Long-Term Outcomes Of Physeal Sparing Over-The-Top Anterior Cruciate Ligament Reconstruction with a Lateral Extra-articular Tenodesis In Skeletally Immature Patients results in decreased failure rate and good functional outcomes: Up To 17-Years Follow-Up

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INTRODUCTION:

While the rate of anterior cruciate ligament (ACL) injuries and reconstruction procedures in children and adolescents is increasing, evidence of long-term outcomes after ACL reconstruction in skeletally immature patients is still lacking. The purpose of this study was, therefore, to assess the long-term survivorship from failure and reoperations and to analyze the functional results and patient reported outcomes (PROMs) in skeletally immature patients who underwent ACL reconstruction with hamstring tendons with an over-the-top technique associated with a lateral extra-articular tenodesis (LET).

METHODS:

Retrospective case series, level of evidence 4. Patients were considered "skeletally Immature" if they had the presence of a femoral and/or tibial open physes in knee MRI at the time of surgery. Ipsilateral and/or contralateral reoperations were recorded. Knee Injury Osteoarthritis Outcome Score (KOOS), Lysholm, and Tegner Activity Level scores were collected at final follow up. Survivorship was inspected through Kaplan Maier method with ipsilateral ACL revision as endpoint. Differences in demographics and PROMs were assessed through Student's t-test.

RESULTS:

43 patients (average age at surgery 13.3 ± 1.6 years) all treated with an OTT technique associated with a LET, at mean follow-up of 11.0 ± 2.7 years were included.

4 patients (9%) underwent revision ACL in the ipsilateral knee at an average of 5.3 ± 2.4 years after surgery, with a failure rate of 5% at 5-year and 10% at 10- and 15-year. A total of 8 patients (19%) underwent contralateral ACL reconstruction after an average of 3.7 ± 3.0 years after surgery. The rate of contralateral ACL reconstruction was 2% at 1-year, 7% at 2-year, 12% at 5-year, 20% at 10-year and 20% at 15-year.

4 patients (9%) underwent knee arthroscopy for a new meniscus tear after an average of 2.2 ± 0.8 years. Moreover, 5 patients (12%) underwent staple removals due to local discomfort. A total of 11 patients (26%) underwent at least one re-operation in the ipsilateral knee after an average of 3.0 ± 2.1 years.

Considering also the previously reported 4 ipsilateral ACL Revisions, a total of 12 patients (28%) experienced a 2nd ACL injury after an average of 4.2 ± 2.8 years from surgery. The overall 2nd ACL injury rate was 2% at 1-year, 7% at 2-year, 16% at 5-year, 30% at 10-year and 30% at 15-year. A higher rate was reported in males, however without statistical significance (p=0.3133).

KOOS subscales were all above the patient acceptable symptom state. Patients with <13 years at surgery showed worse Lysholm and KOOS-ADL compared to those with ≥13 years. Tegner Activity Level score at final follow-up was significantly higher than before surgery and lower than pre-injury level.

DISCUSSION AND CONCLUSION:

The main finding of this study was that physeal sparing over-the-top ACL reconstruction with LET in skeletally immature patients provided a survivorship free from ipsilateral revision ACL reconstruction of 90% at 10- and 15- years of follow up. The rate of ipsilateral ACL re-injury at long term follow up found in the present study was lower than previously reported in the literature after physeal sparing ACL reconstruction using hamstring tendons autograft. Moreover, literature showed that the addition of a LET to ACL reconstruction in this kind of patients was associated with promising short-term outcomes; this aspect was further highlighted by this study, which showed a higher survivorship even at very long term follow up in patients with an associated LET compared to previous studies in which an isolated intraarticular ACL reconstruction with hamstrings was performed. On the other hand, one fourth of the patients needed at least one reoperation. This study also showed that a significantly higher rate of subsequent hardware removal procedure and poorer functional outcomes can be expected among patients under 13 years of age at surgery compared with older patients.

Figure 1: Physeal sparing over-the-top ACL reconstruction with hamstrings tendon autograft and lateral tenodesis. A) Antero-posterior view; B) Lateral view.

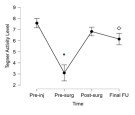

Figure 2: Tegner Activity Level score changes in time. Asterisk represents differences between pre-surgery time and the other three time points; diamond represents differences between pre-injury level and final follow-up.

Table 1: Demographic and Surgical Characteristics

Age at Surgery (years)	13.3 ± 1.6
<13 years	10 (23%)
≥13 years	33 (77%)
Age at Final Follow-up (years)	24.3 ± 1.9
Follow-up (years)	11.0 ± 2.7
Sex (Males/Females)	32 (74%)/11 (26%)
Medial Meniscus Injury	9 (21%)
Repair	7
Meniscectomy	2
Lateral Meniscus Injury	13 (30%)
Repair	6
Meniscectomy	7

Table 2: Rate of 2nd ACL Injuries

	1-year	2-year	5-year	10-year	15-year
Ipsilateral ACL Revision	0%	0%	5%	10%	10%
Contralateral ACL Reconstruction	2%	7%	12%	20%	20%
2nd ACL Injury	2%	7%	16%	30%	30%
Males	3%	9%	22%	45%	45%
Females	0%	0%	0%	18%	18%

Table 3: Patient Reported Outcomes (PROMs)

	Overall	Male (n=30)	Female (n=11)	p-value	Age<13 (n=10)	Age≥13 (n=33)	p-value
VAS Rest	0.8 ± 2.2	0.9 ± 2.4	0.5 ± 1.8	0.627	1.5 ± 3.2	0.6 ± 1.8	0.278
VAS Active	1.3 ± 2.5	1.2 ± 2.4	1.5 ± 2.3	0.759	1.6 ± 3.2	1.2 ± 2.0	0.608
Lysholm	91.5 ± 15.7	91.7 ± 16	91.1 ± 15.5	0.959	82.0 ± 23.4	94.6 ± 11.1	**0.025**
KOOS							
QoL	93.1 ± 12.6	93.9 ± 12.2	91.1 ± 14.1	0.534	92.1 ± 14.4	93.5 ± 12.2	0.767
Symptoms	92.6 ± 16.3	92.6 ± 17.3	92.4 ± 13.9	0.973	85.3 ± 22.4	94.9 ± 13.4	0.103
ADL	99.1 ± 4.0	99.1 ± 4.6	99.2 ± 2.2	0.984	96.7 ± 8.0	99.9 ± 0.3	**0.025**
Sport	97.2 ± 7.8	97.2 ± 7.9	97.2 ± 7.8	0.985	94.9 ± 8.2	97.3 ± 7.8	0.484
Pain	97.8 ± 5.4	97.8 ± 5.8	97.8 ± 4.4	0.986	95.9 ± 8.4	98.4 ± 4.1	0.218