 Newton
Toe off: da 1,2 secondi a 1,5 secondi, da 1000 Newton a 0 Newton
Swing: mancanza di qualsiasi contatto al suolo
Monopodalico e Bipodalico (rating 300 Newton al secondo)
Monopodalico: carico assiale da 0 a 1000 Newton;
Monopodalico: carico con femore anteposto a 40° da 0 a 1000 Newton;
Bipodalico: carico assiale da 0 a 600 Newton
Bipodalico: carico con femore anteposto a 40° da 0 a 600 Newton

Cadaveral hips and Sawbones simulating both cortical and spongiosous regions of the bone under tension
The grade of bone movement within the models under tension, judjed the grade of stability of the osteosynthesis

Mathematical approach
(computer science)

Mechanical testing



The initial plan of the external fixation CH-N was put in MedCad in 2dimentions first and then
Incorporated in CT. and M.R.I. Hip Images studing bone-material bonding
The combination was then developed in 3dimentional imaging

Putting in data (softwares) simulating different clinical situations, definition of the forces acting on the model, under momentary tension and cyclic fatigue, was achieved (FEM technique)

Mechanical Testings completed by:
Mechanical Engineer-Biomechanics
Expert-Orthopaedic Surgeon

M.T.S.(Material Tests System) which produces cyclic stresses (1/10 sec period) was used

Scew nailing or pinning of the femoral head;

Screw Nailing

Technique less interventional with better stabilisation ability

Better resistance in forces producing varus deformity

Advantage of compression at the fracture site

Advantage of unlocking and gliding of the hip screw for dynamization

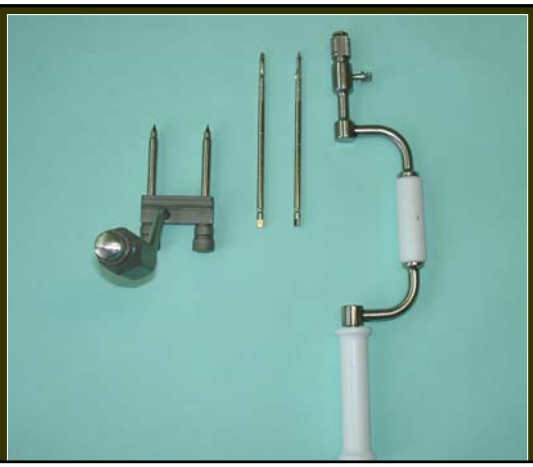
Conclusions of the biomechanical analysis

The CH-N external fixation, especialy in stable pertrochanteric fractures in which compression at the fracture site can be applied, is very close, in mechanical stability, to the internal fixation.

Like in internal fixation special attention should be given to avoiding early full weight bearing in cases of severe osteoporosis, communition of the medial cortex, and obesity

Advantages of the nail compared to the pins

- ***Reinforcement of the external fixation***
- ***Use of guide-pin for insertion***
- ***Less exposure to radiation for the surgeon compared to the systems that use pins***
- ***Advantage of postoperative easy correction of the system***
- ***Avoiding pinning of iliotibial band-tensor fascia lata on the greater trochander (more possible when using multiple pins)***



Cannulated Nails 20,22,24,26 cm.

Protective Sleeves

- *External sleeve for the drill-bit and the nail gauged for counting soft tissue depth.*
- *Internal sleeve-guide for the guide-pin*

The use of drill-bit and nail insertion

Surgical Technique

- *Closed fracture reduction*
- *Radiologic or Fluoroscopic checking of the reduction and insertion of the guide-pin*

Counting the length of the drill-bit and the hip screw

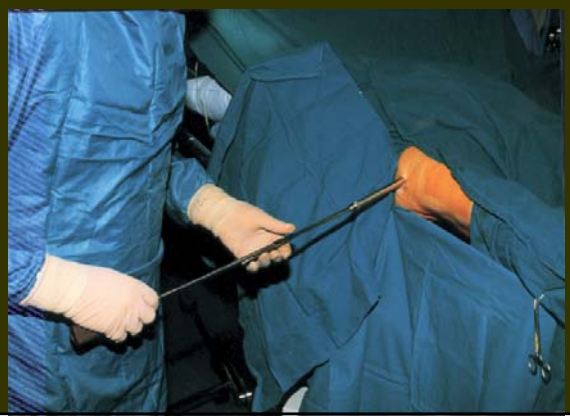
To measure the part of the guide-wire in the bone and consequently that of the drill, an external counter is used

To estimate the length of the hip screw, the depth of the soft tissue is added to the previous count plus 8-10 cm which is the length of the hip screw outer of the skin, greater in cases of valgus insertion

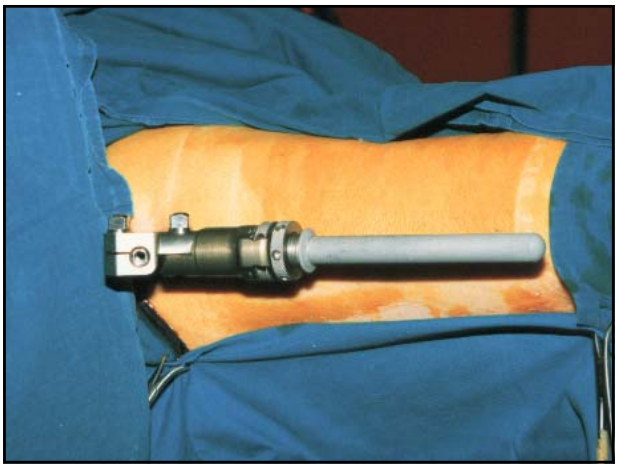
Drill-bit adjustment

Using the same screwdriver that we use for the hip screw insertion, we adjust a special stopper on the drill-bit choosing the drilling depth and the calculated hip screw

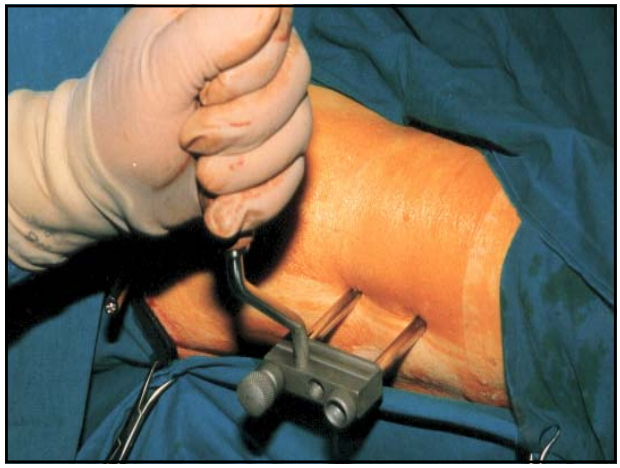
Hip Screw Insertion

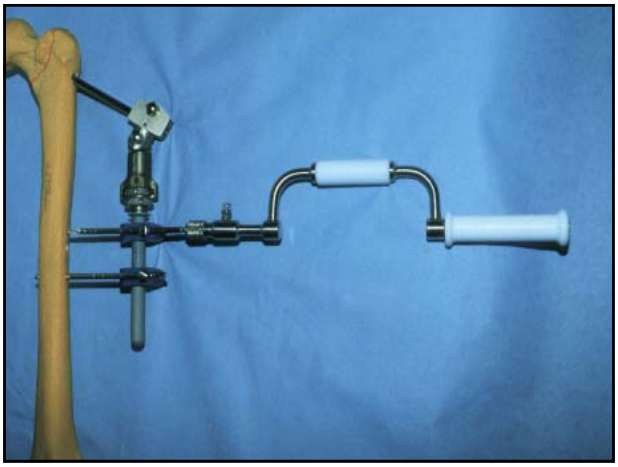


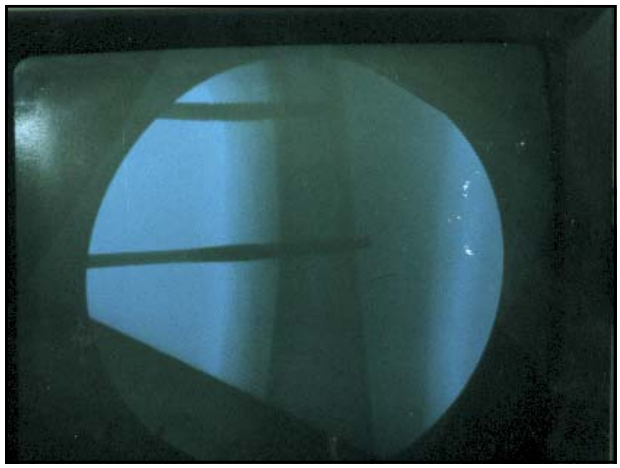
Radiographic or Fluoroscopic Control

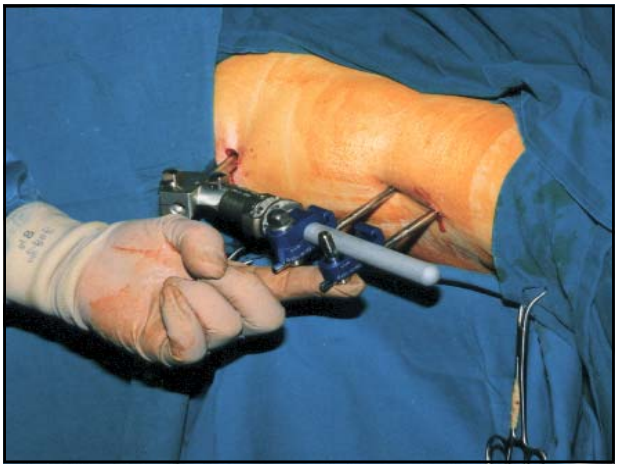


It is indicated to insert the pins in the femur trough the special sleeves, for soft tissue protection, and manually for feeling better the opposite cortex

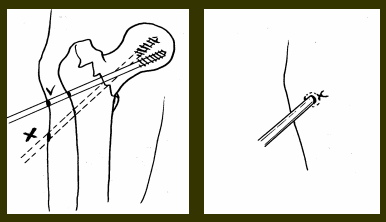








It is preferable to insert the hip screw closer to the greater trochanter => less skin damage when the hip is mobilised (flexion-extension)



In cases of larger opening of the skin it is indicated to use purse-like skin suturing around the hip screw with Nylon 1/0 or PDS.

At the end of the operation, with the patient still under anaesthesia, the knee is mobilised in order to achieve maximum early flexion of this joint, avoiding postoperative stiffness

The patient is tought and begins respiratory excercises as soon as he/she goes up on the ward and sits on a chair 24hrs postop. Supervised walking with support begins 2days postop, if the patient's general condition allows, partialy or fully weight-bearing, depending on the stability of each fracture pattern and the rigidity of each osteosynthesis

If the patient's aftercare can be guaranteed in the house or institution where he/she lived before, and if no complications arise, he/she returns there 3-5days postop

Indications for External Fixation of Pertrochanteric Fractures

- ***Patients in high risk, poor candidates for anaesthesia***
- ***Patients with rare blood group or for which no blood supplies can be procured***
- ***Patients of any age, with stable pertrochanteric fractures, for which proper pin care as out-patients can be guaranteed***
- ***Patients with unstable pertrochanteric or subtrochantetic fractures, for which strictly partially weight-bearing ambulation can be guaranteed, during the callus formation period***

Contraindications-Limitations

- ***Obesity (Body weight>80 Kg)***
- ***Proper pin and nail-care, as an out-patient, cannot be guaranteed (at least once a week using peroxide or Nacl 15% solution)***
- ***Patients with unstable fracture and severe osteoporosis (relative contraindication)***
- ***Incontinence (urine, fecal)***

Advantages

- ***Short operating and anaesthetic time***
- ***Less invasive operative technique***
- ***Single surgeon-no diathermy-no soft tissue suturing***
- ***Zero blood loss***
- ***Immediate operation (no need for waiting until the patient is well controled)***
- ***Short hospitalisation time***
- ***Advantage of postoperative correction of both reduction and compression***

Advantages of the CITIEFFE/CH-N external fixation

- *Correction of the femoral neck-diaphysial ankle intraoperatively and postoperatively*
- *Correction of possible nail insertion into the accetabulum*
- *Distraction (> 1,5 cm.)*
- *Compression*
  - ✓ *at the fracture site (along the axis of the femoral neck)*
  - ✓ *along the axis of femoral diaphysis*
- *Release of the nail permitting its sliding back for enhancing callus formation whenever during this procedure the surgeon judjes it is necessary*
- *Dynamization by axial compression (sping mechanism)*

Disadvantages

▶***Once a week or more often, in case of skin irritation around them, nail and pin care using peroxide or Nacl 15% solution or other*** *antiseptics non skin irritating*

(In cases of superficial infection with pus, removal of the device is recommended. Cure is almost immediate due to excellent perfusion of the region. Suturing of the remaining wound is not recommended. Antiseptic cleaning and dressing soaked in Nacl 15% solution is indicated as also antibiotics for a few days)

Device Removal

Simple, in out-patient's Clinic, under I.M. analgesia

Weekly or more frequently usage of antiseptic biopathes with chlorhexidine gluconate or Nitric Ag or gentamycin ?

1996-2002

72 patients

51 females

21 males

AGE

60-102 Yrs

(Mean 84 Yrs)

All patients had comprimised general physical condition and at least one or more of the following: Diabetes melitus, Heart failure, Renal failure, Cronic Respiratory insufficiency or Stroke

HIP FRACTURES

73

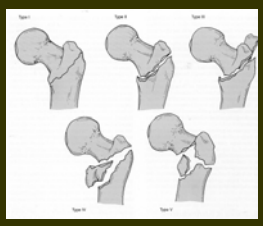
51 Stable 13 Unstable

9 Subtrochanteric

Evans-Jensen Classification

I and II: Stable

II,III, IV: Unstable



-Mean surgical time : 30΄

-Regional Anaesthesia

-Zero blood loss (Transfusion of 1-2 units in only 7 patients with pre-existing anaemia)

-Compression was applied in 50 patients, intraoperatively

-Dynamization - the nail free to slide backwards - 2 months postop was necessary in 7 patients

-Correction of varus deformity at the femoral neck-diaphysis ankle postop was necessary in 4 patients who assumed fully weight-bearing walking earlier than scheduled

(in 2 patients the varus deformity corrected was over 10°)

In 1 patient the nail had to be unscrewed back from the acetabulum, as soon as the postoperative radiographic control revealed the error

-Distraction-elongation was performed intraoperatively in 3 patients with subtrochanteric fractures

-Mean hospitalisation 6 days (3-12 days)

-20 patients were then transferred to a welfare institution

-Mean time needed for consolidation 10,6 weeks (8-13 weeks)

-Consolidation in all patients

(except one case of early removal of the fixaror)

COMPPLICATIONS

***14 Patients (19,4%) died up to 6 months postop**, 2 during hospitalisation*

***19 patients (26,4%) developed local skin irritation** around the pins or the nail that subsided as soon as the device was removed*

Reoperations in three cases

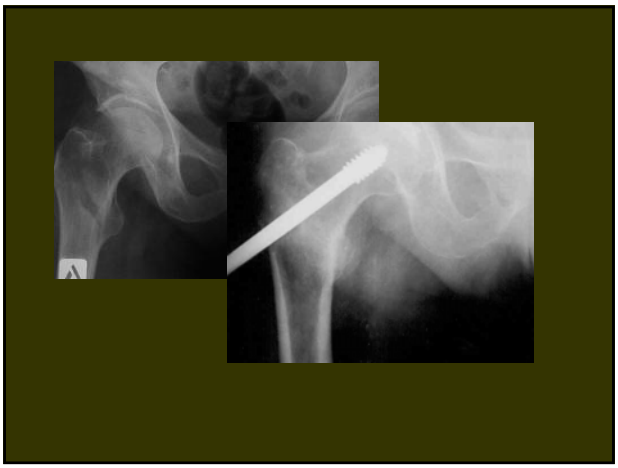
(for infection cased by urine incontinence and inadequate cleaning around the nail and for the case of early removal of the fixator)

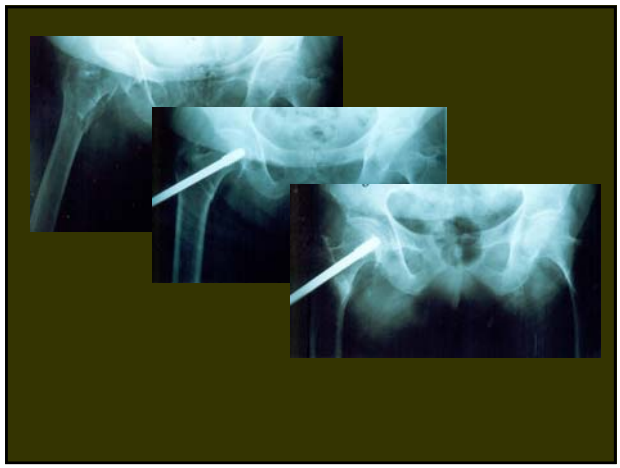
Complications

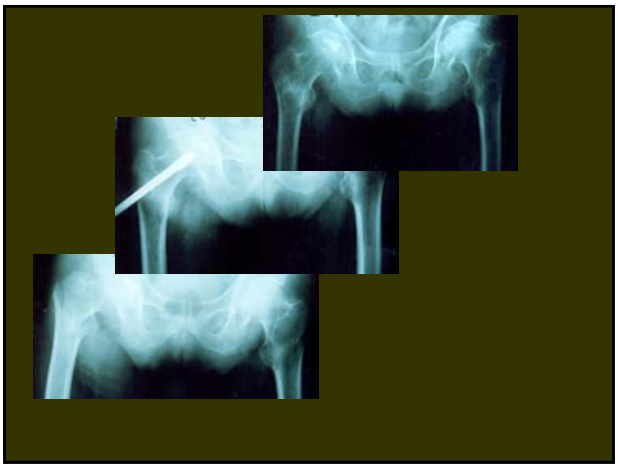
2 patients (2,7%) developed osteitis

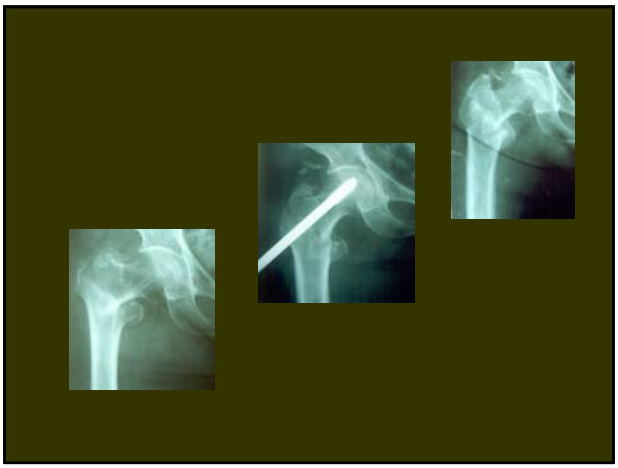
of the outer cortex that subsided after the device removal and meticulous debridement in combination with antimicrobial treatment according to the culture results

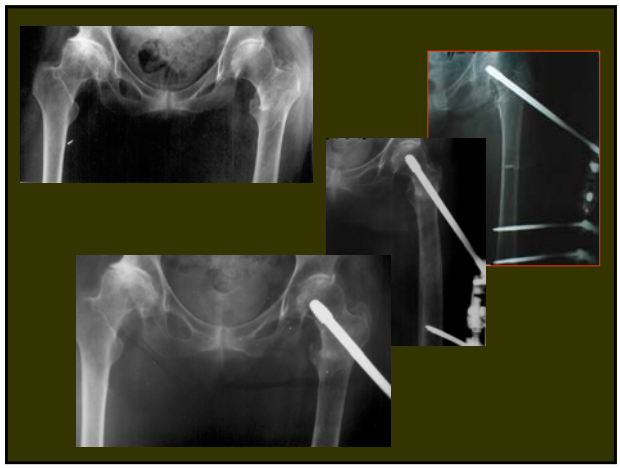
***Varus deformity more than10°** remained after consolidation in **4 patients** with **subtrochanteric** fracture without functional problems*

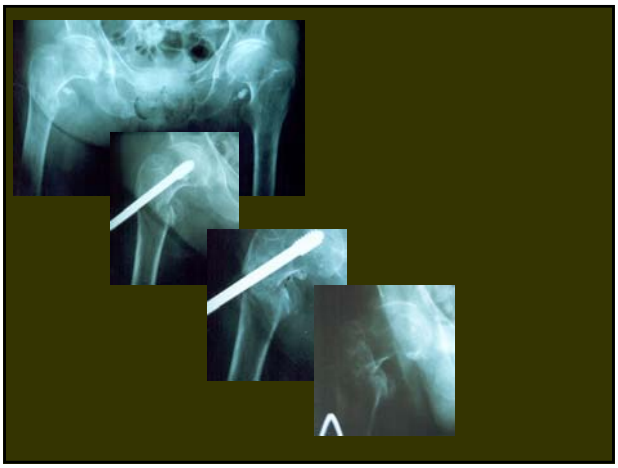


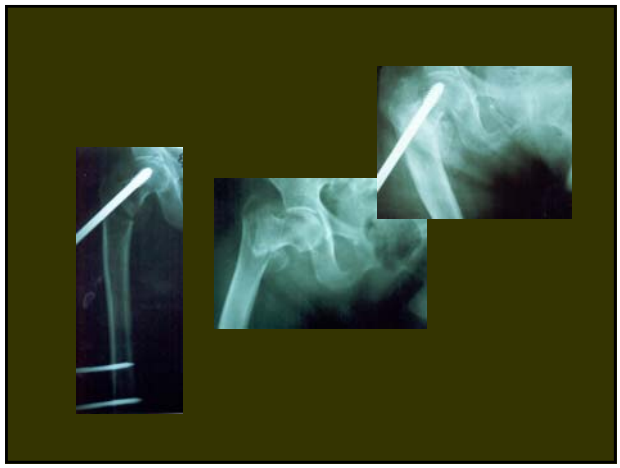


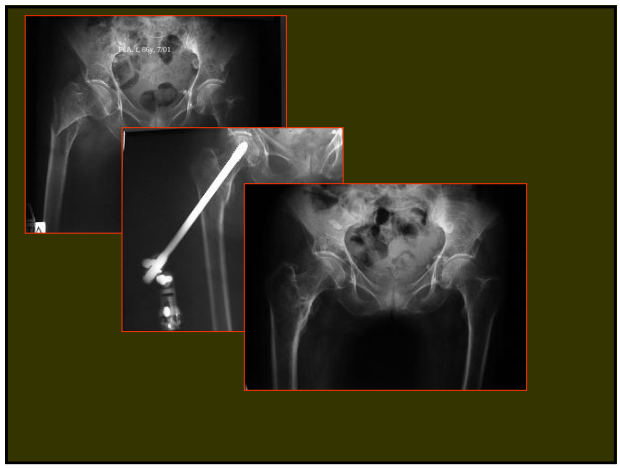


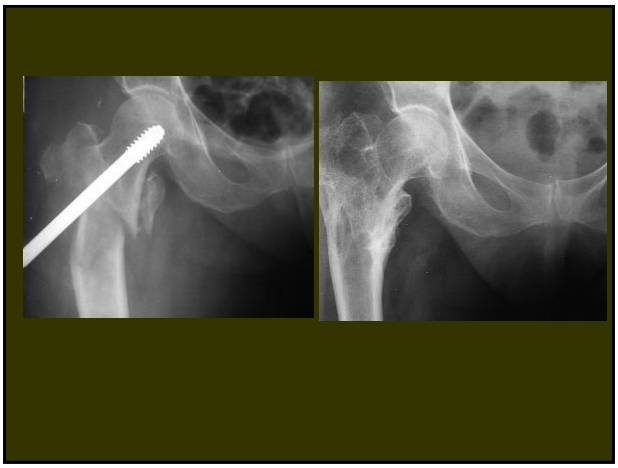


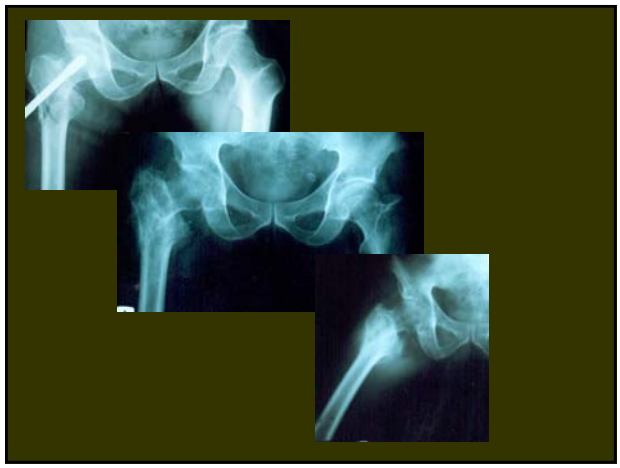


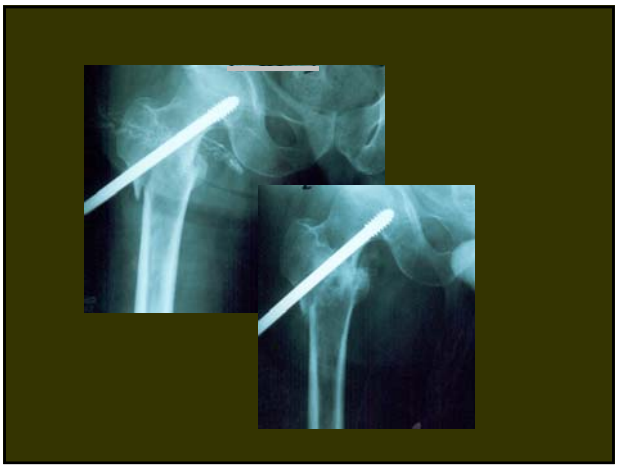


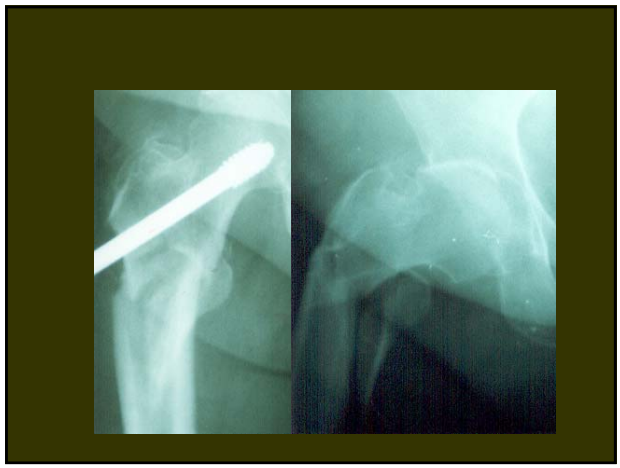


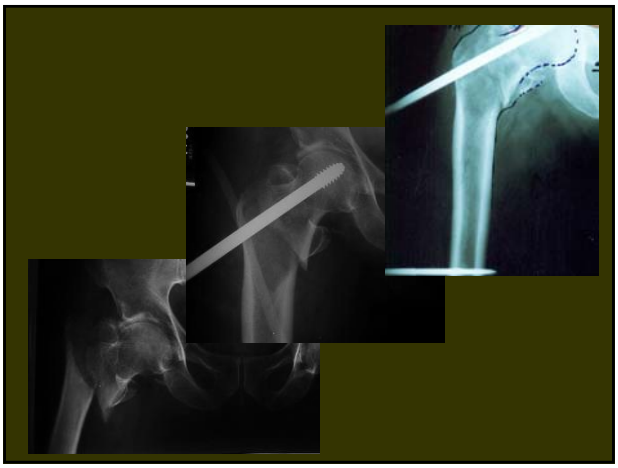












No mechanical failure of the device even when it was used beyond indications!

CONCLUSIONS

Citieffe/CH-N Trochanteric Fixator:

Short operating time

No blood loss

Short hospitalisation time

Advantage of postoperative correction of any varus deformity or penetration of the nail into the hip joint as in osteoporotic patients