Lateral Extra-Articular Tenodesis in Primary Anterior Cruciate Ligament Reconstruction: A Cost-Effective Approach to Lowering Subsequent rupture Rates in High-Risk Patients

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INTRODUCTION: Recent ACL reconstruction methods have shown good outcomes, but studies indicate up to a 20% failure rate in young athletes. Lateral extra-articular tenodesis (LET) is revisited as an adjunct to hamstring autograft ACL reconstruction, reducing instability and re-rupture without increasing osteoarthritis risk. This study explores the cost-effectiveness of incorporating LET in primary ACL reconstruction for high-risk of subsequent re-ruputre patients.

METHODS: Data from the 2-year STABILITY Study on ACL rupture rates with and without LET, alongside hypothetical values representing the iinterquartile range (IQR) of re-rupture rates of STABILITY reported values, were collected. Costs associated with primary ACL reconstruction and revisions for subsequent ruptures were compiled from institutional records and literature to estimate both institutional and national average costs of LET. A cost-benefit analysis using a range of literature values calculated the breakeven point for adding LET, factoring in reduced rupture rates, revision costs, and LET expenses. Additionally, an analysis of KOOS scores from the two-year outcomes of the STABILITY randomized control trial was performed.

RESULTS: At our institutional LET price estimation of $1,188.00, adding LET to primary ACLR is cost-effective up to the price of $1,331 It remains cost-effective at the current price up to an ARR of 4.75, using national subsequent cost of revision ACL and 2-year STABILITY trial. Furthermore, the inclusion of LET remains cost-effective even when considering the national average cost of treating subsequent ACL ruptures. Additionally, it offers enhanced short-term quality of life benefits for up to 24 months post-surgery.

DISCUSSION AND CONCLUSION: Our analysis supports the cost-effectiveness of adding LET to primary ACL reconstruction within specified price and outcome parameters. This approach not only benefits indicated patients by improving their quality of life and decreasing subsequent rupture rates but also reduces the economic burden associated with treating subsequent ACL ruptures through revision ACL reconstruction on healthcare systems.

Figure 1: Break even cost benefit analysis

$$S_{total} \times C_t \times RR_{ACL} = (S_{total} \times C_{LET}) + (S_{total} \times RR_{ACL\,\&\,LET})$$

Solving for C_{LET}

$$C_{LET} = (RR_{LET} \times C_t) - (C_t \times RR_{ACL})$$

Key: S_{total} = total annual surgery; C_t = national healthcare system cost for subsequent ACL revision; RR_{ACL} = rerupture rate from ACL cohort; C_{LET} = additional cost of LET in primary ACL reconstruction; $RR_{ACL\,\&\,LET}$ = rerupute rate in ACL with LET cohort

Adapted from Hatch et al. [17]

Figure 2: ARR needed for cost effective

$$S_{total} \times C_t \times RR_{ACL} = (S_{total} \times C_{LET}) + (S_{total} \times RR_{LET})$$

Solving for ΔRR: $RR_{ACL} - RR_{ACL\,\&\,LET}$

$$\Delta RR = C_b / C_t$$

Key: S_{total} = total annual surgery; C_t = national healthcare system cost for subsequent ACL revision; RR_{ACL} = rerupture rate from ACL cohort; C_{LET} = additional cost of LET in primary ACL reconstruction; $RR_{ACL\,\&\,LET}$ = rerupute rate in ACL with LET Cohort

Adapted from Hatch et al. [17]

Figure 3: Break even rate at different healthcare system subsequent ACL repair

$$S_{total} \times C_t \times RR_{ACL} = (S_{total} \times C_{LET}) + (S_{total} \times RR_{LET})$$

Solving for ARR:

$$Break\ Even\ Rate = (C_t \times RR_{ACL} - C_b) / C_t$$

Key: S_{total} = total annual surgery; C_t = national healthcare system cost for subsequent ACL revision; RR_{ACL} = rerupture rate from ACL cohort; C_{LET} = additional cost of LET in primary ACL reconstruction; $RR_{ACL\,\&\,LET}$ = rerupute rate in ACL with LET Cohort

Adapted from Hatch et al. [17]

Figure 4: Cost per unit increase in Knee Injury and Osteoarthritis Score (KOOS Scores) from STABILITY DATA

$$\frac{(C_{ACL+LET} - C_{ACL})}{(KOOS_{ACL\,\&\,LET} - KOOS_{ACL})}$$

Key: $C_{ACL+}C_{LET}$ = Cost of primary ACL repair with LET; C_{ACL} = Cost of primary ACL repair; $KOOS_{ACL\,\&\,LET}$ = Knee Injury and Osteoarthritis Score for cohort with ACL and concurrent LET; $KOOS_{ACL}$ = Knee Injury and Osteoarthritis Score for primary ACL cohort repair.

Table 1: Itemized Computation for National LET Costs Using Literature and Intuitional Data.

Procedure	Operative Time	Cost OR JAMA	OR Time	Work RVU (32.74/unit)	RVU (32.74/unit)	Totaling RVU Costs	OR Sutures and Staple
LET	15 min	$36/min	$540	9.79	8.8	$608	$40

Table Key: OR: Operating Room; RVU: Relative Work Value; LET: Lateral extra-articular tenodesis

Table 2: Analysis of ARR and Break-even Rates Across Varied LET Costs with Stability Data.

Price Quartiles	LET Price Ranges ($)	Break Even Re-rupture reduction Rate w/ mean revision cost	Absolute Risk Reduction Needed for Cost Effectiveness	Cost Effective (7%)[3]
50%	594.00	3.12%	7.88%	Yes
75%	891.00	4.69%	6.31%	Yes
Institutional Price	1188.00	6.25%	4.75%	Yes
Cost Effectiveness Threshold	1,331.16	7.00	4.00%	-
125%	1485.00	7.81%	3.19%	No
150%	1782.00	9.37%	1.63%	No

Table 3: Break-even Rates Across Various Revision ACLR healthcare system costs

National Healthcare System Cost[14]	Cost of treating subsequent ACL Reconstruction	Break-even Re-rupture Reduction Rate with institutional LET Cost	ARR Needed for Cost Effectiveness	Cost Effective (7%)
25%	$11,775.91	0.91%	10.09%	No
Median	$16,238.43	3.68%	7.32%	No
50%	$19,016.54	4.75%	6.25%	Yes
75%	$23,100.62	5.86%	5.14%	Yes

Table Key: ARR: Absolute Risk Reduction; LET: Lateral Extra-articular tenodesis; ACL: Anterior Cruciate Ligament; ACLR: Anterior Cruciate Ligament Reconstruction

Table 4: Calculating Incremental Cost-Effectiveness Ratio (ICER) with Knee Osteoarthritis Outcomes Score (KOOS) Data from the STABILITY Study

Incremental Cost Effectiveness Ratio (ICER) KOOS						
Time	KOOS ADLs	Price per KOOS ADLs improvement	KOOS Recreation	Price per KOOS Recreation	KOOS QOL	Price per KOOS QOL
3 M	2.5	$ 475.20	4.7	$ 252.77	3	$ 396.00
6 M	1.6	$ 742.50	3.4	$ 349.41	3.6	$ 330.00
12 M	0.7	$ 1,697.14	1.6	$ 742.50	4	$ 297.00
24 M	0.2	$ 5,940.00	0.2	$ 5,940.00	-1.1	$ (1,080.00)

Table Key: ADL: Activities of Daily Living; KOOS: Knee Osteoarthritis Outcomes Score. QOL: Quality of Life; ACLR: Anterior Cruciate Ligament Reconstruction