

Hospitaux de Lyon  
UNIVERSITÉ LYON 1  
Interactive Knee Surgery Edition  
www.primapictures.com



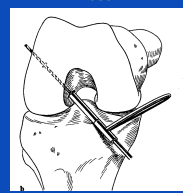
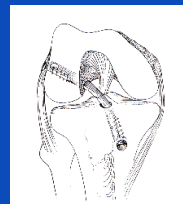
## My intraarticular landmarks


 E Kaya Bicer  
 E Servien  
 S Lustig  
 G Demey

Ph Neyret  
 University of Lyon  


Werner Müller  
**The Knee**  
Form, Function, and Ligament Reconstruction  
1983

**THE CRUCIAL LIGAMENTS**  
Ligament Reconstruction  
Edited by John A. Feagin, Jr.  
1988

9 o'clock

Anterior Cruciate Ligament Insertions on the Tibia and Femur and Their Relationships to Critical Bony Landmarks Using High-Resolution Volume Rendering Computed Tomography  
ML Purnell, AI Larson, W Clancy  
AJSM, 2008, 36,11: 2083-2090


Current Knowledge in the Anatomy of the Human Anterior Cruciate Ligament  
E Kaya Bicer, S Lustig, E Servien, T Aitsiselmi, P Neyret  
Accepted in KSSTA to be published

2

Blue slides were given by W. Clancy

**The Anatomic ACL Insertions as Defined by High Speed CT and Soft Tissue Subtraction**


Mark L. Purnell, M.D.,  
Andrew I. Larson, B.S. M.E.,  
William G. Clancy, M.D.  
Orthopaedic Associates of Aspen and Glenwood Springs



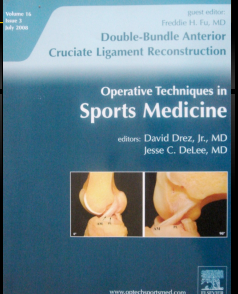
Today....

**'Double bundle concept'**  
mostly accepted

But it might be an oversimplification of a complex organization



Double-Bundle Anterior Cruciate Ligament Reconstruction  
FH Fu  
Operative Techniques in Sports Medicine  
July 2008 Vol 16, 3

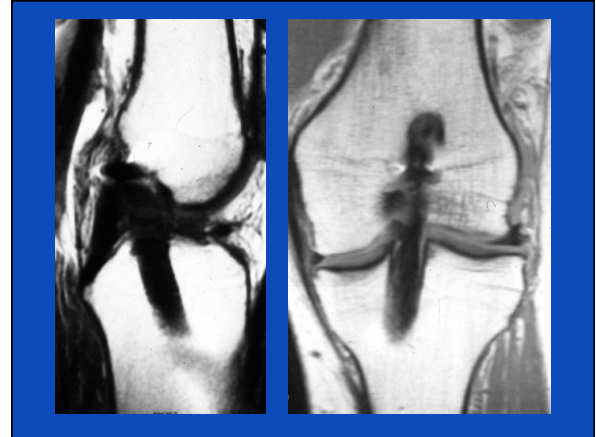


www.orthopaediatrics.com

# SIGNIFICANT CONFUSION

Traditional tibial endoscopic technique produces a vertical cruciate ligament

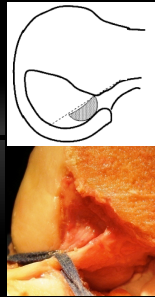
Roof of femur Posterior on the tibia



## Femoral Insertion Site

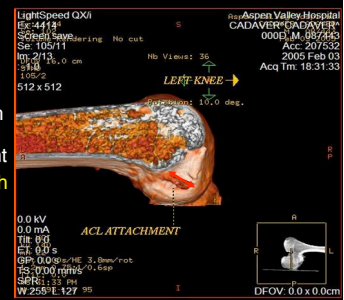
Described as

- ✓ **Segment of a circle** by Girgis (CORR; 1975) (straight anteriorly, convex post side)
- ✓ **Oval** by Odensten & Gillquist (JBJS; 1985)



## Femoral Insertion Site

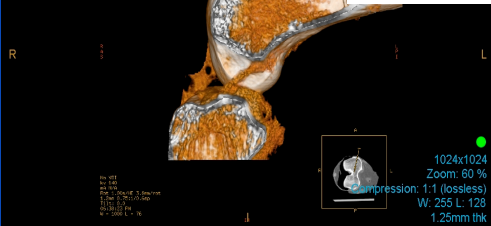
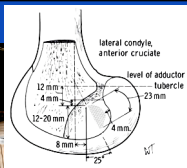
- ✓ **Residents' ridge** (Lateral intercondylar ridge) is a thick bony landmark running from prox to distal through the entire ACL footprint
- ✓ **No fibers of ACL attach anterior to this ridge**



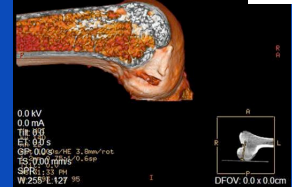
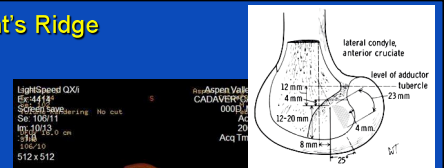
Courtesy of Clancy WG et al

## CT ACL Anatomy Study

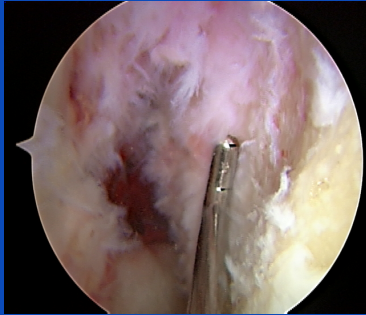
Screen save  
Se: Mar 21, 2006 6:19:43 AM  
Se: CT #309  
Im: 7/16



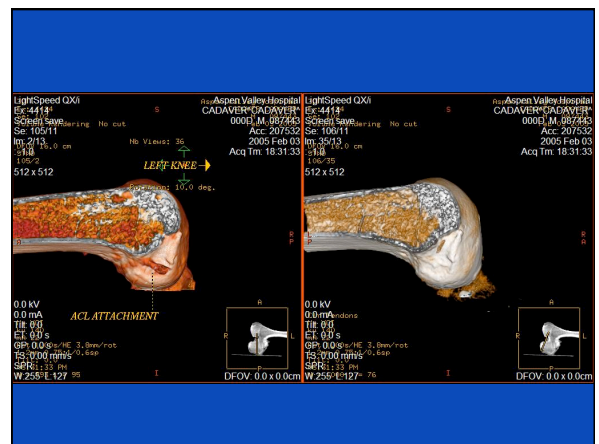
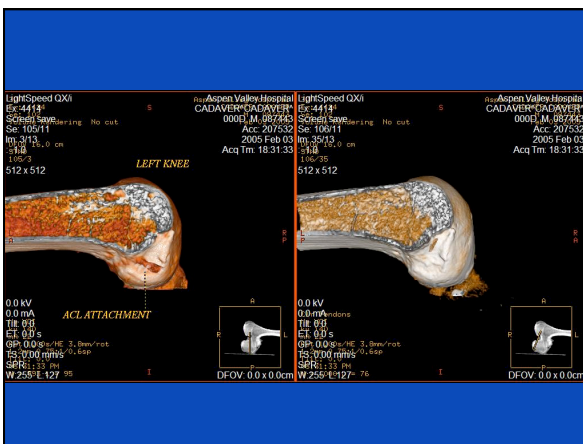
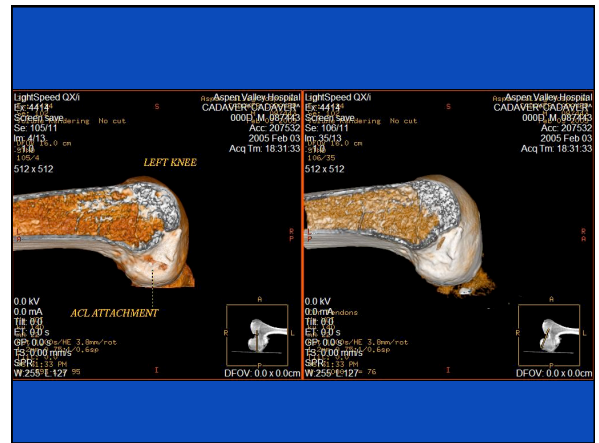
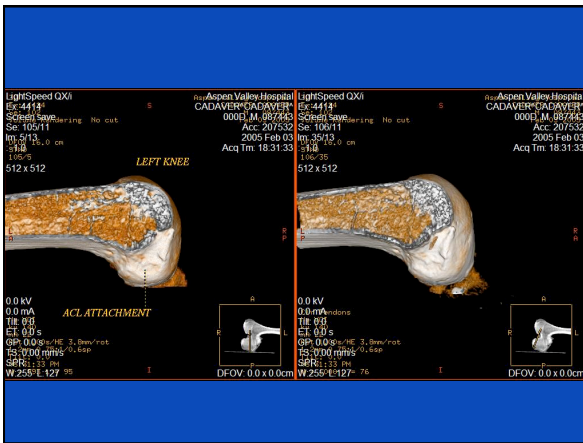
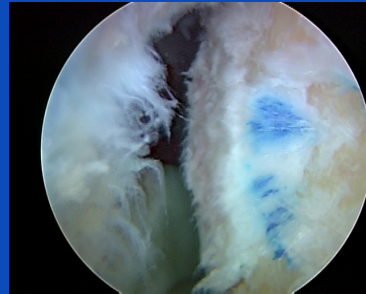
## Residents' Ridge



# Resident's Ridge

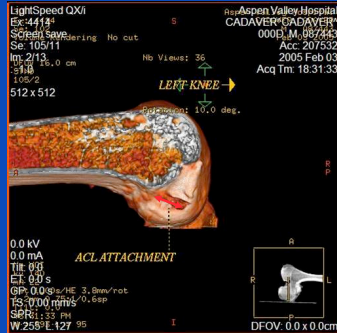


# Resident's Ridge



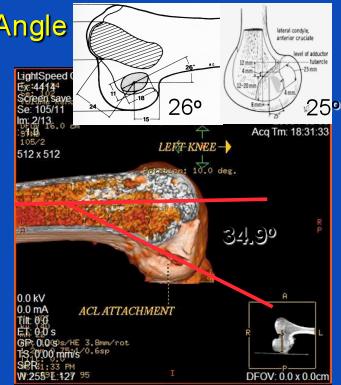
## Ridge Length 15.5 mm (SD 1.5mm)

- 1) 18.4
- 2) 15.6
- 3) 13.7
- 4) 14.6
- 5) 15.3
- 6) 15
- 7) 17
- 8) 14.6



## Ridge to Femur Angle 34.9° (SD 3.79°)

- 1) 35.4°
- 2) 34°
- 3) 30.7°
- 4) 35°
- 5) 30.3°
- 6) 42.3°
- 7) 36.3°
- 8) 34.9°



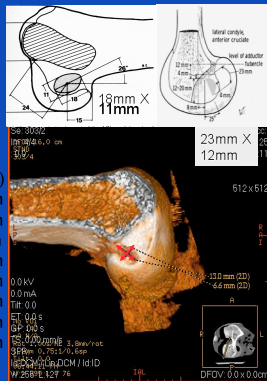
## ACL Footprint

Length  
12.9 mm  
(SD 0.985mm)

- 1) 12.8 mm
- 2) 14.1 mm
- 3) 11.3 mm
- 4) 12.4 mm
- 5) 14.0 mm
- 6) 13.7 mm
- 7) 12.1 mm
- 8) 12.7 mm

Width  
7.1mm  
(SD 1.03)

- 1) 8.6 mm
- 2) 7.3 mm
- 3) 5.9 mm
- 4) 6.4 mm
- 5) 7.3 mm
- 6) 9.7 mm
- 7) 9.1 mm
- 8) 6.6 mm



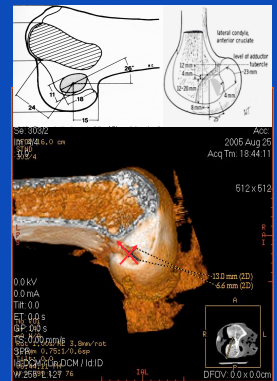
## ACL Footprint to Condyle Distance

Posterior  
3.4 mm  
(SD 0.789mm)

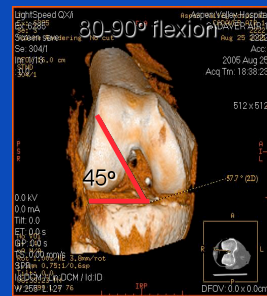
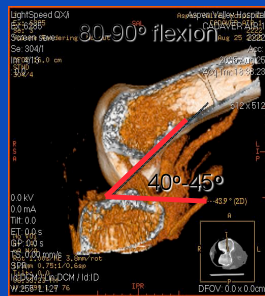
- 1) 2.9 mm
- 2) 3.0 mm
- 3) 4.1 mm
- 4) 2.8 mm
- 5) 4.5 mm
- 6) 2.74 mm
- 7) 3.1 mm
- 8) 5.0 mm

Inferior  
3.3 mm  
(SD 0.83)

- 1) 4.8 mm
- 2) 2.8 mm
- 3) 3.0 mm
- 4) 3.0 mm
- 5) 3.0 mm
- 6) 2.1 mm
- 7) 2.7 mm
- 8) 2.0 mm



## Femoral Insertion Upper Border Tunnel av. 45°



## Femoral Insertion Site

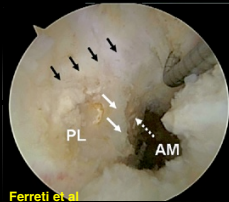
### Area of the femoral insertion site (mean)

|           |             |      |                              |
|-----------|-------------|------|------------------------------|
| Odensten  | JBJS (Am)   | 1985 | 155 mm <sup>2</sup>          |
| Harner    | Arthroscopy | 1999 | 113 ± 27 mm <sup>2</sup>     |
| Mochizuki | Arthroscopy | 2006 | 65 mm <sup>2</sup>           |
| Ferretti  | Arthroscopy | 2007 | 196.8 ± 23.1 mm <sup>2</sup> |
| Siebold   | Arthroscopy | 2008 | 83 ± 19 mm <sup>2</sup>      |

## Femoral Insertion Site

### Lateral Bifurcate Ridge

- ✓ Ridge separating AM & PL bundles on the femoral attachment site
- ✓ Viewed from anteromedial portal

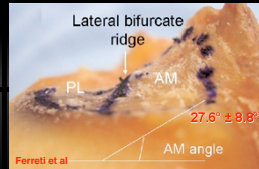


Ferretti et al

Ferretti M et al  
Osseous landmarks of the femoral attachment of the ACL  
*Arthroscopy* 2007;23:1218-1225.



## Femoral Insertion Site



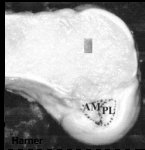
Ferretti et al

Change of slope  
between AM & PL  
femoral attachment  
sites

Ferretti M et al  
Osseous landmarks of the femoral attachment of the ACL  
*Arthroscopy* 2007;23:1218-1225.



## Femoral Insertion Site

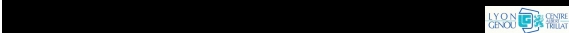


Harner et al *Arthroscopy* 1999  
Both bundles have **same**  
femoral surface area

Mochizuki et al *Arthroscopy* 2006  
Area AM: Area PL → **3:2**

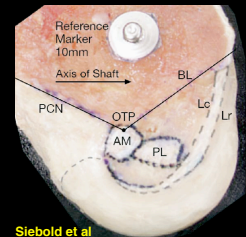


Mochizuki



## Femoral Insertion Site

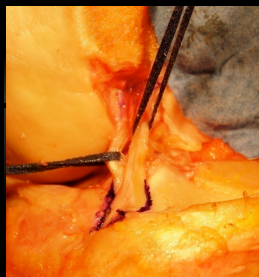
- ✓ Siebold et al *Arthroscopy* 2008  
AM bundle: **52%** of the  
ACL origin  
PL bundle: **48%** of the  
ACL origin



Siebold et al



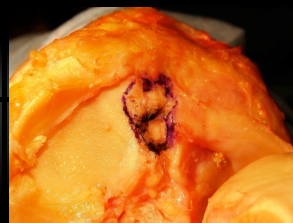
## Tibial Insertion Site



- ✓ Harner *Arthroscopy* 1999  
Tibial attachment  
↓  
**120%** Femoral  
attachment  
✓ Broadest part of ACL

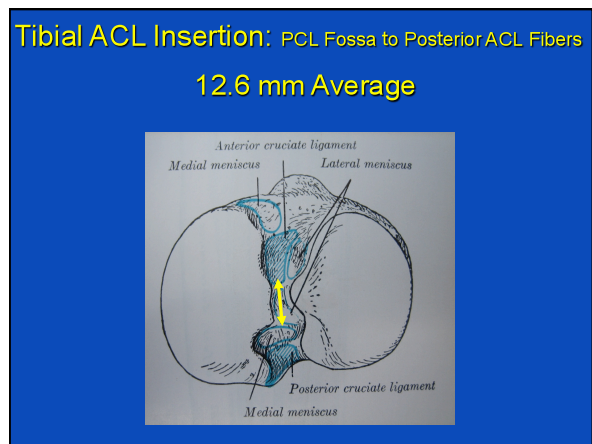
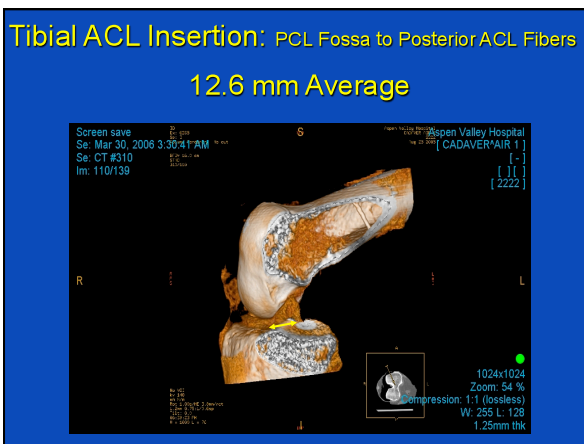
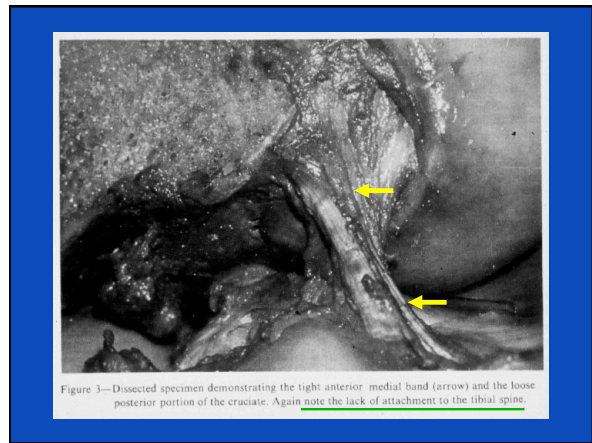
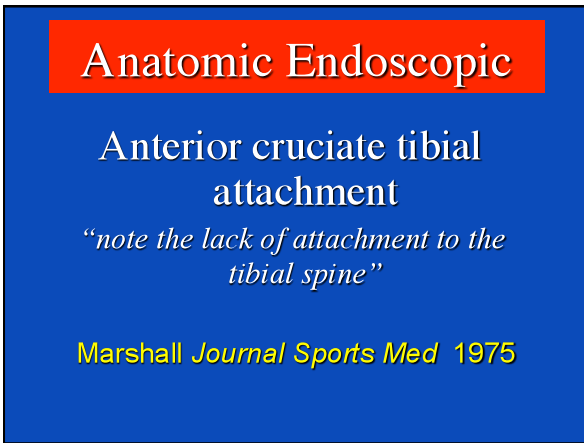
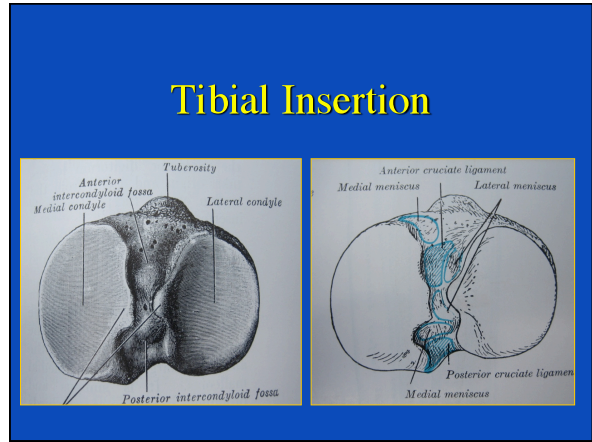
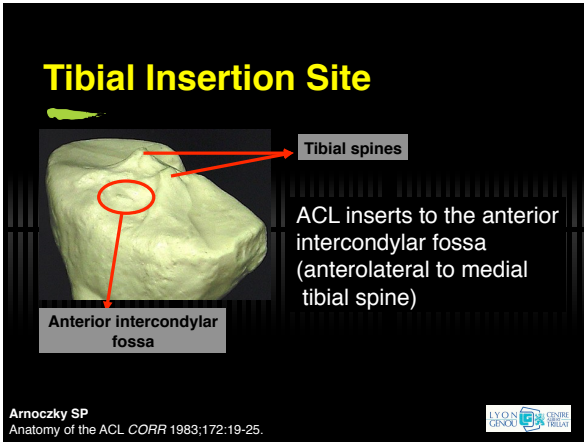


## Tibial Insertion Site



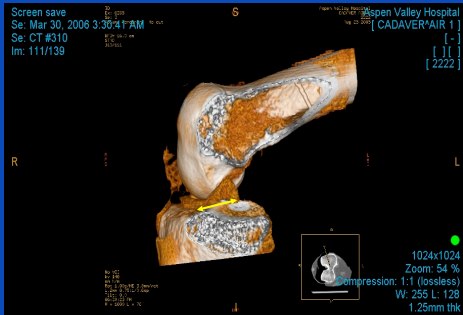
- ✓ Petersen *CORR* 2006  
Mostly **triangular**  
10 – 13 X 15 – 19 mm
- ✓ Tállay *KSSTA* 2008  
**Oval** 77.8%  
**Triangular** 22.2%  
19.5±2.6 X 10.3±1.9 mm





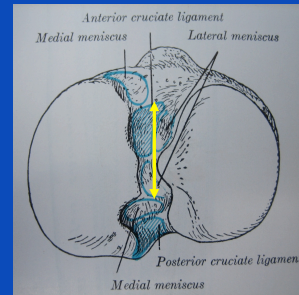
### Tibial ACL Insertion: PCL Fossa to Anterior ACL Fibers

27.2 mm Average



### Tibial ACL Insertion: PCL Fossa to Anterior ACL Fibers

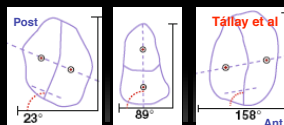
27.2 mm Average



### Tibial Insertion Site

Tállay et al KSSSTA 2008

- ✓ 38.9 % of cases unable to define bundles
- ✓ Orientation of two bundles in the tibial footprint:  $23^\circ - 158^\circ$  (mean  $89.6^\circ$ )



AP orientation of the ACL tibial footprints  
 Angle  $< 90^\circ$  AM-PL orientation  
 Angle  $> 90^\circ$  PL-AM orientation



### Tibial Insertion Site

Area of each bundle on the tibial site

- ✓ **AAM:**  $56 \pm 21 \text{ mm}^2$  ( $52\% \pm 8\%$ )
- ✓ **APL:**  $53 \pm 21 \text{ mm}^2$  ( $48\% \pm 8\%$ )

Harner Arthroscopy 1999

- ✓ **AAM:**  $67 \pm 31 \text{ mm}^2$  (56%)
- ✓ **APL:**  $52 \pm 20 \text{ mm}^2$  (44%)

Siebold Arthroscopy 2008

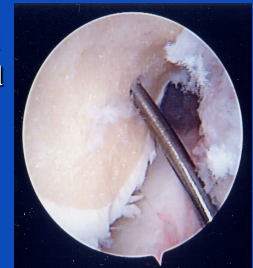


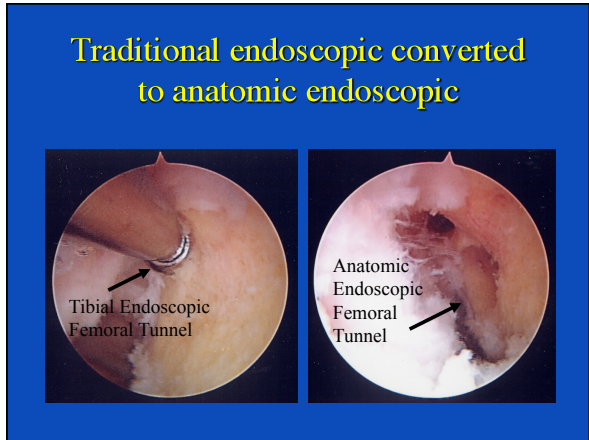
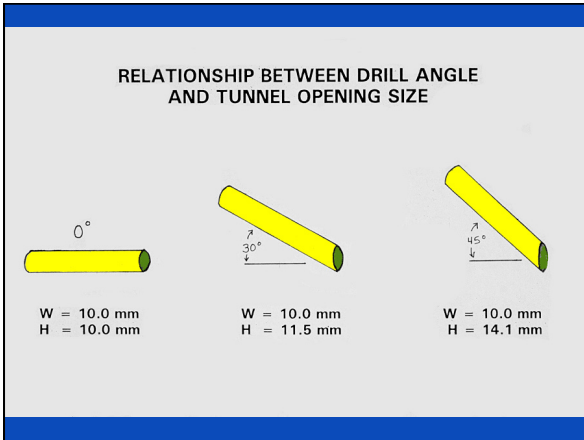
### Clinical relevance

Angle and placement of k-wire determines tunnel location

### Effect of Drilling the Femoral Tunnel on its Location

The reamer is NOT placed perpendicular but angled to the lateral wall of the intercondylar arch





**ACL Femoral Insertion**

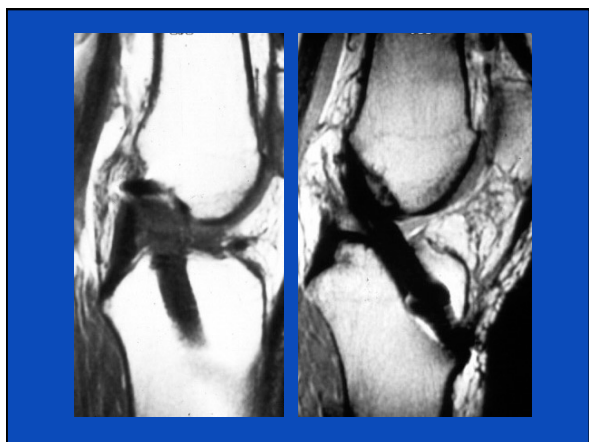
A 10 mm reamer angled 45° makes an 14.1 x 10 mm oval entrance hole directed anterior and superiorly

**ACL Tibial Tunnel**

10 mm Reamer  
Produces an oval exit tunnel on the tibial plateau measuring approximately 10 x 15 mm directed posterolaterally

**ACL Tibial Placement**

The *k-wire*, not the tunnel, is placed anterior and medial to the anatomic insertion of the ACL to compensate for the oval exit tunnel





## Conclusions

- Femoral Tunnel Placement (Single or Double Bundle)
  1. Need to be posterior to the Resident's Ridge
  2. Should be placed at 45° from the tibia (3 or 9 o'clock)

## Conclusions

- Tibial Tunnel Placement (Single or Double Bundle)
  1. Posterior edge of the tunnel needs to be at the base at the anteromedial spine.
  2. Needs to be contained to the medial ½ of the tibial eminance.

## Fu's Concept

### Individual Anatomy

