Universität Rostock

Universitätsmedizin Rostock

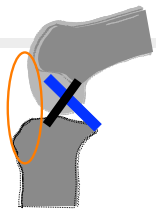
Acl single vs. double bundle reconstruction – Overview of literature

T. Tischer

5th Advanced Course on Knee Surgery, Val d'isere, 2.-7.2.2014

Problem: rotational instability

"traditional" single bundle ACL



⇨ AP stability restored

⊘ rotational stability <u>not</u> restored
Pivot shift <u>not</u> restored

Yagi, Fu, Woo, AOSSM 2001

Outcome after ACL ruptur

Up to 50 % Osteoarthritis 10-20 years after ACL ruptur

Lohmander et al. Am J Sports Med 2007

<u>Systematic literature review:</u>

- 13% osteoarthritis in isolated ACL ruptures
- 48% when combined with meniscus tears

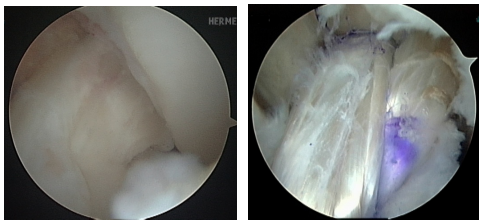
→ **high-level studies missing!**

Oiestad et al. Am J Sports Med 2009
Chu et al. Clin Sport Med 2012
Ajuied et al. Am J Sports Med 2013

Solution ?

Be more antatomic?

Single vs. Double bundle reconstruction?

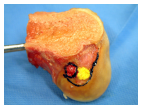


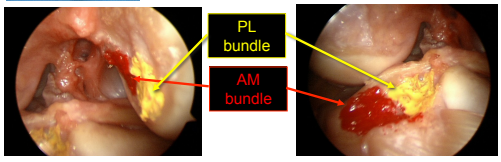
History of 2 bundles

Wilhelm Weber, Göttingen + Eduard Weber, Leipzig
Mechanik der menschlichen Gehwerkzeuge 1836

Rudolf Fick, Innsbruck: Handbuch der Anatomie 1911

Anatomy

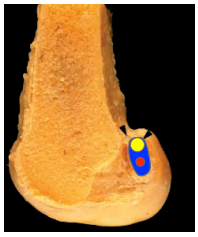


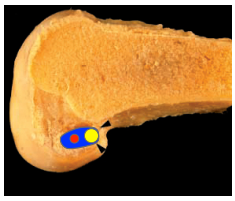


femoral tibial

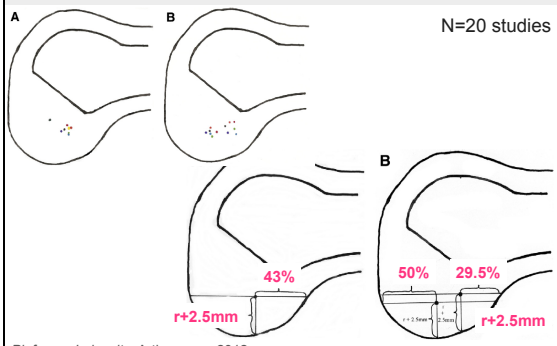
Harner, Baek, 1999

Anatomy: femoral insertion





Review of literature: Anatomy of femoral insertion



Piefer, ..., Lubowitz. Arthroscopy 2012

Review of literature: Anatomy of femoral insertion

Femoral insertion size: wide variation in size and shape!

Article	Size	Shape
Heming et al.[28]	18.4 mm × 9.5 mm	Not described
Purnell et al.[29]	12.9 ± 0.1 mm × 7.6 ± 1.4 mm	Not described
Steckel et al.[24]	Not described	Semilunar
Siebold et al.[30]	15 ± 3 mm × 8 ± 2 mm	Long oval
Yasuda et al.[31]	Not described	Egg shaped
Ferretti et al.[32]	17.2 ± 1.2 mm × 9.9 ± 0.8 mm	Segment of a circle with straight anterior border and convex posterior border
Luites et al.[33]	Not described	Oval
Takahashi et al.[27]	AM: 11.3 ± 1.6 mm × 7.5 ± 1.3 mm; PL: 11 ± 1.7 mm × 7.6 ± 1.0 mm	Elliptic
Edwards et al.[26]	14 ± 2 mm × 7 ± 1 mm	Variable
Mochizuki et al.[25]	AM: 9.2 ± 0.7 mm × 4.7 ± 0.6 mm; PL: 6.0 ± 0.8 mm × 4.7 ± 0.6	Oval
Colombet et al.[17]	13.9 ± 9.5 mm × 9.3 ± 7.1 mm	Variable
Iwahashi et al.[34]	17.4 ± 0.9 mm × 8 ± 0.5 mm	Oval
Stijak et al.[36]	14.4 ± 2.3 mm × 6.8 ± 0.7 mm	Not described

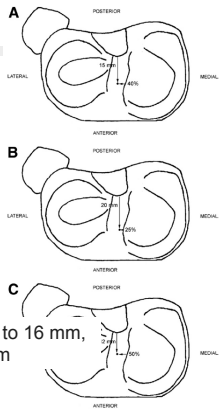
Piefer, ..., Lubowitz. Arthroscopy 2012

Review of literature: Anatomy of tibial insertion N=19 studies

Center:
15mm anterior PCL
40% from medial

AM-bundle:
20mm anterior PCL
25% from medial

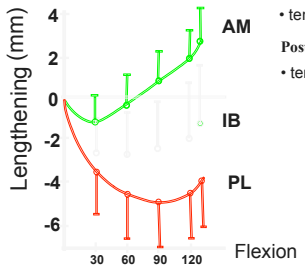
PL-bundle:
12mm anterior PCL
50% from medial



Tibial insertion size: ML width was 7 to 16 mm, and that of AP length was 9 to 19.5 mm

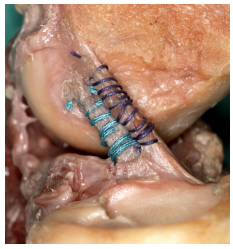
Hwang, ..., Lubowitz. Arthroscopy 2012

Biomechanical analysis



Anteromedial bundle (AM)
• tension ↑ in flexion

Posterolateral bundle (PL)
• tension ↓ in flexion

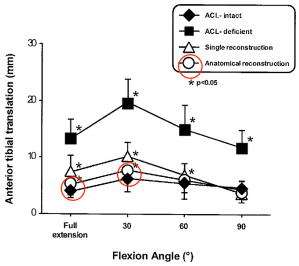


Amis, Dawkins, JBJS(Br) 1991

Biomechanical Analysis of an Anatomic Anterior Cruciate Ligament Reconstruction

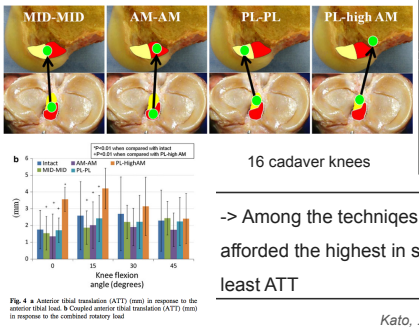
Masayoshi Yagi, MD, Eric K. Wong, MS, Akihiro Kanamori, MD, Richard E. Debski, PhD, Freddie H. Fu, MD, and Savio L-Y. Woo,* PhD

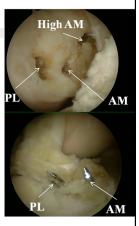
Am J Sports Med 2002



Yagi, Fu, Woo, AJSM 2002

Biomechanical analysis



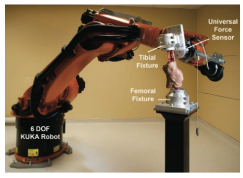


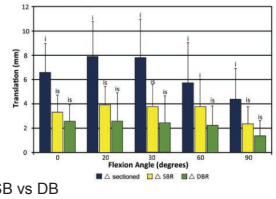
16 cadaver knees

-> Among the techniqes AM-AM afforded the highest in situ force and least ATT

Kato, ..., Fu KSSTA 2013

Biomechanical analysis





9 matched-pair cadaver knees: SB vs DB

-> No significant differences in ATT during pivot shift and anterior loading

Goldsmith, ..., Engebretsen, LaPrade, ... et al. Am J Sports Med 2013

Biomechanical analysis: anatomic or AM femoral tunnel?

Table 1. *ATT in Response to 134-N Anterior Tibial Load*

	ATT (mm)			
			ACL Reconstruction	
Flexion Angle	ACL Intact	ACL Deficient	Center-Center	Center-AM
0°	5.1 ± 0.9	12.9 ± 1.5*	5.9 ± 2.1†	4.8 ± 1.5†
15°	4.1 ± 1.4	14.4 ± 1.0*	4.5 ± 0.5†	5.6 ± 1.7†
30°	4.4 ± 0.8	13.2 ± 0.6*	3.7 ± 0.8†‡	5.3 ± 1.7†
60°	5.6 ± 0.4	12.3 ± 0.8*	6.4 ± 2.0‡	5.8 ± 1.1‡
90°	3.5 ± 1.2	12.0 ± 0.6*	5.9 ± 1.4*†	6.0 ± 1.0*†

Table 2. *ITR in Response to 10-Nm Valgus Torque and 5-Nm Internal Tibial Torque*

	ITR (°)			
			ACL Reconstruction	
Flexion Angle	ACL Intact	ACL Deficient	Center-Center	Center-AM
15°	11.0 ± 0.6	16.8 ± 1.1*	10.4 ± 0.8†‡	11.4 ± 0.5†
30°	10.5 ± 0.6	16.6 ± 0.8*	10.4 ± 0.5†‡	11.0 ± 0.6*†
45°	10.8 ± 0.6	16.9 ± 0.8*	10.3 ± 0.6†‡	11.1 ± 0.6†

-> Anatomic SB ACL with femoral center position may further improve rotational stability without sacrificing anterior stability.

Driscoll et al. Arthroscopy 2012

Anatomic double bundle reconstruction: literature review

-> question remain if better protection of menisci and prevention of osteoarthritis and if more surgical complexity and revision potential justifies benefits

Crawford et al. KSSTA 2007

Comprehensive Systematic Review

Is double-bundle ACL reconstruction superior to single-bundle?

1995 – 2012:

25 randomized controlled trials

21 prospective comparative studies

14 retrospective comparative studies

Based on current evidence, double-bundle reconstruction appears to have fewer re-ruptures and less antero-posterior and rotatory laxity.

Major drawback:
Includes studies with very different techniques (transtibial, anteromedial, ...)

Björnsson, ..., Fu, ... et al. KSSTA 2013

Comprehensive Systematic Review

Anatomic single- versus double-bundle ACL reconstruction

8 randomized controlled trials

7 prospective comparative studies

Anatomic double-bundle ACL reconstruction is superior to anatomic single-bundle reconstruction in terms of restoration of knee kinematics, primarily A-P laxity.

Wheter these improvements of laxity result in long-term improvement of clinical meaningful outcomes remains uncertain.

Desai, ..., Fu, ... et al. KSSTA 2013

Comprehensive Systematic Review

19

Anatomic single- versus double-bundle ACL reconstruction

8 randomized controlled trials

7 prospective comparative studies

Anatomic ACL double-bundle reconstruction demonstrated less anterior laxity using KT-1000 arthrometer and less A–P laxity measured with navigation. Anatomic double-bundle ACL reconstruction **did not lead to significant improvements** in pivot-shift test, Lachman test, anterior drawer test, total IRER or graft failure rates compared to anatomic single-bundle ACL reconstruction.

Desai, ..., Fu, ... et al. KSSTA 2013

Comprehensive Systematic Review

20

Level of Evidence in Anterior Cruciate Ligament Reconstruction Research

The key finding is that most therapeutic studies on primary ACL reconstruction are of a low level of evidence!

Samuelsson, ..., Fu, ..., Karlson Am J Sports Med 2013

Prospective Randomized Study

21

A Prospective Randomized Study Comparing Double- and Single-Bundle Techniques for Anterior Cruciate Ligament Reconstruction

N=103 (DB 53, SB 50), ST/G

Femoral tunnel drilled through anteromedial portal, interference screw, FU 26 months

Clinical exam no difference (pivot-shift, KT-1000, manual Lachman, ROM, Lysholm, Tegner, KOOS, 1-legged hop, square hop test)

-> no difference between anatomical single and double bundle techniques

Ahlden, ..., Karlsson, ... et al. Am J Sports Med 2013

Prospective Randomized Study

22

Double-Bundle vs Single-Bundle Anterior Cruciate Ligament Reconstruction

N=90 (DB 30, SB 60), ST/G, FU 5 years

Clinical exam no difference (pivot-shift, KT-1000, IKDC, Lysholm)

Graft failure SB 7, DB 3

Osteoarthritis SB 33%, DB 20%

-> knee stability and OA were similar after 5 years

Suomalainen et al. Am J Sports Med 2012

Prospective Randomized Study

23

A Prospective Study Comparing Individualized Anatomic Single- and Double-Bundle Reconstruction

N=101 (DB 69, SB 32), ST/G, FU 30 months

Depending on intra-OP insertion size SB or DB used

Clinical exam no difference (Lysholm, IKDC, KT-1000, pivot-shift)

-> no difference between individualized anatomical single and double bundle techniques

Hussein, ..., Fu. Am J Sports Med 2012

Study Results

24

Progression of Osteoarthritis After Double- and Single-Bundle Anterior Cruciate Ligament Reconstruction

N=130 (DB=65, SB=65), x-ray before and at final follow up

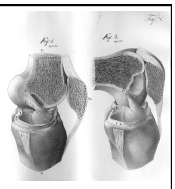
F/U average 5.5 years

Graft Failure DB=4, SB=2

-> DB technique compared to SB not more effective in prevention OA and did not have a more favorable outcome after minimum 4 years follow-up

Song et al. Am J Sports Med 2013

Take home



- Look out for the anatomy! It does not change over years!
- Single bundle not single bundle!
- Newer techniques show biomechanical advantages (AM portal drilling)
- Individualized surgery! (Double bundle in large footprints?)
- Difficult to measure clinical differences between anatomical SB and DB
- small advantages for DB compared to SB (however not statistically)

Take home

- Look out for the anatomy! It does not change over years!
- Single bundle not single bundle!
- Newer techniq ? ? ? ? ? al advantages
- Individualized surgery! (Double bundle in large footprints?)

DB takes more surgical time
More expensive (4 Fixation points)
Revision more difficult?

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