Anatomic ACL repair:

Results of ACL double bundle reconstruction in 2010-metaanalysis

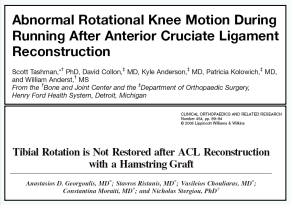
Professor Lars Engebretsen MD PhD

Reported Clinical Outcomes of Single-Bundle ACL Reconstruction

- Restores ATT within 0 - 3 mm of the normal knee in 85% of cases
- However, ATT as measured by KT-1000 and the Lachman test does not correlate with the functional outcome following ACL surgery
- Residual "mini pivot-shift test or "pivot glide" reported in 15 – 34% of patients following single-bundle ACL reconstructions
- Radiographic degenerative changes observed in up to 70% of long-term follow-up after single-bundle ACL reconstruction

Single-bundle ACL Reconstruction: In Vivo Kinematic Studies

- Single-bundle ACL reconstructions do not restore normal tibial rotation during walking, stair descent with directional change, jumping landing directional change, lunges or downhill running

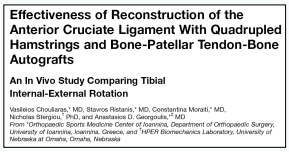

Abnormal Rotational Knee Motion During Running After Anterior Cruciate Ligament Reconstruction

Scott Tashman,*† PhD, David Collon,‡ MD, Kyle Anderson,‡ MD, Patricia Kolowich,‡ MD, and William Anderst,‡ MS

From the *Bone and Joint Center and the †Department of Orthopaedic Surgery, Henry Ford Health System, Detroit, Michigan

Tibial Rotation is Not Restored after ACL Reconstruction with a Hamstring Graft

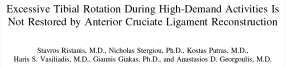
Anastasios D. Georgoulis, MD*; Stavros Ristanis, MD*; Vasileios Chouliaras, MD*; Constantina Moraiti, MD*; and Nicholas Stergiou, PhD†


Effectiveness of Reconstruction of the Anterior Cruciate Ligament With Quadrupled Hamstrings and Bone-Patellar Tendon-Bone Autografts

An In Vivo Study Comparing Tibial Internal-External Rotation

Vasileios Chouliaras,* MD, Stavros Ristanis,* MD, Constantina Moraiti,* MD, Nicholas Stergiou,† PhD, and Anastasios D. Georgoulis,*‡ MD

From *Orthopaedic Sports Medicine Center of Ioannina, Department of Orthopaedic Surgery, University of Ioannina, Ioannina, Greece, and †HPER Biomechanics Laboratory, University of Nebraska at Omaha, Omaha, Nebraska


Excessive Tibial Rotation During High-Demand Activities Is Not Restored by Anterior Cruciate Ligament Reconstruction

Stavros Ristanis, M.D., Nicholas Stergiou, Ph.D., Kostas Patras, M.D., Haris S. Vasiliadis, M.D., Giannis Giakas, Ph.D., and Anastasios D. Georgoulis, M.D.

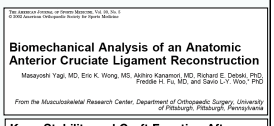
Biomechanics of Single-Bundle ACL Reconstruction

- Cadaveric biomechanical studies have shown that SB ACL reconstructions are effective at controlling ATT but do not control combined valgus-internal rotation loads (stimulated pivot shift)


2002 Richard O'Connor Award Paper

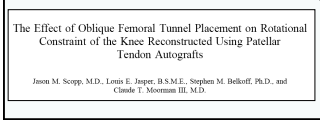
Knee Stability and Graft Function Following Anterior Cruciate Ligament Reconstruction: Comparison Between 11 O'clock and 10 O'clock Femoral Tunnel Placement

John C. Loh, M.D., Yukihisa Fukuda, M.D., Eiichi Tsuda, M.D., Richard J. Steadman, M.D., Freddie H. Fu, M.D., and Savio L-Y. Woo, Ph.D., D.Sc.


Biomechanical Analysis of an Anatomic Anterior Cruciate Ligament Reconstruction

Masayoshi Yagi, MD, Eric K. Wong, MS, Akihiro Kanamori, MD, Richard E. Debski, PhD, Freddie H. Fu, MD, and Savio L-Y. Woo,* PhD

From the Musculoskeletal Research Center, Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, Pennsylvania


The Effect of Oblique Femoral Tunnel Placement on Rotational Constraint of the Knee Reconstructed Using Patellar Tendon Autografts

Jason M. Scopp, M.D., Louis E. Jasper, B.S.M.E., Stephen M. Belkoff, Ph.D., and Claude T. Moorman III, M.D.


Knee Stability and Graft Function After Anterior Cruciate Ligament Reconstruction

A Comparison of a Lateral and an Anatomical Femoral Tunnel Placement

Yuji Yamamoto, MD, Wei-Hsiu Hsu, MD, Savio L-Y. Woo,* PhD, DSc, Andrew H. Van Scyoc, Yoshiyuki Takakura, MD, and Richard E. Debski, PhD

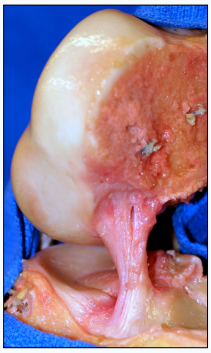
From the Musculoskeletal Research Center, Department of Orthopaedic Surgery, Department of Bioengineering, University of Pittsburgh, Pittsburgh, Pennsylvania

Summary of Single-Bundle ACL Reconstructions

- 15 – 34% of single-bundle ACL reconstructions have a residual mini pivot-shift
- *In vitro* biomechanical studies have shown that single-bundle ACL surgical techniques fail to restore normal tibial rotation and normal knee kinematics
- *In vivo* gait studies have demonstrated that current single-bundle ACL surgical techniques fail to restore normal tibial rotation
- BUT! These studies hav for the most part been done with the transtibial technique

The Double-Bundle Concept

It has been suggested that a more anatomical ACL surgical technique which more closely reproduces the normal anatomy of the ACL and the ACL insertion sites and tensioning pattern of the normal ACL will improve rotational control and therefore improve the clinical results of ACL surgery.



Biomechanical Analysis of an Anatomic Anterior Cruciate Ligament Reconstruction

Masayoshi Yagi, MD, Eric K. Wong, MS, Akihiro Kanamori, MD, Richard E. Debski, PhD, Freddie H. Fu, MD, and Savio L-Y. Woo,* PhD

From the Musculoskeletal Research Center, Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, Pennsylvania

- ATT for the DB reconstruction closer to the intact knee than the SB reconstruction
- ATT under combined rotatory load for the DB reconstruction closer to the intact knee than the SB

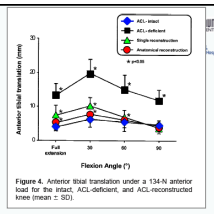


Figure 4. Anterior tibial translation under a 134-N anterior load for the intact, ACL-deficient, and ACL-reconstructed knee (mean ± SD).

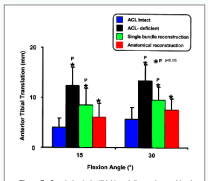


Figure 7. Coupled anterior tibial translation under combined 5-N-m internal tibial torque and 10-N-m valgus torque for the intact, ACL-deficient, and ACL-reconstructed knee. * Indicates significant difference when compared with the intact knee, P indicates significant difference when compared with the anatomic reconstruction (mean ± SD).

Influence of Anterior Cruciate Ligament Bundles on Knee Kinematics

Clinical Assessment Using Computer-Assisted Navigation

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- ATT during anterior drawer test better controlled by AMB than PLB reconstruction
- PLB better controlled anterior tibial translation during the Lachman test
- Both bundles contribute to control of anterior laxity during the pivot shift test
- PLB more important than the AMB in controlling tibial rotation during the pivot shift test

Summary of Biomechanical Studies

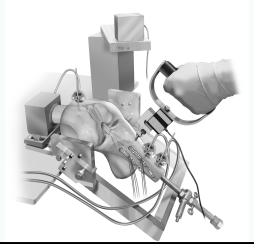
- The AM bundle resist ATT in the flexed knee
- The PL bundle resist ATT in the extented knee
- The PL bundle plays an important role in controlling tibial rotation
- DB reconstructions restore knee kinematics more closer to that of the normal knee compared to SB reconstructions
- BUT! The comparisons are primarily done with the transtibial technique

Summary

- The PLB plays an essential role in controlling ATT near extension and tibial rotation (pivot shift)
- Biomechanical, kinematic and clinical studies have shown that current SB ACL reconstruction techniques fail to restore tibial rotation to normal
- Biomechanical and early clinical studies suggest that DB ACL reconstructions provide better control of tibial rotation compared to SB reconstructions
- Abnormal tibial rotation may lead to early OA and may explain the 14 – 34% rate of pivot glide following current SB ACL reconstruction techniques

The Kinematic Impact of Anteromedial and Posterolateral Bundle Graft Fixation Angles on Double-Bundle Anterior Cruciate Ligament Reconstructions

- Colin J. Anderson,*† BA
- Benjamin D. Westerhaus,*
- Sean D. Pietrini,* BS
- Connor G. Ziegler,* BA
- Coen A. Wijdicks,* MSc
- Steinar Johansen,‡ MD
- Lars Engebretsen,‡ MD, PhD
- Robert F. LaPrade,* MD, PhD



The effect of fixtion angles:

- **Conclusions:**
- the fixation angles of the AM and PL bundle grafts significantly impacted knee kinematics.
- fixation at 0°/0°, 60°/0°, 45°/15°, or 75°/15° restored normal stability to the knee while fixation at 30°/30°, 60°/60°, and 90°/90° over-constrained the knee.
- as long as the PL graft was fixed in the range of 0° to 15°, the AM graft could be fixed up to 75° without restricting knee laxity.
- however, fixation of the PL graft at 30° of knee flexion and above significantly over-constrained the knee and may predispose the graft to failure

Pubmed search 301209

- Acl double bundle and clinical results
- 108 hits
- 10 studies
- 2 year follow up

- Comparison Between Single- and Double-Bundle Anterior Cruciate Ligament Reconstruction: A Prospective, Randomized, Single-Blinded Clinical Trial.
- Aglietti P, Giron F, Losco M, Cuomo P, Ciardullo A, Mondanelli N.
- Am J Sports Med. 2009 Sep 30. [Epub ahead of print]

Comparison Between Single- and Double-Bundle Anterior Cruciate Ligament Reconstruction

CONCLUSION

After 2 years, the clinical results are in favor of the DB reconstruction as demonstrated by the better VAS and final objective IKDC scores and lower KT-1000 arthrometer side-to-side difference in anterior tibial translation. A trend in favor of the DB group in pivot-shift incidence and sports activity recovery was recorded but did not reach statistical significance.

Results: All the patients reached a minimum follow-up of 2 years. No differences between the 2 groups were observed in terms of KOOS and IKDC subjective score. A statistically significant difference in favor of the DB group was found with the VAS ($P < .03$). The objective IKDC final scores showed statistically significantly more "normal knees" in the DB group than in the SB group ($P = .03$). There was 1 stability failure in the DB group and 3 in the SB group. The KT-1000 arthrometer data showed a statistically significant decrease in the average anterior tibial translation in the DB group (1.2 mm DB vs 2.1 mm SB; $P < .03$). The incidence of a residual pivot-shift glide was 14% in DB and 26% in SB ($P = .08$).

Conclusion: In the 2-year minimum follow-up, DB ACL reconstructions showed better VAS, anterior knee laxity, and final objective IKDC scores than SB. However, longer follow-up and accurate instrumented in vivo rotational stability assessment are needed.

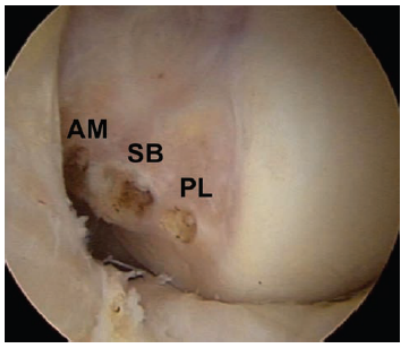


Figure 9. In the single-bundle (SB) technique, the femoral guide wire was drilled aiming a position in the middle of the anteromedial (AM) and posterolateral (PL) bundle attachments.

Conclusions vary from:

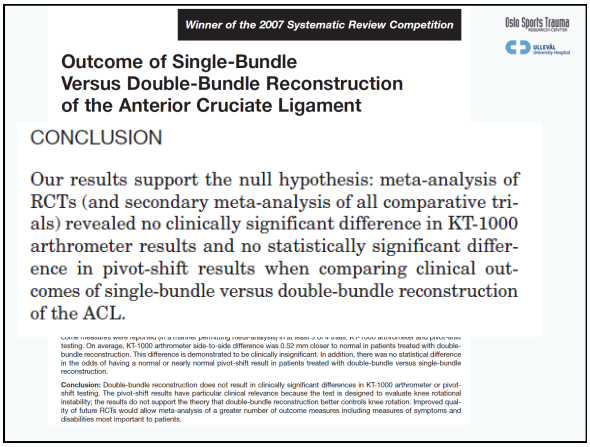
- "the results do not support the theory that double-bundle reconstruction better controls knee rotation"

To:

- In the 2-year minimum follow-up, DB ACL reconstructions showed better VAS, anterior knee laxity, and final objective IKDC scores than SB. However, longer follow-up and accurate instrumented in vivo rotational stability assessment are needed.

Table 2. RCTs or cohort studies comparing Db and SB acl recon

Study	Publication year	Pro(spective) / Retro(spective)	Time span	Number of subjects included (Follow-up)	Description of included subjects	Injuries	Follow-up months (mena)	Knee function	Radiological outcome
Aglietti et al.	2009	Pro RCT	06-09	70		ACL	24	Db better	None
Tsuda et al	2009	Pro	06.09	144	.	ACL	24	No difference between PT and DB	None
Meredick et al	2008	metaanalysis	1997-2001			ACL		No difference	None
Kondo et al	2008	cohort		328		ACL	24	DB better	None
Gudas et al	2008	cohort		70		ACL	24	No difference	None
Siebold et alet al	2008	Pro RCT		70	29	ACL	19	DB significant better	None
Streich et al	2008	Pro RCT		50	Highly competitive	ACL	24	No difference, but SB done w new technique	None
Muneta et al	2007	Cohort/Rct		68		ACL	24	Trend for better results in DB	None
Jarvelal	2007	Pro RCT		65		ACL	24	Improved rotational stability, otherwise equal	None


Winner of the 2007 Systematic Review Competition
Oslo Sports Trauma
Outcome of Single-Bundle
Versus Double-Bundle Reconstruction
of the Anterior Cruciate Ligament
CONCLUSION
Our results support the null hypothesis: meta-analysis of RCTs (and secondary meta-analysis of all comparative trials) revealed no clinically significant difference in KT-1000 arthrometer results and no statistically significant difference in pivot-shift results when comparing clinical outcomes of single-bundle versus double-bundle reconstruction of the ACL.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