International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2023; 9(1): 76-80

https://www.orthopaper.com
Received: 05-10-2022
Accepted: 13-11-2022

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Radiographic changes among patients post anterior cruciate ligament repair

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DOI: https://doi.org/10.22271/ortho.2023.v9.i1b.3275

Abstract
Introduction: Many studies have been done indicating patients more likely to develop osteoarthritis (OA) post anterior cruciate ligament (ACL) injury in spite of having an anterior cruciate ligament reconstruction (ACLR) done. In this study, we aimed at identifying factors causing early post traumatic arthritis (PTOA) among patients who've underwent ACLR. The hypothesis used here was that cartilage defects and meniscus injuries would also contribute to worse PTOA based on the Osteoarthritis Research Society International (OARSI) atlas criteria.
Methods: A total of 30 patients who agreed for ACLR returned for follow-up took semiflexed knee radiography at least 12 months post ACLR. Baseline data of demographics, meniscal status/treatment, graft used, and status of the cartilage were collected. All knee radiographs were graded based on the OARSI criteria.
Results: Higher OARSI grades were noted among the patients, with meniscal repair/meniscectomy, with a mean of 5.14 involving both the compartments on the medial and lateral sides. The overall OARSI grading difference between both knees for the patients after ACL reconstruction showed more osteoarthritic changes in the affected knee with a mean score difference of +2.43. Gender, graft type, cartilaginous defects was not significantly associated with higher OARSI grade.
Conclusion: Analysis of the 40 patients in our study showed that after a follow-up period of 12 months, shows that post ACLR patients are likely to develop OA changes at an early time point of 12 to 18 months. These results will be useful in counselling patients regarding the explanation of the risks. ACL tear patients who are not in need of meniscal repair post meniscus damage with cartilage defects can be reassured of the less chances of developing early OA changes within 12 to 18 months of ACLR.

Keywords: Anterior cruciate ligament; meniscal injury; articular cartilage; knee osteoarthritis

Introduction
Anterior Cruciate Ligament reconstruction is one of the best options out there for patients who have an ACL tear and need to return to their active lifestyle. Many studies show that post traumatic osteoarthritis (PTOA) is highly likely in ACL tear patients despite undergoing ACLR [1, 2].In our study, patients came back for clinical examination, functional testing and x-rays [standardized posteroanterior, semiflexed metatarsophalangeal(MTP) views] of both knees after a minimum of 12 months after ACLR. The study sample enrolled patients who've torn their ACL, with previously healthy uninjured knees with nil prior surgeries. Changes according to the compartments have also been mentioned. Osteoarthritis Research Society International (OARSI) atlas criteria which is a whole joint grading system was used in this study. It assesses the joint based on compartment wise changes and structural changes of osteoarthritis (OA). The theoretical assumption was meniscus damage and cartilaginous defects found during the ACLR would be linked with worse PTOA changes based on the OARSI grading after 12 to 18 months.

Materials and Methods
The ACL injured patients were selected for the study based on the following criteria for the Inclusion criteria:
- age<40 years of age
- No concomitant ligament surgery

- No revision surgery
- Surgically normal contralateral knee

Exclusion criteria

- Pregnancy
- Previous ipsilateral intra-articular surgery
- Double-bundle technique
- Patella fracture
- Partial ACL sparing technique
- Intra-articular infection
- Meniscus transplant

Standardised forms were filled up by the study subjects at the time of the procedure. The operating surgeon filled forms which included: graft type (bone–patellar tendon–bone autograft, hamstring tendon autograft, or allograft), meniscal damage, treatment for meniscal damage (no tear, untreated tear, partial meniscectomy, total repair), and cartilage status based on modified Outerbridge classification was graded from grade 1 to 4. The operating surgeons had agreed upon the treatment and grading systems and showed high reproducibility.

For all cases tourniquets were applied. Standard anteromedial (AM) and anterolateral (AL) portals were used for exploratory and diagnostic purposes to assess the cartilage and meniscus status. With precision and care the ACL was removed with specific attention being given to the ACL bundles. ACL double -bundle reconstruction was done through transtibial technique to create the femoral tunnel. Guide wire was placed on the femoral footprint of the AM bundle through the tibial tunnel. A depth of 35 to 40mm was drilled for the AM femoral tunnel. Drill bit of size 4.5 mm was used to breach the far cortex of the AM femoral tunnel. After concentric reaming femoral socket was formed. Marking hook was mounted on the femoral guide and was pushed into the socket. From the medial to lateral direction a guide pin was drilled through the femur. Guide wire replaced the guide pin and it was taken through the tibial tunnel. Wire loop loaded with graft was used. The tendon grafts were trimmed and diameters were adjusted. AM tendon graft was trimmed such that the diameter came to 8mm to 9mm.and likewise the PL graft was trimmed till a diameter of 7 to 8 mm. Beath pin with a long looped suture was passed from the AM portal and out through PL portal. Bioabsorbable screws was fixed on the tibial side. At 0° to 10° of flexion, the PL bundle was tensioned and fixed. Likewise AM bundle was fixed at 60 to 90 degrees of flexion. The rehabilitative phases were

1. From the procedure to roughly 2 weeks. Aim-to achieve full range of motion and normal gait
2. Approximately 2-6 weeks. Aim - improvement of the strength of the muscles and providing neuromuscular preparation
3. Approximately 7-12 weeks. Aim - ability to run and jump.
4. Approximately 13-16 weeks. Aim - advancing of ability to run and jump
5. Approximately 17 weeks and onward. Aim - ability to play sports with 85% contralateral strength and contralateral on hop tests.

X rays were taken when patients came for follow up after a period of 12 months following ACLR. When there were image quality issues associated with certain patients they needed to be excluded from further study. Institutional approval was obtained. Bilateral knee radiography in standardised semiflexed knee MTP views were taken. The OARSI atlas criteria were used to grade all knee radiographs. An orthopaedic resident and a radiology resident were chosen as independent raters for the bilateral knees. Both the raters were blinded for the assessment. Scores were averaged when there was a disagreement. Chi-square test was used to find the p-value which was found to be significant at less than 0.05. The outcomes measured were the difference in OARSI grades for the affected knee minus the unaffected knee for i.) the medial compartment, ii) the lateral compartment, and iii) total knee (sum of the compartments on the medial and lateral sides).

Results

Of the 30 patients included for this study 22 patients were found to have developed osteoarthritic changes. The changes were graded based on OARSI atlas. Of the 30 patients enrolled 11 were female and 19 were male. The age distribution was between 21 and 39 years of age with a mean of 31 years. 16 patients had their right ACL affected and 14 had the left side affected.29 of them had associated meniscus damage- 14 patients had medial compartment involvement, 11 of them had lateral compartment involvement and 4 of them had both meniscus involvement on the affected knee.9 patients had total meniscal repair done.13 patients had partial meniscectomy done. (Figure 1)

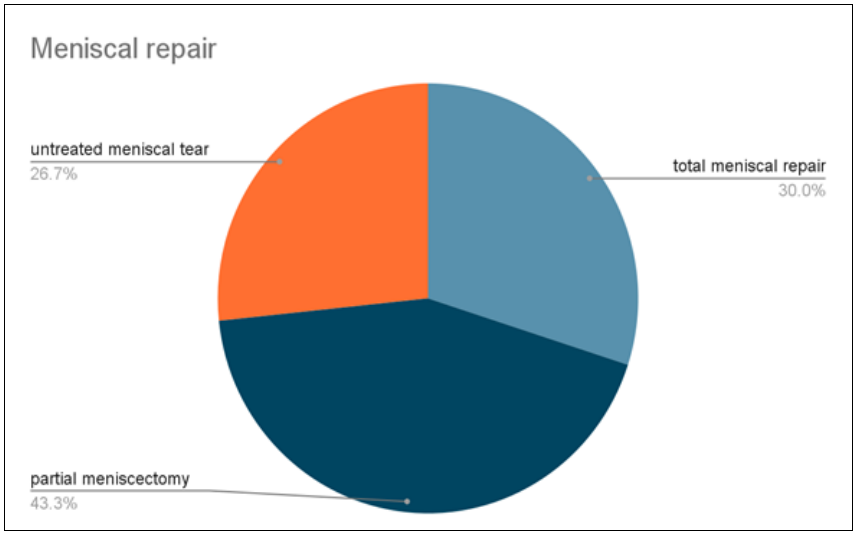

Fig 1: showing percentages of patients who underwent meniscal repair, partial meniscectomy and untreated meniscal tears

7 patients had their meniscal damage treated conservatively since it wasn't large enough to warrant intervention. 9 patients had BMIs over 30.15 of patients had received a bone-patellar tendon -bone autograft while the rest received hamstring grafts. None of them received any allografts.6 patients had cartilage involvement. 22 patients who had undergone meniscal repair showed higher OARSI scores with a mean of 9.59 when compared to the other 7 patients who did not undergo any meniscal repair (mean OARSI score - 5.14). (Figure 2)

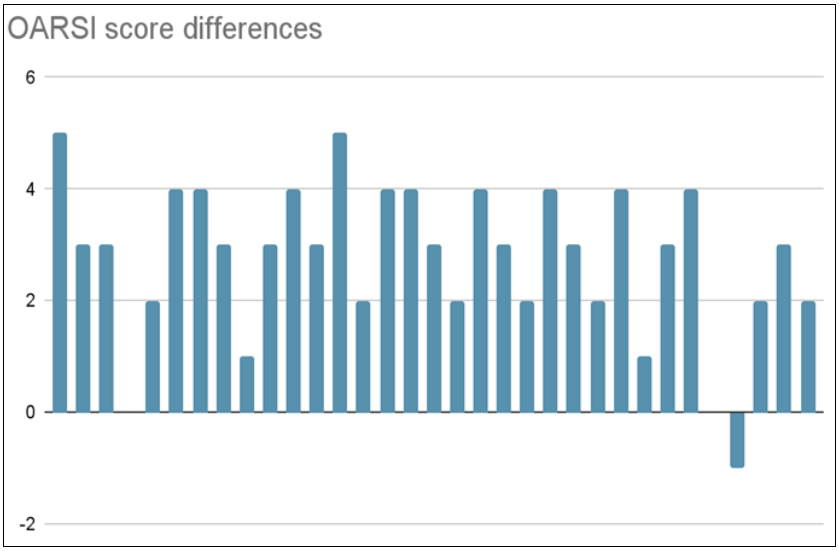

Fig 2: showing OARSI score differences between the affected knee and the contralateral knee for total combined scores involving both medial and lateral compartments.

The differences in the OARSI grades were calculated for the medial compartment and lateral compartment along with a total score calculation. The medial compartment score difference was having a mean of +1.5 (range -1 to +4). The lateral compartment score difference had a mean of +1.2 (range -1 to +4) with the total score difference standing at a mean of +2.43 (range -1 to +5). P-value was calculated using chi-square test and was found to be significant of value <0.05. Among the 23 patients, they had reported some postop complications such as infection-superficial (4) and deep (3), haemorrhage (2), graft failure (1) following the Acl repair. (Table 1)

Discussion

This study included 30 patients for the study and had at least 12 months of follow-up to predict the factors leading to PTOA following ACLR. We selected a relatively group of subjects [<40 years of age] who had an ACLR without concomitant ligamentous injuries [medial and lateral collateral ligaments, posterior cruciate ligament] with a normal unaffected contralateral knee without any history of surgical procedures; and did not have surgery done during the follow-up period either. OARSI grading was used to grade the radiographic changes. Patients had statistically significant worse PTOA in both compartments when they had undergone meniscus repair or meniscectomy. Meniscectomy showed more changes than patients who had undergone meniscal repair. Nontreated meniscus tears which were small and did not need surgical repair or meniscectomy did not show significant PTOA changes. The type of graft used, cartilage status and sex did not show any significant role in the PTOA changes noted. There were studies which analysed the chances of developing OA of the knee post ACLR. A study by Li *et al* [3, 4] did a study with 249 patients. It was a retrospective cohort study where they compared the KL grades in single bundle ACLR knees versus normal knee. Factors such as patients undergoing meniscectomy on the medial side, follow-up periods which were of longer duration, and BMI readings which were on the higher side were predicative of developing of knee osteoarthritis. A study by Patterson *et al* [5, 6] showed us a similar pattern where patients who were upwards of the normal BMI values along with higher age groups were at higher risk of developing osteoarthritis based on the MRI findings. A meta-analysis of previously done 16 studies with at least 10 years of postoperative observance by Claes *et al* revealed that post ACLR, a bisection of the total patients who underwent meniscectomy had developed OA changes associated with the knee while only 16% of patients, who did not undergo meniscectomy developed OA changes They utilized a follow up period of 1 to 5 years [5]. There was a study done by Culvenor *et al* with the help of findings from magnetic resonance imaging, with a follow-up period of 1 year. The injured knees were compared with their contralateral sound knees. It reports patients who underwent meniscectomy showed higher radiographic changes favouring osteoarthritis. [6] Similar changes were also present for those patients who had above normal BMI before and after the procedure.31 studies were systematically reviewed which showed that meniscus injury was major contributor to knee OA [7, 8, 9, 10]. This study differs from the previous studies, which have shown that meniscus damage contributes to OA, by showing that meniscectomy also gives rise to further OA changes. Even as early as 12 months, patients started showing OA changes, who underwent meniscal repair/meniscectomy, after adjusting for confounding variables. 10% meniscus contact reduction gives rise to 65% rise in peak joint contact stress, according to previous recent studies [11]. Higher stress on the cartilage of the articular surface could lead to faster OA changes of the injured knee. Post ACLR.A past finding that medial meniscal repair gave rise to reduced medial joint space is similar to the current finding of meniscus repair being linked with worse OARSI grading. One more previous study by our group revealed the lateral compartment joint space wasn't much affected post lateral meniscus repair but the current study shows OARSI grades leaning to more OA

changes. This probably might be due to more osteophytic formation than joint space narrowing since OARSI grades are used. Nepple *et al* did a meta analysis and found that 26.9% meniscal repairs failed (reoperation/ clinical failure) in ACLR knees, with outcomes followed up for 5 years. [12] It is plausible that below optimal surgical techniques/skill could have contributed to meniscus repair failure leading to more OA changes. Larger ACL tears requiring repair points towards greater injuries in terms of severity, which is also plausible. Astonishingly, one of our hypothesised factors cartilage defect did not show significant outcomes of OARSI grading. The study grouped cartilage defect grades 2 to 4 in a single group which does not give the results for grade 4 alone. [13] The current span for this study might be a bit short for detecting effects of articular cartilage defects, although a study by Shelbourne *et al* showed significant OA changes developing at a mean of 8.7year post ACL tear [14]. Articular cartilage defects which are focal might not be leading to wider OA changes radiographically. A further study with a longer follow-up period would be essential to give more accurate results. Since there were no baseline radiographs, that is to be considered as a limitation of this study. Since there were no baseline radiographs, the contralateral unaffected knee of the same patient was used for comparisons. It may be argued that such a method is superior in the sense the unaffected knee is subject to similar levels of stress, same genetics, age, activities and other factors which were not measured as the other knee which is studied in this study. This method was supported by Tourville *et al* and a few other studies [15, 16] Apart from the aforementioned factors, pre-operative varus/valgus alignment wasn't measured which can predispose to medial and lateral compartment changes in the study group. The other limitation that we might have experienced is that the follow-up period might be a bit too short for proper detection of OA changes and the OARSI grading might not have enough sensitivity to detect early OA changes.

Table 1: Patient demographics and data

S.no	Age	Gender	Side	Meniscus damage		Total Meniscus repair/partial meniscectomy	BMI>30	Graft type	Cartilage - involvement	OARSI total score Affected side	Difference in OARSI grades (affected knee - unaffected knee)		
				Medial	Lateral						Medial	Lateral	Total
1	28	f	r	y	n	TMR	y	BA	y	13	+4	+1	+5
2	32	m	r	n	y	PM	n	HA	n	8	+3	0	+3
3	25	m	r	y	y	TMR	y	HA	y	9	+3	0	+3
4	27	f	l	n	n	-	y	BA	y	2	-1	+1	0
5	33	m	r	y	n	PM	y	HA	y	8	+2	0	+2
6	39	f	r	y	y	TMR	y	HA	n	9	+1	+3	+4
7	31	m	l	n	y	PM	y	BA	y	8	+1	+3	+4
8	39	f	r	y	n	PM	y	HA	y	9	+3	0	+3
9	37	m	l	n	y	-	y	BA	y	4	0	+1	+1
10	39	m	r	y	n	PM	y	HA	y	8	+3	0	+3
11	34	f	l	y	y	TMR	n	BA	y	12	+3	+1	+4
12	21	m	r	y	n	-	y	BA	n	6	+2	+1	+3
13	33	f	l	y	y	TMR	y	HA	y	13	+3	+2	+5
14	35	m	r	y	n	-	y	BA	y	4	+2	0	+2
15	21	m	l	n	y	PM	n	HA	n	12	0	+4	+4
16	37	m	r	y	n	PM	n	BA	y	12	+3	+1	+4
17	25	m	l	n	y	PM	y	HA	y	9	-1	+4	+3
18	24	f	r	y	n	-	n	BA	y	5	+1	+1	+2
19	32	f	l	n	y	PM	y	BA	y	11	0	+4	+4
20	27	m	r	y	n	PM	n	HA	y	11	+4	-1	+3
21	26	f	l	n	y	-	y	BA	n	6	+1	+1	+2
22	30	m	r	n	y	TMR	n	HA	y	12	0	+4	+4
23	31	m	r	n	y	-	y	BA	y	5	0	+1	+1
24	38	m	l	y	n	PM	y	BA	y	11	+4	-1	+3
25	21	f	l	y	n	PM	n	HA	n	12	+4	0	+4
26	31	m	r	y	n	TMR	n	HA	y	9	+1	-1	0
27	37	m	l	y	n	-	n	BA	y	6	0	-1	-1
28	39	f	l	y	n	PM	y	HA	y	8	+1	+1	+2
29	31	m	l	n	y	TMR	y	BA	y	7	-1	+4	+3
30	32	m	r	n	y	TMR	y	HA	y	7	-1	+3	+2

Legend:
- TMR - Total meniscus repair
- PM - partial meniscectomy
- BA - bone-patellar tendon-bone-autograft
- HA - hamstring autograft

Conclusion

Analysis of the 40 patients in our study showed that after a follow-up period of 12 months, ACLR is associated with higher radiographic changes according to OARSI grading, involving both compartments of the knee. Patients who underwent partial meniscectomy/total meniscus repair were more likely to develop OA changes than those patients with meniscal defects left untreated. This study shows that post ACLR patients are likely to develop OA changes at an early time point of 12 to 18 months. These results will be useful in counselling patients regarding the explanation of the risks associated ACLR and meniscus repair/meniscectomy following ACL tear with/without meniscus injuries. ACL tear patients who are not in need of meniscal repair post meniscus

damage with articular cartilage damage can be reassured of the less chances of developing early OA changes within 12 to 18 months of ACLR.

Conflict of Interest
Not available

Financial Support
Not available

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How to Cite This Article
Ramkumar SDM, Ravi A, Kumar A, Sandeep PK, Subash Y. Radiographic changes among patients post anterior cruciate ligament repair. International Journal of Orthopaedics Sciences. 2023;9(1):76-80