Graft properties

Table 1
Biomechanical characteristics of selected grafts. Comparison of quadriceps tendon, patellar tendon, and quadrupled hamstring with the native ACL

Graft	Tensile Load (N)	Stiffness (N/mm)	Cross-Sectional Area (mm^2)
Quadriceps tendon[4,12]	2352	463	62
Patellar tendon[13]	2977	620	35
Quadruple hamstring[14]	4090	776	53
Native ACL[15]	2160	242	44

Table 2
Complications of selected grafts for ACL reconstruction. Incidence of anterior knee pain and patellar fracture as well as the resultant weakness after quadriceps tendon, patellar tendon, and hamstring tendon after graft harvest

Graft	Anterior Knee Pain (%)	Weakness (% Loss)	Patellar Fracture (%)
Quadriceps tendon	5[21]	11[6]	1.2[6]
Patellar tendon	17–26[21,22]	10–18[23]	0.2–1.8[24,25]
Hamstring	11[22]	10[23]	Not applicable

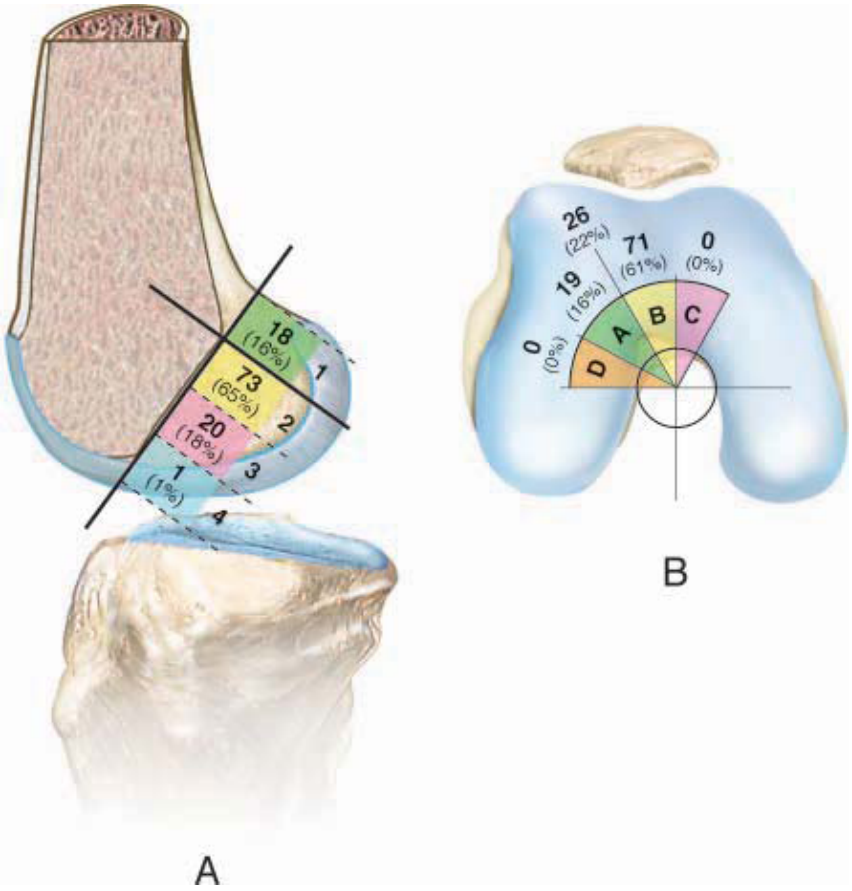
Surgery Vs Non-op: after ACL-rupture

- ?better long-term results.
- In this retrospective cohort study, 136 patients with isolated ACL-rupture who had been treated by bone-ligament-bone transplant or conservatively were identified.
- We observed significantly better knee-stability (P = 0.008) but more osteoarthritis (Grade II or higher) after ACL-reconstruction (42% vs. 25%).
- Physical activity levels were similar in both groups during the follow-up period (P = 0.16). Eleven years after ACL-rupture the physical activity levels are similar for both groups.
- After ACL-reconstruction, stability is higher as is osteoarthritis, whereby the result is not necessarily perceived as better subjectively.
- The risk of secondary meniscal tears is reduced after ACL reconstruction, which reduces the negative effects of OA after surgery.
- Kessler. Knee Surg Sports Traumatol Arthrosc. 2008 May;16(5):442-8 T

ACL

- Errors in the femoral site are more critical because of the proximity to the center of axis of knee motion.
- The practical implications of this anterior location are “capturing” of the knee and loss of flexion or stretching and perhaps clinical failure of the graft as flexion is achieved.
- Posterior placement of the femoral tunnel or placement of the graft over the top of the lateral femoral condyle produces a graft that is taut in extension but loosens with flexion. This location produces an acceptable result, since the instability from an anterior cruciate ligament deficiency occurs near terminal extension.
- Basic science studies have shown that the normal anterior cruciate ligament is not isometric. The fiber bundles of the anterior cruciate ligament are under variable stress during knee motion.
- The anteromedial bundle undergoes higher stress during flexion, and the posterolateral bundle undergoes higher stress during extension.

Prevalence of Nonanatomical Graft Placement. Noyes. *Am J Sports Med 2010 38: 1987*



- There is a wide variation reported in the normal angle of the native ACL, ranging from 58 to 75 in the coronal plane2 and from 45 to 67 in the sagittal plan

- This study, the mean ACL graft angles were 70.8 in the coronal plane and 62.5 in the sagittal plane

Femoral tunnel

Most common error is non isometric anterior tunnel placement within intercondylar notch rather than at its normal posterior insertion;

Graft that tightens (pulls up into the tibial tunnel) with flexion will have a much higher chances of failure

Tunnel positioning:

- **anterior graft placement** (results in high strain on graft as knee is flexed;
  - this restricts flexion of knee if graft remains intact, or it may elongate graft if the range of motion is restored;
- **posterior placement** or distal to normal site of attachment results in excessive tightening of the graft when knee is extended;
-

Lateral tunnel placement:

- w/ a right knee, place the tunnel at about the 11 o'clock position;

Double tunnel

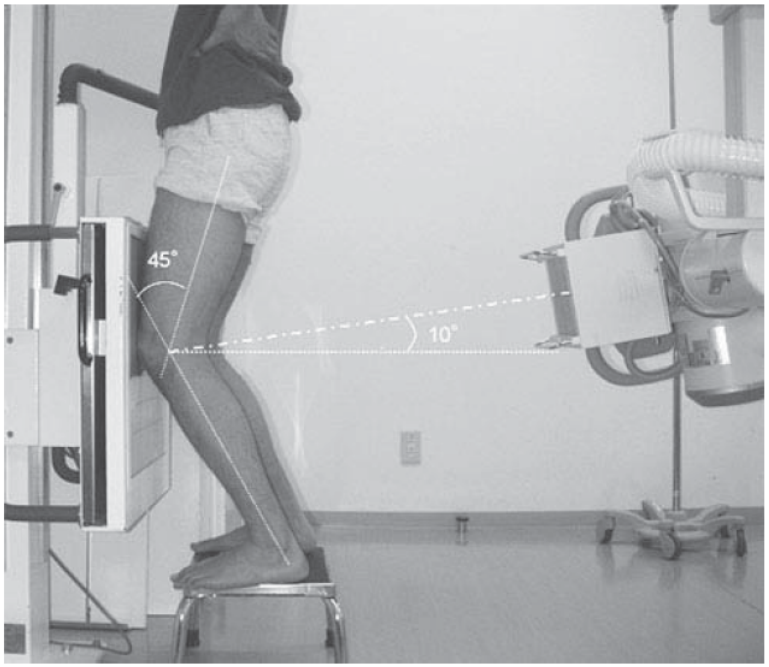


Fig. 1 A weight-bearing posterior–anterior view at 45° of flexion of the knee was taken with the radiographic beam from 10° superiorly to be parallel to the tibial articular surface

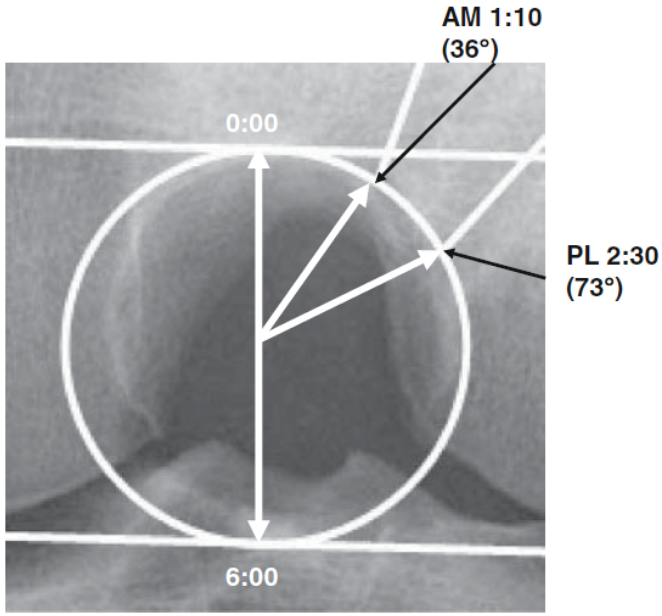


Fig. 3 A magnified image of Fig. 2. The o'clock description of femoral tunnel placement was 1:10 for AM bundle and 2:30 for PL bundle in this case

Knee Surg Sports Traumatol Arthrosc
DOI 10.1007/s00167-010-1243-9

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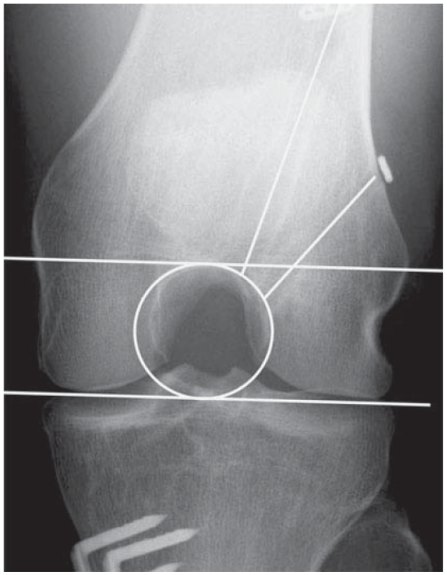


Fig. 2 O'clock description of the femoral tunnel placement in the intercondylar clock was defined on the weight-bearing posterior–anterior view at 45° of flexion of the knee. The clock was drawn between the two lines. One line connected the distal edges of the medial and lateral femoral condyles. The other was parallel to the previous line through the top of the posterior intercondylar notch. After the center of the femoral tunnel opening was marked, the line connecting the center of the clock and the cross-point between the clock and the extension of the femoral tunnel to the joint was described as time shown on the clock

Conclusion

O'clock description of femoral tunnel position on the posterior intercondylar clock using the 45° W/B PA view is simple, practical, and reproducible both in the "isometric" and in the "anatomic" double-bundle ACL reconstructions. The assessment will be useful for describing tunnel position in ACL reconstructions in conjunction with clinical results.

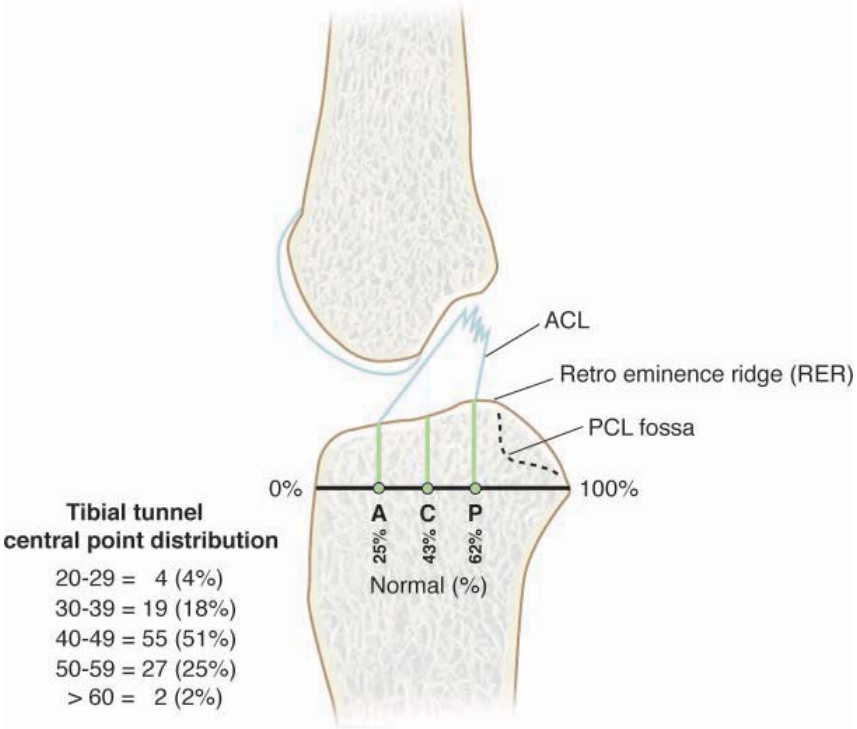
Tibial tunnel

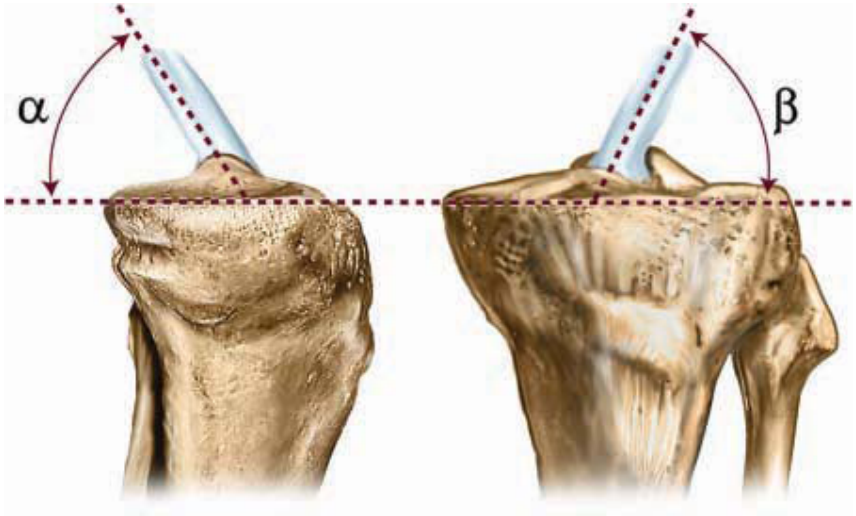
- Leave the drill 1 cm protruding into the joint and slowly extend the knee;
  - this will give an indication of whether residual notch impingement is present;
  - if impingement is still present, then additional notchplasty can be performed and the tibial interference screw can be placed anterior to the tibial bone plug (which moves the graft slightly posteriorly);
  -

- -

- **Final notchplasty check:**
  - shut off the inflow cannula, and insert the scope thru the tibial tunnel;
  - directly observe the femoral condyle and the notch as the knee is taken thru a full range of motion and ensure that there is no bony impingement;

43% Tibial tunnel





The center angle of the ACL graft in the coronal and sagittal planes on the tibia was determined using the method described by Scanlan et a

- <30* is preferred
- May cause less arthritis

- In full extension; in line with Blumensat's line.
- More anterior screw in tibia limits extension
- Screw in the posterior 1/3 rd of Blumensat's line
- In the postero-medial part of the native ACL insertion and from anterior to posterior at 26 ± 4° with respect to the mechanical axis of the leg, in the sagittal view

ACL failures Vol. 38, No. 10, 2010. *Am J Sports Med*

- 122 patients after failure of 1 or more ACL reconstructions.
- The patients presented with an obvious grade 2 or 3 pivot shift and instability symptoms, and
- 77% rated their knee conditions as poor or fair.
- In our prior study on ACL revision,41 nearly 70% of the patients had pain with daily activities before surgery, and 81% rated their knee conditions as poor or fair.
- Many studies have discussed the correlation of vertical tunnels and failure of ACL reconstruction,especially due to the lack of rotational control in obliterating the pivot-shift phenomena.
- In this study, a misplaced ACL femoral or tibial graft tunnel was found in 88%
- In the current study, other causes for ACL failure previously identified as playing a major role, such as abnormal lateral joint opening due to posterolateral ligament injury, varus or valgus osseous malalignment, and other associated ligament injuries

- The criteria for a misplaced or nonanatomical graft in this study was 50% of the graft located outside of the native ACL femoral or tibial footprint.
- The data showed that in 48% of the knees, the graft was entirely on the intercondylar femoral roof. In addition, 31% of the graft tunnels were located at the apex of the roof and lateral femoral wall.

- The technique for identification of the ACL femoral attachment
- A. The anteromedial portal to completely visualize the lateral femoral wall instead of the anterolateral portal because a prominent anterior ‘‘resident’s ridge’’ may block adequate visualization of the entire posterior ACL attachment.
- B. In primary reconstructions, the residual ACL fibers clearly show the ACL femoral attachment. It is important to visualize the posterior articular cartilage edge of the lateral femoral condyle.
- C. The native ACL 3 to 4 mm anterior to the posterior articular cartilage edge. The
- guide pin is placed 8 mm from the cartilage edge, which leaves an approximate 3- to 4-mm back wall for a 9- to 10-mm single tunnel.

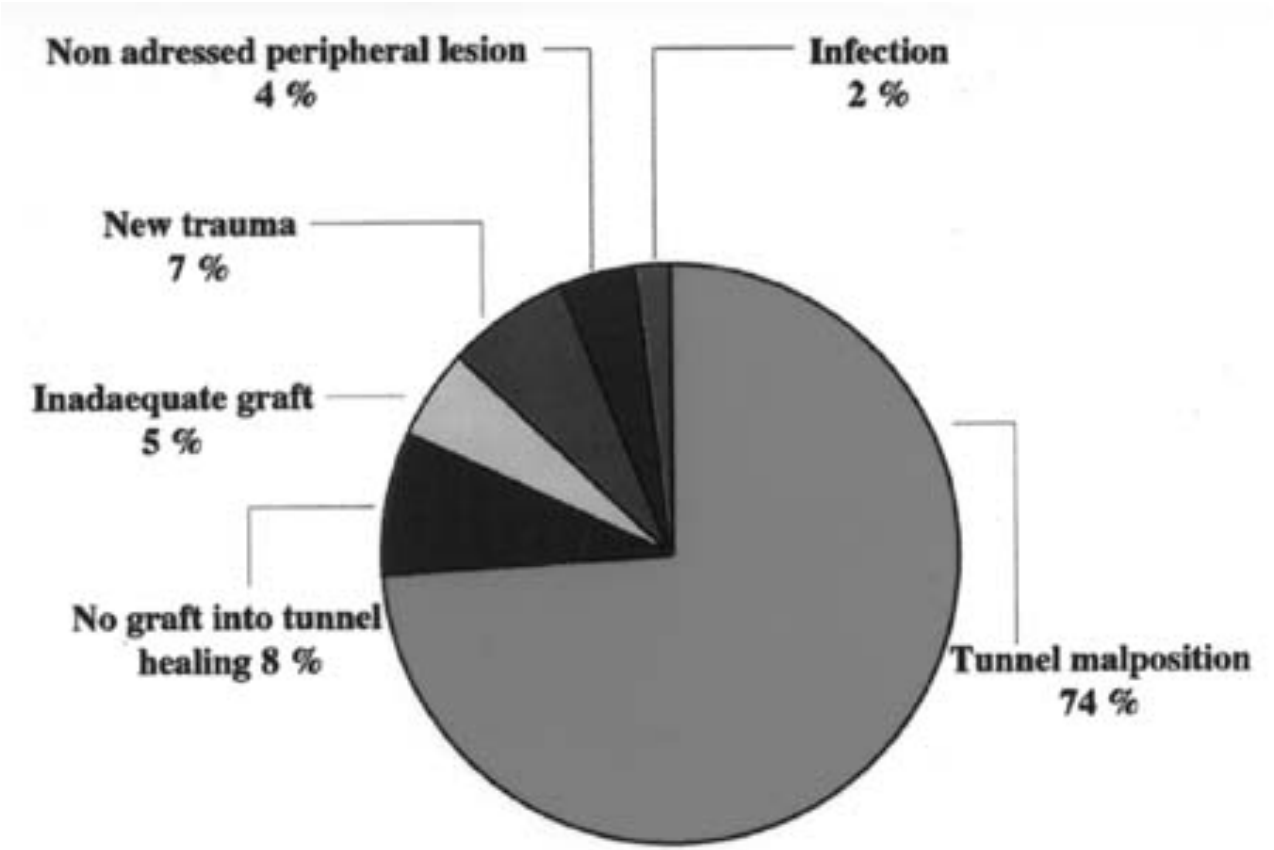
- Importantly, 37 of 107 knees (35%) had errant extension of the tibial tunnel too far posteriorly, out of the ACL tibial attachment and into the retro-eminence ridge. This resulted in a marked vertical graft orientation in the sagittal plane that is less effective in resisting combined anterior tibial translation and internal tibial rotation.
- There is a wide variation reported in the normal angle of the native ACL, ranging from 58 to 75 in the coronal plane2 and from 45 to 67 in the sagittal plane in full knee extension.

- Tibia: At surgery, this includes identification of the posterior interspinous ridge of the proximal posterior cruciate ligament fossa (retro-eminence ridge), the medial tibial spine or eminence, and the lateral meniscus anterior horn attachment. The remaining ACL fibers identified at surgery allow the tibial attachment and the ACL center to be easily marked. This usually results in placement of the guide pin 3 to 4 mm anterior to the posterior rim of the lateral meniscus
- The drilling of the tibial tunnel should be carefully performed to avoid the mistake of the drill migrating to a more posterior position, removing the posterior tibial tunnel wall, and extending into the retroeminence ridge, which results in a vertical graft.
- It was necessary to bone graft tibial and femoral tunnels in 18 knees.
- It is highly probable that technical details associated with dependent transtibial drilling of the femoral tunnel resulted in the high number of nonanatomical grafts in this study.

- In our prior study on ACL primary reconstruction, 40 we found that in 36 of 87 knees (41%), an anatomical ACL graft placement could not be achieved with the transtibial technique, thereby necessitating a 2-incision procedure.

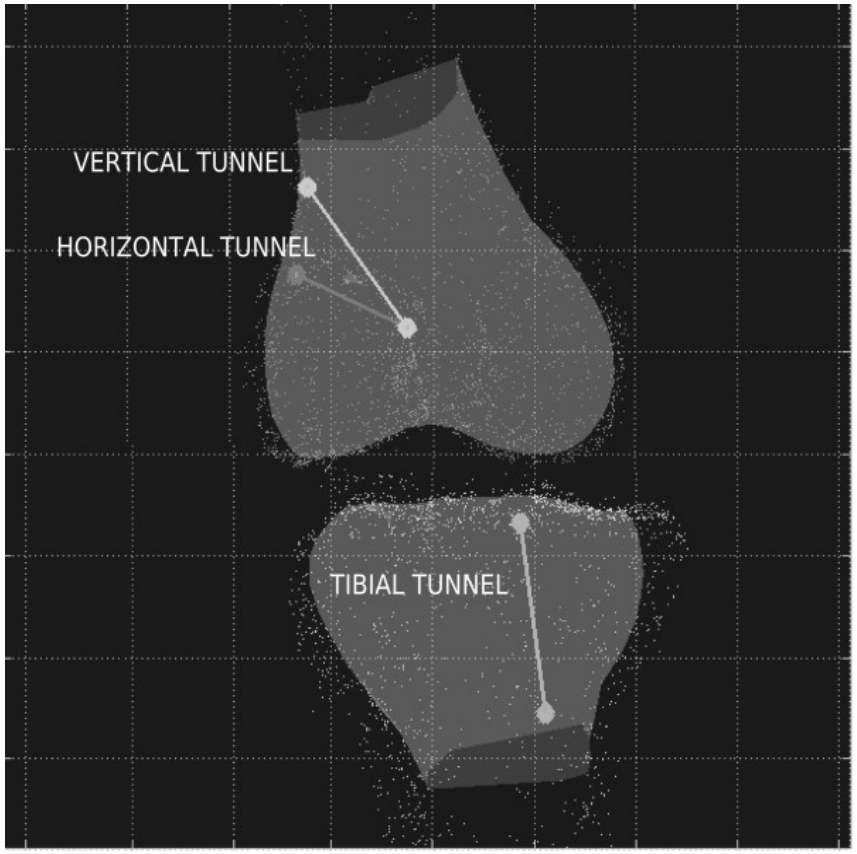
- It is recommended that surgeons who perform a relatively low volume of ACL reconstructions, including those in residency training, may consider adopting a 2-incision technique that has a known precision in the retrograde drilling of the femoral tunnel within the ACL femoral attachment.
- The use of an anteromedial portal for independent drilling of the femoral tunnel does require operator experience, as the hyperflexed knee position results in decreased visualization and the possibility of a short femoral tunnel and damage to the medial femoral condyle.
- Independent tibial and femoral tunnel surgical techniques in our experience represent a more reliable method to achieve an anatomical position of the ACL graft.

REVISION ACL



- 75% due to tunnel malposition

Horizontal Vs Vertical tunnel

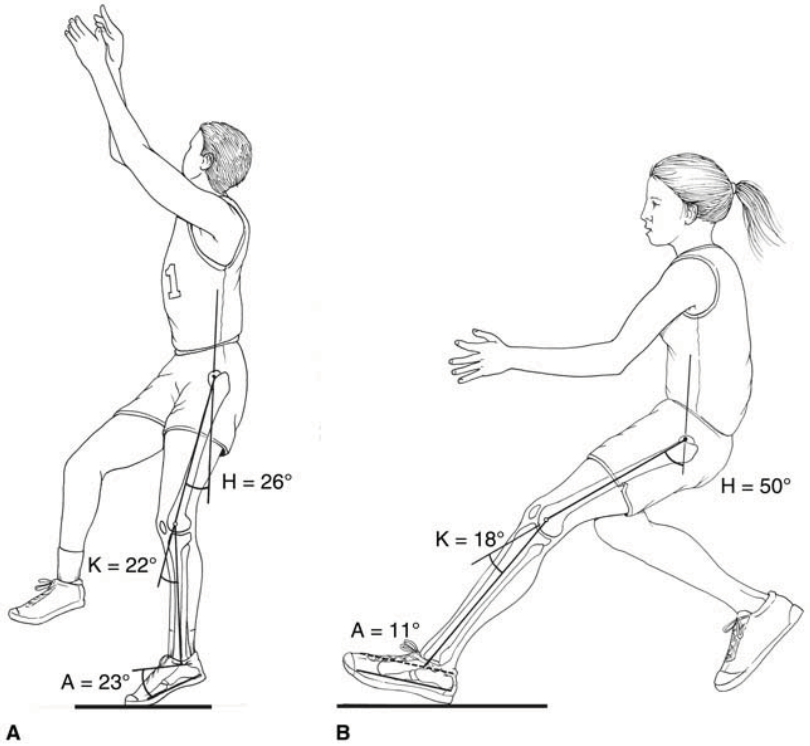


Safe and unsafe landing

- It is more likely that quadriceps contraction contributes to ACL injury by increasing the compressive loads on the tibiofemoral joint rather than by introducing a large anterior force.

- Meyer was the first to demonstrate that excessive joint compressive loads and internal torque can lead to complete ACL rupture in human cadaver knees. They reported peak compression loads at failure ranging from 2,900 N to 7,800 N at knee extension angles ranging from 30° to
- 120°.

- Dejour and Bonnin23 reported a 6-mm increase in anterior tibial translation with monopodal stance for every 10° increase in tibial slope.



The injured athletes had significantly less ankle plantar flexion than did uninjured control athletes at the point of initial ground contact

- We propose that a combination of forces contributes to noncontact ACL injury.
- It is likely that an external impulsive axial force is the primary force .
- The provocative position of initial ground contact in or close to a flatfooted position (ie, reduced ankle plantar flexion) and increased hip flexion predispose the knee to ACL disruption by reducing the dampening capabilities of the leg and by placing the lateral tibial compartment closer to the subluxated position.
- Knee abduction (ie, valgus) also may play an important role, especially in female athletes, by potentially reducing the compression force threshold needed to produce a noncontact ACL injury.

Bioabsorbable Versus Metal Interference

J Bone Joint Surg Am. 2011;93:572-580

- Background: Graft fixation during anterior cruciate ligament (ACL) reconstruction can be achieved with use of either bioabsorbable screws or metal screws. Although bioabsorbable screws and metal screws have similar fixation strengths, bioabsorbable screws eliminate the need for removal. In addition, postoperative imaging is easier to interpret when bioabsorbable screws are used. Bioabsorbable screws may be associated with an increased inflammatory response, an increased risk of screw breakage, incomplete screw absorption, or tunnel widening.

- Conclusions:
- The clinical results associated with bioabsorbable screws and metal screws are statistically similar. Laxity

- The complication rates associated with bioabsorbable screws and metal screws were also similar.

- The results of this meta-analysis support the hypothesis that there are no significant differences in the outcomes associated with bioabsorbable screws as compared with metal screws for ACL reconstruction.