Tibial Slope and Primary ACL Injury

- Non-contact ACL injury is a multi-factorial phenomenon
- Risk factors have been investigated for the purposes of injury prevention
- Limitations include: more recent outcome, less control for other factors
- Tibial slope in primary ACL injury has been investigated in varying circumstances
- Biomechanically, a higher tibial slope in the presence of a compromised ACL will generate a higher anterior shear component of the tibiofemoral reaction force, resulting in increased anterior motion of the tibia relative to the femur

Focus on the trends rather than the absolute values reported
- As the tibial rotation or lateral tilt increases, the stereotactic projection of the TS will artificially increase on lateral radiography or MRI
- The values of any study cannot be true clinical correlates
- Stay cognizant of the limitations of measuring the TS radiographically

Measuring Tibial Slope

Differences in Medial and Lateral Posterior Tibial Slope

- As the tibial rotation in lateral X-ray is increased, the stereotactic projection of the TS will artificially increase on lateral radiography or MRI
- Tenon regression of the limitations of measuring the TS radiographically
- Focus on the trends rather than the absolute values reported

CONCLUSIONS

- Standardised mean difference 0.49 (95% CI 0.30-0.68, p<0.0001)
- Lateral TPS meta-analysis of 1706 subjects

- Standardised mean difference 0.34 (95% CI 0.18-0.49, p<0.0001)
- Medial TPS meta-analysis of 4747 subjects

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- As the tibial rotation or lateral tilt increases, the stereotactic projection of the TS will artificially increase on lateral radiography or MRI
- The values of any study cannot be true clinical correlates
- Stay cognizant of the limitations of measuring the TS radiographically

Risk factors have been investigated for the purposes of injury prevention
- Limb alignment, neuromuscular forces, landing techniques, femoral notch width, female gender

- Mathematical models, biomechanical models, cadaveric studies
- Clinical evidence, mathematical models, biomechanical models, cadaveric studies
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- Tibial slope in ACL injured vs controls
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Clinical evidence, mathematical models, biomechanical models, cadaveric studies

Steep PTS represents a risk factor for non-contact ACL injury
- Increased strain in ACL with increasing PTS, but not confirmed in all studies
- Artificially increased PTS results in increased ATT relative to femur
- Has shown moderate repeatability

The role of the tibial slope in sustaining and treating anterior cruciate ligament injuries

Conclusion: Feucht MJ et al. KSSTA 2013
- Cadaveric studies
- Statistically increased PTS results in increased ATT relative to femur
- Mathematical models
- Forward shear in ACL with increased PTS, but not confirmed in biomechanical models
- Clinical evidence, mathematical models, biomechanical models, cadaveric studies
- Statistical increase in ATT relative to femur
- Increased strain in ACL with increasing PTS, but not confirmed in all studies
- Difficulties in investigating one risk factor independently
- Rule of increased PTS in recurrent instability after ACL R/C

Repetitive overloading and subsequent elongation of the graft with accelerated rehabilitation and early weight-bearing may alter the dynamic stability of the knee

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Mechanical relevance of tibial slope influenced by other surface parameters

Rotational movements between tibia and femur are influenced by both medial and lateral slopes and axial tibiofemoral compression. Biomechanical relevance of tibial slope is influenced by surface parameters.

Conclusion: Feucht MJ et al. KSSTA 2013

Meniscal slope, depth and concavity of MTP

Slope-decreasing osteotomy

...not clear on value as a tool in treating ACL insufficiency, or requirement in establishing a three-dimensional graft. Consideration in ACL revision cases, especially with multiple failed ACL R/C established approaches in veterinary medicine in dogs.

Formal clinical review at 2, 5, 7, 10, 15 and 20 years

Hazard ratio = 3.0

Further ACL injury following primary ACL R/C likely to be multifactorial, but an increased PTS appears to have a significant association with recurrent ACL injuries.

Adolescents did not have higher tibial slopes than adults.

Further ACL injury following primary ACL R/C is likely to be multifactorial, but an increased PTS appears to have a significant association with recurrent ACL injuries.

20 Year Prospective Study

Further ACL injury following primary ACL R/C is likely to be multifactorial, but an increased PTS appears to have a significant association with recurrent ACL injuries.
Surgical Tibial Slope Correction

- Not a 'new' concept
- Long-standing treatment for ACL deficiency in dogs

- 9 subjects 2nd revision ACL + tibial deflexion osteotomy and follow up of 2 years
- Mean PTS corrected from 130 to 40 (used anatomical axis)
- "recommend correction of tibial slope if it exceeds 120, to reduce the risk of graft retear"

- 5 subjects 2nd revision ACL + tibial anterior osteotomy and follow up of 32 months
- Mean PTS corrected from 13.60 to 9.20 (used mechanical axis)
- "restores knee stability and function with satisfactory clinical outcomes in patients who experience recurrent ACL ruptures with an associated increased PTS"

Summary

- Methods of measurement are flawed
- No matter how you measure, at this stage repeat injury studies are only based on xray measurement, and show those 20% at upper end of spectrum have 4-11x more chance of re-injury
- Recommendation:
  - Use a reproducible and convenient/easy method of measurement on all your patients undergoing ACL reconstruction in a PERFORM A POST-OP XRAY
  - Perform a reproducible and anatomical ACL R/C
  - Counsel those 20% at the upper end of PTS measurement on the risk of re-injury