Femoral Shortening

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Closed Femoral Shortening: History

Initial Description

1869: Francesco Rizzoli
Two cases for post-traumatic LLD
Osteoclast used for osteotomy
Shortening & overriding femoral shaft
No internal fixation
Femoral Shortening: History

Transverse  Oblique
Reported Techniques for Femoral Fixation

1. Cast

2. Tenon & Mortise (+ cast) - Calvé

3. Internal Fixation
   - 1907: Deutschlander: plate & screws
   - 1917: Shands: wire sutures
   - 1918: Fassett: Lane plate
   - 1923: Royle: intramedullary pegs
   - 1935: White: pins & plaster
Closed Intramedullary Osteotomy

Intramedullary Saw

- 1962: Küntscher IM saw
- 1973: Winquist & Hansen

Fixation: Reamed IMN

Küntscher IM saw
Closed Femoral Shortening: Indications

**Indications**

Skeletal maturity
LLD = 2 to 6 cm

**Potential advantages vs leg lengthening**

- Shorter hospitalization
- Faster mobilization
- Decreased risk of joint stiffness
- Faster healing
Closed Femoral Shortening: Winquist Technique

**Position**
Lateral on traction table

**Surgical Steps**

A: Ream

B & C: Osteotomy with IM saw

D: Split osteotomized fragment

E: Manipulate & shorten femur

F: Insert IMN

G: Interlocking screws if shortened ≥4cm

Winquist et al (1978)
Closed Femoral Shortening: Review of Literature

Available Literature

Most articles published > 20 years ago 1,2,3,5,6

Position:
Supine or lateral
Traction table

Osteotomy location:
Mid-diaphyseal

Implant: reamed IMN
Most done without interlocking screws

Closed Femoral Shortening: Review of Literature

223 patients in 4 studies

• Union rate 97.5 - 100%

Most common complications:

• Rotational malunion
• ARDS
• Distraction at osteotomy site
• Delayed union
# Closed Femoral Shortening: Review of Literature

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>N</th>
<th>Amount Shortened (cm)</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapman et al</td>
<td>1991</td>
<td>31</td>
<td>not stated</td>
<td>unplanned residual LLD (2) delayed union (1)</td>
</tr>
<tr>
<td>Blair et al</td>
<td>1989</td>
<td>20</td>
<td>3.4 (2 - 5)</td>
<td>Malrotation (2 of 15 patients reexamined)</td>
</tr>
<tr>
<td>Winquist</td>
<td>1985</td>
<td>154</td>
<td>3.7 (2 - 7)</td>
<td>wound infection (1) nonunion (1) delayed union (1) malrotation &gt; 20° (3)</td>
</tr>
<tr>
<td>Sasso et al</td>
<td>1993</td>
<td>18</td>
<td>4.4 (3 - 5)</td>
<td>ARDS (1) malrotation (2) distracted osteotomy site (1)</td>
</tr>
</tbody>
</table>
“Long-term *loss* of muscle force should be expected after a *mid-shaft* shortening of the femur of more than *10%*”  *Holm et al 1994*

“after two years the quadriceps and hamstrings had *recovered* to within 93% and 96% of their preoperative values respectively, a change that was *not statistically significant*”  *Barker et al 2004*
<table>
<thead>
<tr>
<th>Winquist Technique</th>
<th>Modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Position</strong>: Lateral, traction table</td>
<td><strong>Position</strong>: supine, leg free</td>
</tr>
<tr>
<td><strong>Surgical Steps</strong></td>
<td><strong>Surgical Steps</strong></td>
</tr>
<tr>
<td>A : Ream</td>
<td>A. Identify osteotomy site</td>
</tr>
<tr>
<td>B &amp; C : Osteotomy with IM saw</td>
<td>B. Elevate periosteum</td>
</tr>
<tr>
<td>D : Split osteotomized fragment</td>
<td>C. Multiple drill holes</td>
</tr>
<tr>
<td>E : Manipulate &amp; shorten femur: manually with 2nd unscrubbed surgeon</td>
<td>D. Ream</td>
</tr>
<tr>
<td>F : Insert IMN</td>
<td>E. Ex-fix</td>
</tr>
<tr>
<td>G : Interlocking screws if shortening ≥ 4cm</td>
<td>Osteotomy : IM saw + osteotome</td>
</tr>
<tr>
<td></td>
<td>Split osteotomized fragments</td>
</tr>
<tr>
<td></td>
<td>Shorten &amp; reduce femur : ex-fix pins / osteotome</td>
</tr>
<tr>
<td></td>
<td>Control reduction alignment / rotation with ex-fix</td>
</tr>
<tr>
<td></td>
<td>Insert IMN</td>
</tr>
<tr>
<td></td>
<td>Interlocking screws all cases</td>
</tr>
<tr>
<td></td>
<td>Remove ex-fix</td>
</tr>
</tbody>
</table>
**Technique Modification: Multiple Drill Holes**

**Surgical Steps**

- **Identify osteotomy site**
- **Elevate periosteum**
- **Multiple drill holes**
- **Ream**
  - Ex-fix
  - Osteotomy: IM saw + osteotome
    - Split osteotomized fragments
    - Shorten & reduce femur: ex-fix pins / osteotome
  - Control reduction alignment / rotation with ex-fix
- **IMN**
- **Interlocking screws**
- **Remove ex-fix**

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Technique Modifications: Fixator Assisted Nailing

Surgical Steps

- Identify osteotomy site
- Elevate periosteum
- Multiple drill holes
- Ream
- **Ex-fix**
  - Osteotomy: IM saw + osteotome
  - Split osteotomized fragments
  - Shorten & reduce femur: ex-fix pins / osteotome
  - Control reduction alignment / rotation with ex-fix
  - IMN
  - Interlocking screws
  - Remove ex-fix

Proximal pin

Distal pin
Technique Modifications: Ex-fix

Ex-fix pins prior to osteotomy

1st pin: lesser trochanter

2nd pin: distal femur
**Technique Modifications: Percutaneous Osteotome**

**Surgical Steps**
- Identify osteotomy site
- Elevate periosteum
- Multiple drill holes
- Ream
- Ex-fix

**Osteotomy**: IM saw + osteotome
- Split osteotomized fragments
- Shorten & reduce femur: ex-fix pins / osteotome
- Control reduction alignment / rotation with ex-fix
- IMN
- Interlocking screws
- Remove ex-fix
Closed Femoral Shortening: Surgical Technique

Surgical Steps

Identify osteotomy site
Elevate periosteum
Multiple drill holes
Ream
Ex-fix
Osteotomy: IM saw + osteotome

Split osteotomized fragments

Shorten & reduce femur: ex-fix pins / osteotome
Control reduction alignment / rotation with ex-fix
IMN
Interlocking screws
Remove ex-fix
**Technique Modifications : Ex-fix**

**Surgical Steps**

- Identify osteotomy site
- Elevate periosteum
- Multiple drill holes
- Ream
- Ex-fix
- Osteotomy : IM saw + osteotome
  - Split osteotomized fragments
- **Shorten & reduce femur : ex-fix pins / osteotome**
- Control reduction alignment / rotation with ex-fix
- **IMN**
  - Interlocking screws
  - Remove ex-fix

**Diagram**

- Femur reduced acutely
- Temporary external fixation applied
- Antegrade nail inserted

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Closed Femoral Shortening: Surgical Technique

**Surgical Steps**

- Identify osteotomy site
- Elevate periosteum
- Multiple drill holes
- Ream
- Ex-fix
- Osteotomy: IM saw + osteotome
- Split osteotomized fragments
- Shorten & reduce femur: ex-fix pins / osteotome
- Control reduction alignment / rotation with ex-fix
- IMN

**Interlocking screws**

**Remove ex-fix**
Surgical Modifications: Rationale

- Interlocking screws
  - Control rotation
  - Prevent distraction at osteotomy

- Percutaneous Osteotome
  - Less manual manipulation of leg
  - Less risk of DVT
Case Example 1

• 16 y/o M
• h/o neonatal sepsis
• previous L hip surgery for coxa vara @ age 13
• 2.5 cm LLD
Case Example 1
20 y/o F

Left CFD / fibular hemimelia

h/o multiple lengthening procedures, including ISKD

LLD 6.5cm radiographically (4cm functionally)
Case Example 2

Pre-op

Post-op
Case Example 3

21 y/o M with 3 cm LLD, h/o Perthes L hip

Preop

Immediate post-op

Post-op healed
Multiple drill hole osteotomy performed at site of distal osteotomy.
Multiple drill hole osteotomy performed at site of distal osteotomy

Beaded guidewire inserted
Femur overreamed 2 mm greater than diameter of nail to be inserted

Reamings exit at distal osteotomy site
c. Femur overreamed 2 mm greater than diameter of nail to be inserted

d. External fixator pins inserted

Reamings exit at distal osteotomy site
Intramedullary saw used to perform bone cuts
Intramedullary saw used to perform bone cuts
i. Proximal multiple drill hole osteotomy performed
j. Osteotome twisted 90° to complete distal osteotomy

k. Osteotome twisted 90° to complete proximal osteotomy
1. Back-cutting chisel used to split intercalary segment twice
Back-cutting chisel used to split intercalary segment twice.

Femur reduced acutely.
n. Temporary external fixation applied

o. Antegrade nail inserted
Nail locked proximally

Nail locked distally
p. Nail locked proximally

Nail locked distally

q. External fixator removed
Position: supine, free leg

**Surgical Steps**
- Identify osteotomy site
- Elevate periosteum
- Multiple drill holes
- Ream
- Ex-fix
- Osteotomy: IM saw + osteotome
- Split osteotomized fragments
- Shorten & reduce femur: ex-fix pins / osteotome
- Control reduction alignment / rotation with ex-fix
- Insert IMN
- Interlocking screws all cases
- Remove ex-fix
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