

Tibial Plateau Blood Supply Biomechanics

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Background :

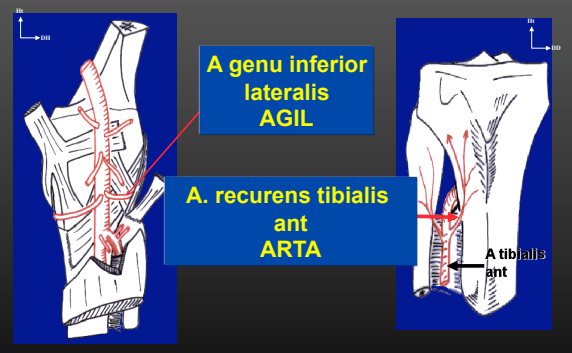
Arthroscopic or mini invasive treatment
Theoretical advantages :

1. To minimize post op morbidity
2. To reduce injury of the tibial plateau blood supply
3. To reduce volume of hardware at a threshold which is compatible with a sufficient fixation

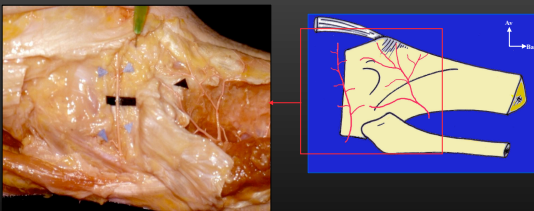
Background :

- **Blood Supply of the lateral tibial plateau** D. Hannouche, F. Duparc, P. Beaufils
Surg Rad Anat 2006
- **Plate versus 2 Screws : cadaver study**
P Boisrenoult, S Bricteux, P. Hardy, P. Beaufils
RCO 2000
- **Literature**

Blood Supply

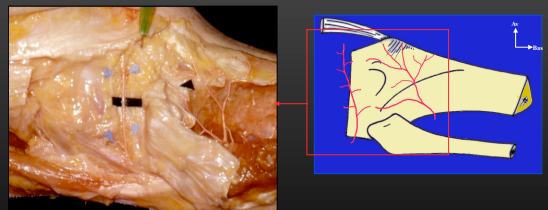


- 11 cadavers knees : posterior approach
- selective injection of the two arteries
- latex : blue and red




1- Anatomy of both systems

- branches
- intraosseous penetration



2- Intraosseous vascularity

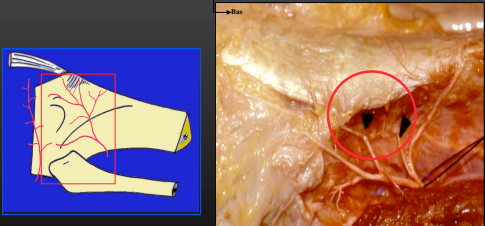
- Intraosseous vessels
- Intraosseous coloration



The diagram on the left shows a cross-section of the femur with red lines representing intraosseous vessels. The photograph on the right shows a real-life view of the femur with a red coloration indicating vascularity.

ARTA

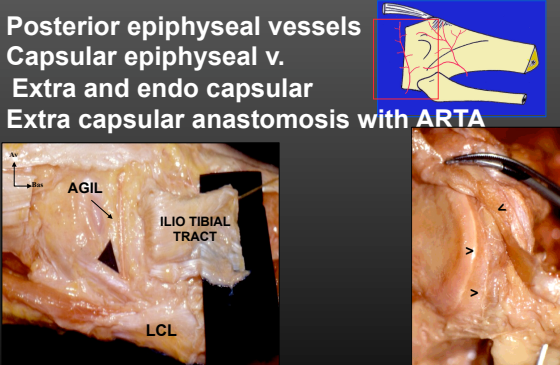
- 3 to 7 metaphyseal vessels
- 1 to 4 epiphyseal intra osseous vessels
- Anterior Tibial Tubercle
- Patellar Tendon
- Constant Anastomosis with AGIL



The diagram on the left shows the anterior tibial artery (ARTA) and its branches. The photograph on the right shows a surgical view of the knee joint with the ARTA highlighted in red.

AGIL

- Posterior epiphyseal vessels
- Capsular epiphyseal v. Extra and endo capsular
- Extra capsular anastomosis with ARTA



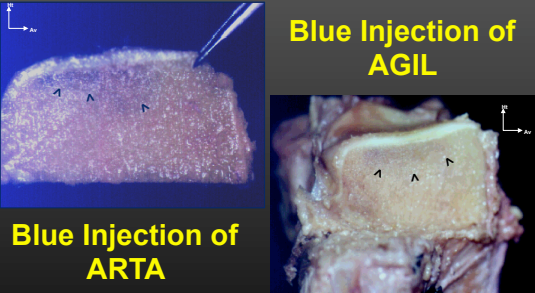
The diagram on the right shows the AGIL and its vascular supply. The photographs on the left show surgical views of the knee joint with the AGIL and Ilio Tibial Tract (ITB) labeled.

Intra Osseous Vascularity

- Is given by both arteries

Blue Injection of ARTA

Blue Injection of AGIL

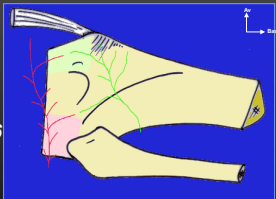


The photographs show the results of blue dye injections into the ARTA and AGIL, highlighting the intraosseous vascularity.

Blood supply of the Tibial Plateau is given by both systems

AGIL
Martinez, 1973
Kirschner, 1996

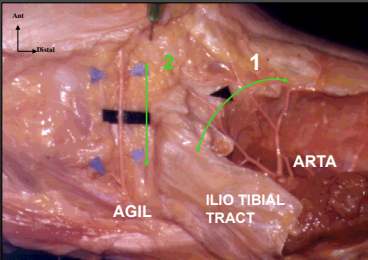
ARTA
Gambarelli, 1954



The diagram shows the tibial plateau with red lines representing the blood supply from the AGIL and ARTA.

Antero lateral Approach

Tear of both systems : ARTA and AGIL



The photograph shows the antero-lateral approach to the knee joint, with the ARTA and AGIL labeled. The Ilio Tibial Tract (ITB) is also visible.

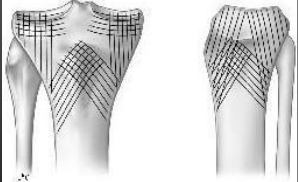
- 1- Elevation of ant muscles.
- 2- Arthrotomy below the lat meniscus

Arthroscopic or Mini Invasive Approach

- Preserves as maximum as possible the vessels coming from ARTA and AGIL
- Percutaneous screws or pins : less damage than plate

Biomechanics


- 2 questions :
1-which type of fixation ?
2-filling or not the gap?



Which type of fixation ?

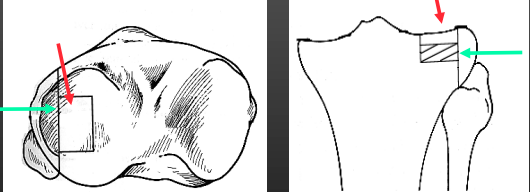
P. Boisrenoult, S Briceux, P. Hardy, P. Beauflis

- To assess the resistance to compressive forces of 2 screws fixation versus plate fixation
- Using a Schatzker 2 fracture model



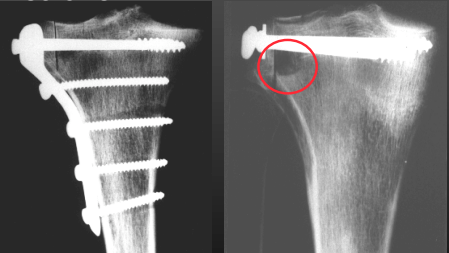
Type II

10 pairs of tibiae issued from fresh cadavers




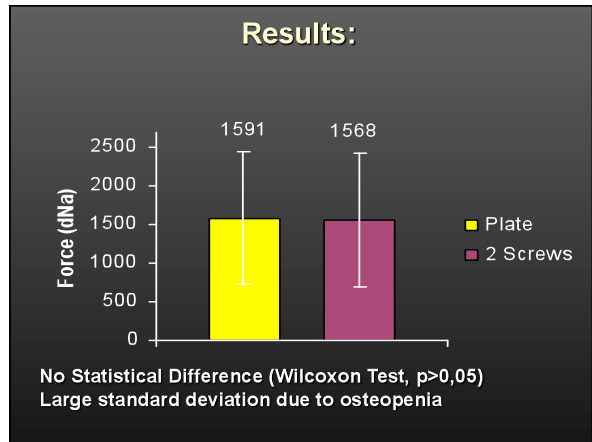
Split + depression
Removal of the subchondral cancellous bone

- 10 were fixed with plate (6 holes) and 10 by two cannulated cancellous screws



- compression test were carried out on type MTS 810 testing machine.
- axial compression with a femoral unicompartement prosthesis
- speed : 2mm/mn
- failure = displacement \geq 2mm





- Similar to Koval 's (1992), Parker 's (1999), Karunakar's (2002) studies (Schatzker 1)
- Schatzker Type 2 model is a more relevant model
- Schatzker 3 : Patil 2006 : 2 6.5cancellous screws is similar to 4 3.5cortical screws

What about unstable fractures

Ali Clin Biomech 2003

Duocondylar fracture model (sawbone)

- 5 different fixations (no locking plate)
- The best fixation :
 - Dual plate : 4218N
 - Two ring Hybrid fixator : 4184N

What about « unstable » fractures

Higgins J Orthop Trauma 2007

Duocondylar fracture model (cadavers knee)

- Dual plate versus lateral locking plate
- “dual-plate fixation allows less subsidence ... when compared to isolated locked lateral plates”

Filling or not the gap ?

Bone Mineral Density

Ali 2006 – cadaver study

Dual plate versus external fixator- bicondylar fracture

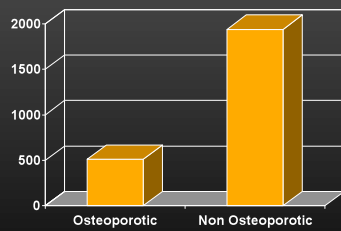
“BMD (DXA, pQCT) around the fracture site had the best correlation with the failure load regardless of the fixation technique. The two fixation methods tested performed equally well, ...”

Filling or not the gap ?

Quality of bone

Patil Knee 2006

Schatzker 3 model - sawbone



Filling or not the gap ?

Augmentation

Welch JBJS 2003

Schatzker 3 model – goat

Calcium phosphate vs cancellous bone

No Fixation

“Cancellous autograft did not maintain an anatomical reduction of the tibial plateau fractures in this model. In contrast, augmentation with calcium phosphate cement prevented subsidence of the fracture fragment “

Filling or not the gap ?

Augmentation

Yetkinler J Orthop Trauma 2001

Schatzker 3 model – human cadavers knee

Calcium phosphate bone cement alone vs cancellous bone graft + screw fixation

“calcium phosphate cement provides equivalent or better stability than conventional open reduction and internal fixation in pure depression tibial plateau fractures “

Conclusion

Stability of the construct depends on :

- Bone mineral density
- Stability of the fracture

Screws are sufficient in most of the cases but the more the fracture is unstable or the bone density is weak, the more the fixation should be stable :

- plate or external fixator instead of screws
- augmentation with phosphate calcium cement or cancellous graft