Femoral tunnel positioning & widening after MPFL R

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Femoral insertion: 15.4 mm

- MCL – adductor tubercle
  (Tuxoe et al., Conlan et al.)
- Anterior / MCL
  (Feller et al.)
- 9.5 mm proximal § 5 mm posterior
  (Nomura et al.)

Isometry § Graft positioning
Which consequence?

Proximal
- graft tension (0 - 60° flexion)
- medial FP pressure
- chondral lesions

Proximal and anterior
- graft tension (from 90° flexion)
- Flexion pain

Distal
- graft tension
- Non-functional graft

Isometry § Graft positioning
Which consequence?

Influence of positioning in the frontal plane +++
Is it only a biomechanical theory?

Need an in vivo study
Materials and methods

• X-rays
  – Method of Schöttle et al.
  – Method of squares

• CT-scan

• MRI
  – Same centre
  – Same radiologist
  – Same protocol
Materials and methods

Patellar height

Trochlear dysplasia

TT-TG Distance
Patellar tilt
Materials and methods

• X-rays (P)
  – Method of Schöttle et al.
    • 11 cadaver knees
    • Femoral insertion of the MPFL

Materials and methods

- **X-rays (P)**
  - Method of Schöttle et al.
    - Femoral tunnel diameter 7mm
    - Correct positioning +/- 7mm
Materials and methods

• X-rays (P)
  – Method of the squares

- D4-D5-E4-E5: Anatomical
- <4: Posterior
- >5: Anterior
- <D: Distal
- >E: Proximal
Materials and methods

- MRI: tunnel femoral sagittal plane

  - Distance tunnel/posterior condyle
    - 20 to 30 mm: Good positioning
    - <20 mm: Posterior tunnel
    - >30 mm: Anterior tunnel
Materials and methods

- MRI: femoral tunnel
  - Frontal plane

  - Distance tunnel / joint line
    - 25 to 35 mm
      - Good positioning
    - <25 mm
      - Distal tunnel
    - >35 mm
      - Proximal Tunnel
Results

35 knees (32 patients)
June 2005 – June 2007

22 isolated MPFL
13 MPFL

2 knees (2 patients) lost of FU at 6 months

3 knees (2 patients) contacted by phone at 1 y
IDKC + Kujala score

n=30 knees (28 patients)
Complete data
Minimum FU: 24 months

n=20 isolated MPFL
n=10 MPFL+ other procedure

n=29 MRI
n=29 CT-Scan

follow-up 31 months (24-42)
## Results

<table>
<thead>
<tr>
<th></th>
<th><strong>Series</strong> (n=30)</th>
<th></th>
<th><strong>« isolated MPFL »</strong> (n=20)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preop</td>
<td>Last FU</td>
<td>p</td>
<td>Preop</td>
</tr>
<tr>
<td>Subjectif IKDC score</td>
<td>52.7 ± 7.7 (40-76)</td>
<td>79 ± 15 (52-100)</td>
<td>&lt;0.05</td>
<td>53.8 ± 9 (39-76)</td>
</tr>
</tbody>
</table>

### ACTIVITIES (n=20)

<table>
<thead>
<tr>
<th></th>
<th>Not difficult</th>
<th>Minimally Difficult</th>
<th>Difficult</th>
<th>Very difficult</th>
<th>Impossible</th>
</tr>
</thead>
<tbody>
<tr>
<td>squat</td>
<td>70%</td>
<td>20%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>n=14</td>
<td>n=4</td>
<td>n=2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kneel</td>
<td>70%</td>
<td>20%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>n=14</td>
<td>n=4</td>
<td>n=2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Results

<table>
<thead>
<tr>
<th>Correct Positioning</th>
<th>Schöttle’s Method</th>
<th>«Squares» method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct Positioning</td>
<td>70% (n=21)</td>
<td>70% (n=21)</td>
</tr>
<tr>
<td>Proximal</td>
<td>17% (n=5)</td>
<td>17% (n=5)</td>
</tr>
<tr>
<td>Anterior</td>
<td>10% (n=3)</td>
<td>10% (n=3)</td>
</tr>
<tr>
<td>Proximal § Anterior</td>
<td>3% (n=1)</td>
<td>3% (n=1)</td>
</tr>
<tr>
<td>Distal</td>
<td>0% (n=0)</td>
<td>0% (n=0)</td>
</tr>
<tr>
<td>Posterior</td>
<td>0% (n=0)</td>
<td>0% (n=0)</td>
</tr>
</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th>Tunnel</th>
<th>MRI</th>
<th>«Squares» Method</th>
<th>Schöttle’s Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct positioning</td>
<td>65% (n=19)</td>
<td>69% (n=21)</td>
<td>69% (n=21)</td>
</tr>
<tr>
<td>proximal</td>
<td>17% (n=5)</td>
<td>17% (n=5)</td>
<td>17% (n=5)</td>
</tr>
<tr>
<td>anterior</td>
<td>11% (n=3)</td>
<td>11% (n=3)</td>
<td>11% (n=3)</td>
</tr>
<tr>
<td>anterior § proximal</td>
<td>7% (n=2)</td>
<td>3% (n=1)</td>
<td>3% (n=1)</td>
</tr>
<tr>
<td>distal</td>
<td>0% (n=0)</td>
<td>0% (n=0)</td>
<td>0% (n=0)</td>
</tr>
<tr>
<td>posterior</td>
<td>0% (n=0)</td>
<td>0% (n=0)</td>
<td>0% (n=0)</td>
</tr>
</tbody>
</table>

**30 ± 6 mm (25-51)**

**27 ± 3.6 mm (20-38)**
## Tunnel positioning Consequences?

<table>
<thead>
<tr>
<th></th>
<th>IKDC score</th>
<th>Knee flexion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Series</strong></td>
<td>79</td>
<td>140°</td>
</tr>
<tr>
<td></td>
<td>(range, 52-100; SD 15)</td>
<td>(range, 135-160; SD 5)</td>
</tr>
<tr>
<td><strong>Optimal tunnel placement</strong> (n= 19)</td>
<td>79</td>
<td>140°</td>
</tr>
<tr>
<td></td>
<td>(range, 57-98; SD 15)</td>
<td>(range, 140-160; SD 5)</td>
</tr>
<tr>
<td><strong>Non-optimal tunnel placement</strong> (n=10)</td>
<td>81</td>
<td>140°</td>
</tr>
<tr>
<td></td>
<td>(range, 52-100; SD 15)</td>
<td>(range, 135-160; SD 5)</td>
</tr>
<tr>
<td><strong>p</strong></td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>
Clinical Outcome are very encouraging ....

.... for any tunnel position .....
Consequences?

Femoral tunnel widening

- 2005 - 2010: 55 patients (n=59)
- 37 Female, 14 Male (Sex ratio: 2.6/1)
- 39 isolated MPFL (+ 16 with ATT transfer)
- Exclusion criteria:
  - Recurrent surgery
  - Neuro
  - Associated procedure (except ATT)
POST OPERATIVE ANALYSIS

- Minimum follow-up: 2y
- IKDC subjective score
- Lateral X-ray: vertical et horizontal tunnel measurement
POST OPERATIVE ANALYSIS

- Measures: 2 independent observers, compared

- Tunnel area calculation → 2 groups:
  - Area < 2 X theoretical area = Normal group
  - Area > 2 X theoretical area = Widened group
RESULTS

- Mean IKDC:
  - Pre operative: 56
  - Post operative: 76

- Patellar dislocation: 0

- Normal tunnels: n=32 (58%)
- Widened tunnels: n=23 (42%)
**RESULTS**

- **Caton-Deschamps Index:**

<table>
<thead>
<tr>
<th></th>
<th>Normal Group</th>
<th>Widened Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1.2</td>
<td>72 %</td>
<td>48 %</td>
</tr>
<tr>
<td>≥1.2</td>
<td>28 %</td>
<td>52 %</td>
</tr>
</tbody>
</table>

\[ p = 0.03 \]

More patella alta in widened group

\[ N=55 \]
RESULTS

Femoral Tunnel Positioning

<table>
<thead>
<tr>
<th></th>
<th>Normal Group</th>
<th>Widened Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal</td>
<td>66%</td>
<td>56%</td>
</tr>
<tr>
<td>Non Optimal</td>
<td>34%</td>
<td>44%</td>
</tr>
</tbody>
</table>

p=0.05

More malpositioned tunnel in widened group

N=55
RESULTS

- Subjective IKDC score:

  76 in BOTH groups

  \( p=0.43 \)
RESULTS

- Subgroup analysis:
  - Isolated MPFL vs MPFL + ATT
  - Trochlear Dysplasia

(p=0.87)
DISCUSSION

TUNNEL WIDENING IN MPFL-R:

- **Patella alta** &/or **femoral tunnel malpositioning** are two statistically significant factors

- Mechanical reason:
  - overtight graft? (Thaunat & Erasmus, Knee 2007, KSSTA 2009)
  - excessive anisometry?
DISCUSSION

TUNNEL WIDENING IN ACL-R:

- **Biological theory:**
  - PLLA-screw reducing bone tunnel widening 
    *(Robinson, Knee 2006)*
  - Hypertrophy and high stiffness of the graft in tunnel widening 
    *(Neddermann, AJSM 2009)*
DISCUSSION

- **Mechanical theory (ACL-R):**
  - Early motion increasing the amount of tibial tunnel widening (*Hantes, Arthroscopy 2004*)
  - Acute femoral tunnel angle and malpositionning increasing tunnel widening (*Segawa, KSSTA 2001; XU, Arthroscopy 2011*)
DISCUSSION

- **Weakness of the study**
  - 2 y minimal FU
  - No consensus for tunnel widening sizing

- X-Ray vs CT-scan / MRI

  (Webster, AJSM 2005 et Fules, Knee 2003)
CONCLUSION

- Preventing widening by
  - Optimal femoral tunnel positionning: fluoroscopy
  - ATT distalization when needed

- No role of trochlea dysplasia

Thank you
Knee Technique Guide

MPFL reconstruction with autologous gracilis tendon using the two bone tunnel technique

Prof. Elvire Servien, MD, PhD