

# 2019 ARTHREX TECHNOLOGY SYMPOSIUM

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## ACL graft selection and related data. Is there any “Best” graft?

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# Introduction

- While mechanical strength and fixation issues have been optimized graft choice remains a controversial issues regarding
  - Harvesting morbidity
  - Clinical outcome
- Historically BTB was the graft of choice
- Quadrupled HST has known a large development due to the ease of harvesting and less residual AKP vs BTB
- Other options include
  - Central third of the quadriceps tendon
  - Allografts
  - Synthetics

# 01 Autografts

Table 1: Main mechanical properties of ACL tissue grafts

<i>Graft</i>	<i>Ultimate Strength (N)</i>	<i>Stiffness (N/mm)</i>	<i>Cross-Sectional Area (mm<sup>2</sup>)</i>
Intact ACL	2160	242	44
BTB (10mm)	2977	620	50
Quadruple hamstring	4590	861	53
Quadriceps tendon (10mm)	2352	463	62
Anterior <u>tibialis</u> tendon (single)	3412	344	38
Posterior <u>tibialis</u> tendon (single)	3391	302	48

All these grafts exhibit a **mechanical strength** above the native ACL as well as a much higher **stiffness**  
This is related to **collagen fibers orientation**  
(parallel vs spiraled)

# Commonly used autografts

- Central third of the patellar tendon with 2 bone plugs (BPTB or BTB)
- Four-stranded hamstring tendons (either 2xGracilis and 2xST, or 4xST)
- Central third of the quadriceps tendon

# 01-1

## Autografts long term results

# BTB outcome beyond 10 years\* (10-24.5 years)

- IKDC A & B: 46-90.6 %
- IKDC subj:74-83
- Return to same sports level: 84%
- Grade 2-3 OA: c.a. 20%
- Re-rupture: <5 % (new trauma)
- Revision rate: <2%
- Main issue: AKP 15-94%

\* Mihelic R et al 2011, Gerhard P et al 2013, Ahn JH et al, 2012, Pernin et al 2012, Leys T et al 2012

# HST outcome beyond 10 years\* (10-15 years)



- IKDC A & B: 75-90.3 %
- IKDC subj:75-90
- Grade 2-3 OA: c.a. 20%
- Re-rupture: 8-17 % (new trauma)
- Main issue: Re-rupture

\* Leiter JR et al 2013, Leys T et al 2012, Streich NA et al 2013



## QT outcome (2-5 years)\*

- No long term results
- Low postoperative pain
- Low harvesting site morbidity
- Low complication rate
- Residual laxity as BTB
- Better flexor muscles strength recovery

\*DeAngelis JP et al 2008, Sione HS et al 2014, Xerogeanes JW et al 2017, Iriuchishima T et al 2017

## Summary of the factors to be considered in ACL autograft selection

Graft type	Anterior knee pain	Anterior knee numbness	Failure rate	Knee tightness	Residual weakness	Extension deficit	Patient satisfaction
BPTB	High	High	Low	High	Quadriceps muscle	High	High
Hamstring	Low	Low	Slightly Higher	Slightly lower	Hamstrings	Low	High
Quadriceps	Low	Low	Low	High	Quad mucle	Low	High

# 01-2

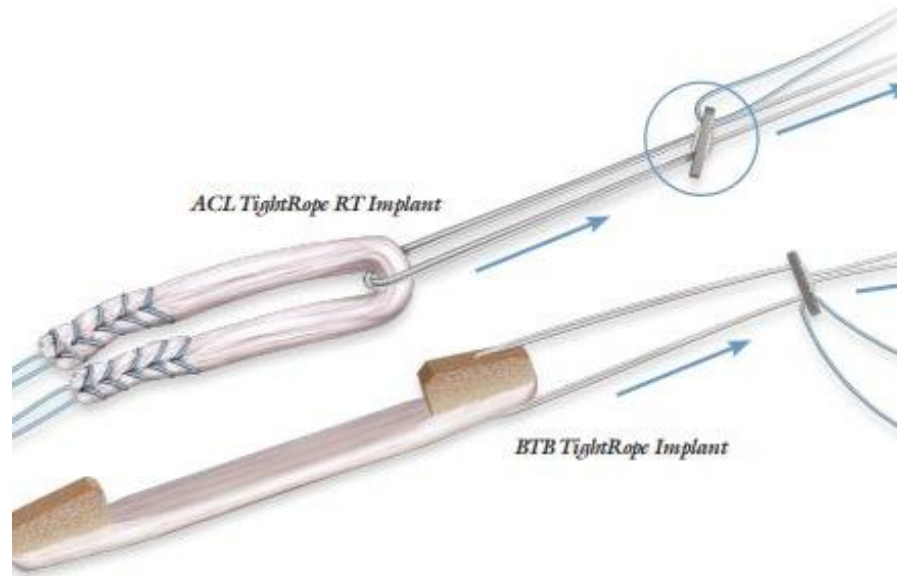
## Autograft comparative studies

# 4SHT vs BTB- Meta-analysis

- Li S et al, 2012: 9 RCT (225 BTB vs 266 HST)
  - BTB significantly less pivot shift
  - HST less AKP
  - HST less extension deficit
  - HST more graft failure
  - No difference in knee function but BTB provides better stability
- Xie X et al, 2015: 14 RCT, 8 prospective cohort studies (931 BTB vs 999 HST)
  - No difference in residual laxity, objective IKDC, graft failure, extension or flexion deficit
  - BTB significantly less pivot shift
  - BTB significantly more return to preinjury level
  - 4SHT significantly less AKP and kneeling pain

# 4SHT vs BTB- Meta-analysis

- Samuelsen BT et al, 2017
  - 14 RCT, 10 prospective comparative studies, 1 high quality national registry i.e 47,613 patients with 2-10 years FU
  - Significantly more graft ruptures in the 4SHT group but failure rate remains low (2.8% vs 2.84%)
  - No difference for pivot shift and Lachman test



# QT vs 4SHT or BTB- Meta-analysis



- Hurley ET et al, 2018
  - 15 clinical trials, 1910 patients
  - QT resulted in significantly less AKP than BTB
  - No difference in graft rupture between QT, 4SHT, BTB
  
- Belk JW et al, 2018
  - 8 RCT 368 QT vs 225 BTB and 150 4SHT, 2.9 yrs FU
  - QT resulted in less post-operative laxity than 4SHT
  - QT and BTB showed no laxity difference
  - No difference in graft failure rate (av. 2.8%) for QT, BTB, 4SHT

# QT vs 4SHT or BTB- Meta-analysis



- Mouarbes D et al, 2019
  - Meta analysis level 2
  - 27 studies including 2856 patients: 581 QT, 514 BTB, 1761 HS
  - QT vs BTB: no difference for KT1000, Lachman test, pivot-shift, Lysholm, IKDC subj or graft failure.
  - QT showed significantly less donor site pain compared to BTB
  - QT vs HS: no difference for KT1000, Lachman, pivot-shift, IKDC subj, donor site pain, graft failure
  - QT showed a significant better Lysholm score than HS

# 02 Allografts



# Allografts

- Avoid drawbacks of tendon harvesting morbidity
- This is the graft of choice in the USA (legal issues) for primary ACL (40% in Kaiser Permanente centers vs 0.3-6.3% in Europe)
- Fresh frozen tendons are the most widely used: tibialis anterior/posterior, Achilles, BTB, and even HS
- Issues: tissue bank reliability for donor selection, revision rate, and cost



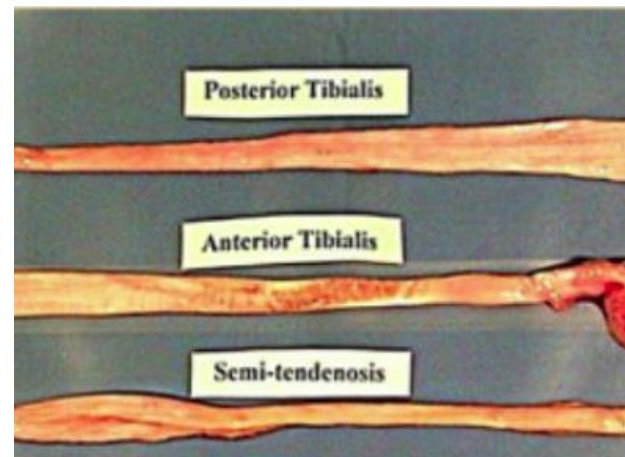
A. Achilles tendon



B. Hamstring tendon



C. Patellar tendon



# Allograft outcome

- Almqvist KF et al, 2009. 50 pts 10.5 years FU
  - Isolated ACLR
  - Tibialis anterior or posterior, fresh frozen
  - IKDC 97(74-100)
  - Lysholm median value 95 (76-100)
  - Failure rate 5.45 %, trauma-related

# Allograft outcome- Comparative studies Allo vs Auto\*



- Edgar CM et al, 2008. Allo 4SHT vs auto (level 2)
  - Prospective cohort study of 84 patients with 4 years av. FU (3-6 years)
  - No difference for functional scores, KT 1000 and IKDC
  - No difference in re-ruptures
  - Allograft revision rate: 4.3%
  - Autograft: 8.1%
  
- Kleipool AE et al, 1998. 36 Allo BTB vs 26 auto
  - 46 months FU
  - Allo group: 85% IKDC A & B
  - Auto group: 70 % IKDC A&B (NS)

# Allograft outcome- Systematic reviews Allo vs Auto\*



- Foster TE et al, 2010
  - 31 prospective comparative studies level 1 or 2 (BTB & 4SHT)
  - No KT 1000 difference
  - IKDC A or B: Allograft 82.9% vs 87.2% in Auto group
  - Failure rates: 8.2% for allo group vs 4.7% in auto group (NS)
  - More complications in the autograft group but NS
  
- Maletis GB et al, 2013.
  - Multicenter study involving 9817 primary ACLR with mean 1.5 yr FU
  - Comparison auto BTB vs auto HS and allografts (many types)
  - Allografts had a 3.02 times higher risk of revision compared with auto BTB
  - Auto HS behave similarly to allografts
  - For each year increase in age the risk of revision decreased by 7 %

# 03 Discussion

# Discussion

- In the field of ACL graft choice medical literature is far to be optimal.
- Many comparative studies have a low level of evidence 2-4.
- Meta-analyses do not reach identical conclusions and include significant bias.
- Currently there is no meta-analysis level 1 available for ACL graft choice and despite numerous published articles there is no clear-cut evidence of the superiority of one graft source vs another

# Discussion- Autografts

- Overall, BTB provides an excellent stability, minimal residual laxity, a high and earlier return to sports at the same level.
  - Issues: cosmesis, KP, pain at kneeling. However, situation has improved with double incision technique and subcutaneous harvesting saving of the infrapatellar branch of the saphenous nerve.



# Discussion- Autografts

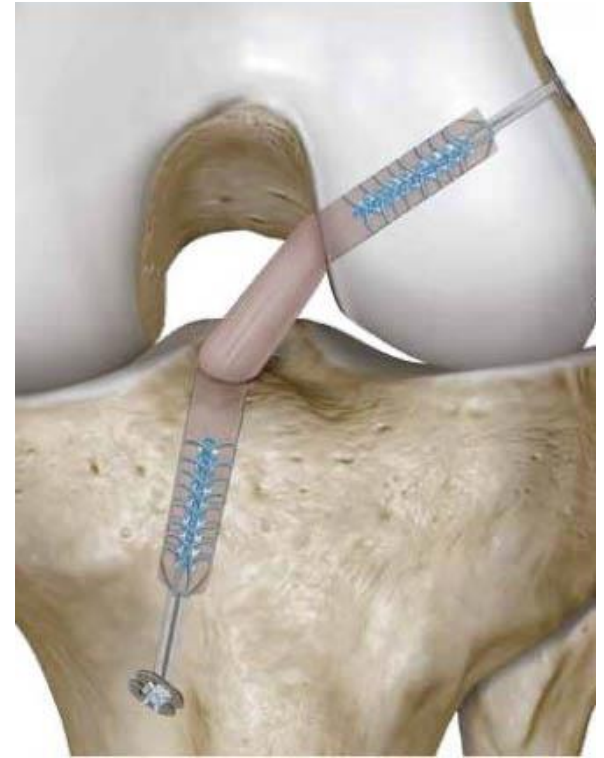
- 4SHT: function similar to BTB, slightly more residual laxity mostly in female patients, almost no harvesting site morbidity.
  - Issues: decrease flexor strength (which may contribute to graft re-rupture), higher failure rate than BTB mostly in females and hyperlax patients also when graft diameter <8mm.





# Discussion- Autografts

- QT: similar results to BTB without harvesting site morbidity.
  - Issues:?



# Discussion-Allografts

- Major advantages: no donor site morbidity, shorter procedure, less post-operative pain.
- Functional and anatomical results similar to 4SHT with (maybe) a higher failure rate.
- Failure rate depends on graft processing, source, age and activity level of the recipient.
  
- In terms of cost effectiveness (Mistry H et al, 2019) clinical results with autografts are as good as or slightly better than with allografts. However, allografts cost more, indicating that autografts are more cost-effective and should usually be the first choice.
  - Cost of an ACL allograft (UK 2016/17 prices): £ 2,250 (USD 2,884)
  - Total cost of the procedure with allograft: £ 4,395 (USD 5,634)
  - Total cost of the procedure with autograft: £ 2,145 (USD 2,750)



# Discussion

- Both auto and allografts can provide excellent results in ACL reconstruction and lead to a high percentage of satisfied patients.
- However, differences exist among the graft choices.
- Both the similarities and the differences are important to discuss with the patients so that they get the best information available when making a graft's choice.

# Discussion

- Graft source is not the only cause for graft failure.
- Many other factors have to be taken also into consideration: surgical technique with graft positioning, fixation devices, secondary restraints, rehabilitation.

# 04 Take-home messages

# Take home messages

- There is no “Best” graft
- There is no universal graft for ACL reconstruction
- Discuss with the patient and adapt the choice to his/her profile
- ONE TYPE CAN'T FIT ALL !
- Remember graft choice is only one factor contributing to the success of ACL Rec. Graft positioning, fixation, rehabilitation, secondary restraints insufficiency are also KEY FACTORS

Thank You