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Prediction of Hamstring Graft length Preoperatively by Using Anthropometry in ACL Deficient Patient Undergoing ACL Reconstruction Surgery-a prospective study

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Abstract

Introduction: Preoperative estimation of graft parameters can be useful while using hamstring grafts in ACL reconstruction surgeries. This may be important during per operative execution of the planning. Anthropometric parameters may be an easy way to predict the length and diameter of hamstring tendons. A prospective study was conducted to find the correlation between different anthropometric parameters of the patients on the length and diameter of the graft.

Methods: In this study, we predict the length of the Hamstring graft pre-operatively by using Anthropometric parameters like age, sex, height, BMI, thigh circumference, and thigh length in ACL deficient patients undergoing ACL reconstruction surgery. A total of 30 patients were studied for an average duration of 9 months in the post-operative period through regular follow-up visits. The pre-operative and post operative Lysholm scores and IKDC scores were used to assess the functional outcome of this technique.

Results: A total of 30 patients, 29 males and 1females were studied. The commonest

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age group of patients was 17-31 years. The most common mode of trauma was Road Traffic Accidents followed by Sports Injury. Most patients presented to us with an isolated ACL tear. Patients height and thigh length demonstrated a Positive correlation with Gracilis and Semi tendinosus graft length for ACL repair while reconstruction surgery. Most of the patients (86.66%) had Excellent Lysholm scores at 9 month follow up. 93.33% of them were able to return to their pre injury activity level. The functional outcome was not affected by the age, sex, side or the associated injury. A very small proportion of patients developed minor complications that were easily managed by medications and physiotherapy.

Conclusion: Hamstring tendon graft length is predictable preoperatively by using anthropometric parameters. ACL reconstruction using a quadrupled hamstring graft is an excellent option for patients with ACL rupture and provides a stable functioning knee with minimal complications and no residual loss of range of motion.

Keywords: Anterior Cruciate Ligament, Reconstruction Surgery, Graft, Hamstring

Introduction

The knee joint is one of the most commonly injured joints in our body and the most commonly injured ligament in the knee is the anterior cruciate ligament. literature supports that the most common cause of ACL injury is various kind of sports activities. Due to the ever-increasing Road traffic accidents and increased participation in sports , there is an increase in the incidence of various Ligament injuries of the knee.[1]

The ACL is the primary stabilizer of the knee and prevents anterior translation, it restricts valgus and rotational stress up to a certain degree. The symptoms of an ACL injury are knee instability, pain and a decrease in joint functions. Although conservative treatment with intensive physiotherapy, bracing, and lifestyle modification can be tried in some patients with less anticipated knee function, in symptomatic young active individuals, ACL reconstruction is necessary.[1,2]

The main aims of ACL reconstruction are to restore intact knee stability and normal knee kinematics. ACL injuries are mostly associated with a meniscus injury, which needs to be addressed. Osteoarthritis of the knee is a common complication of ACL and meniscal injuries are not addressed properly. The standard procedure for ACL reconstruction is an arthroscopic reconstruction using an autogenous graft. Traditionally, bone patellar tendon bone was considered the gold standard; however, nowadays hamstring tendon (Gracilis and Semi-tendinosus) are being increasingly used for ACL reconstruction.[1,2]

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ACL reconstruction can be performed as a single or double-bundle procedure but due to the significant limitations of a double-bundle procedure, single-bundle ACL reconstruction remains the surgeons' choice. Despite the importance of hamstring autograft, individual variation in the width of the tendon remains a measure change if one can calculate the size of the graft pre-operatively. The decision of the hamstring Semi-tendinosus or Gracilis or both is to be planned.[1,2]

Some studies say it is possible to predict craft size using anthropometric measurements like Gender, Height, and Body mass index. Hence this study is a plan to co-relate the association of the anthropometrical measurement of an individual to the pre-operative assessment of hamstring tendon and graft size.

Aims and objectives

1. To predict hamstring graft length by using anthropometric measurement preoperatively.
2. The correlation of preoperatively measurement of the tendon length and diameter with preoperatively harvested graft length and diameter.
3. To study the functional outcome of the ACL reconstruction using the hamstring tendon graft in ACL deficient knees.

Methods and materials

This study was conducted at the Department of Orthopedics, LLRM medical college, Meerut for a period of 1.5 year duration. The study was conducted on 30 patients admitted through OPD of SVBP Hospital, Meerut and this was a prospective study.

Inclusion criteria

1. Age 20-50 years (skeletally matured) with clinical and MRI evidence of anterior cruciate ligament insufficiency
2. No history of previous surgery on knee
3. Anormal contralateral knee
4. Associated medial or lateral menisci injury
5. Associated Grade I and II LCL and MCL injuries

Exclusion criteria

1. Asymptomatic individuals
2. Any associated bony injury
3. Local skin infection
4. Associated posterior cruciate ligament injury Patient with osteoarthritic knee
5. Associated Grade III and IVLCL and MCL injuries

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6. Prior ACL reconstruction was done using a patellar bone tender graft, associated fracture, or hamstring injury.
   Patients with ACL tear proven clinically and radiologically were admitted to the Department of Orthopedics. Routine investigations like hemoglobin, total and differential counts, platelet counts, liver function tests, kidney function tests, random blood sugar, chest X-ray, and ECG was done for exclusion of any comorbidity and for preanesthetic workup.

All patients were explained about the injury, diagnosis, various management options . Consent for surgery was obtained from all the patients. Patients and their attendees were well explained the advantages and disadvantages of the procedure.
All the patients undergoing arthroscopic ACL reconstruction with an autologous hamstring graft, Pre-operative variable studied were age, sex, height, BMI, and thigh circumference. Thigh circumference was taken in the bulkiest portion of the contralateral thigh i.e approximately 15 cm above the superior pole of the patella. Thigh length was measured from the anterior superior lilac spine to medial joint line.

All the patients in our study were operated under spinal anesthesia in the supine position. All patients were subjected to post operative anteroposterior and lateral radiographs to determine the tunnel placement and position of endobutton and interference screw. Patients were followed at 6 weeks, 3 months, 6 months, and 9 months and functional outcome were assessed. The International Knee Documentation 2000 score(IKDC)[68] and Lysholm[68] and Gillquist Knee Scoring Scale were used for the evaluation of patients.

Data from 30 patients having ACL reconstruction with semitendinosus-gracilis (STGT) auto graft were evaluated. Variables included pre-operative height, weight, body mass index (BMI), age, gender, and intra-operative graft diameter and graft length measured.

After the analysis of data results were concluded statistically as Mean, Medium, Mode, Standard Deviation, Percentage and Frequency. Fisher's exact test was use to compare the proportions. Student's t-test and Mann-Whitney test were used to determine the mean difference between continuous data.

Observation & Result

In the present study, 30 cases of ACL injury were managed by arthroscopic ACL reconstruction with an autologous semitendinosus-gracilis graft with pre-operatively anthropometry and intraoperatively measurement of graft and follow-up for 1.5 years at regular intervals in LLRM Medical College, Meerut.

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Socio-demographic variables	Frequency	Percentage
Age		
17-24	10	33.33%
25-31	10	33.33%
32-38	6	20.00%
39-45	1	3.33%
46-52	3	9.09%
Gender		
Male	29	96.66%
Female	1	3.33%
Side		
Right	19	66.33%
Left	11	36.66%
Mode Of Injury		
Road Traffic Accident (RTA)	20	66.66%
Sports	9	30.00%
Fall	1	3.33%
Time Interval		
1-3 Months	16	53.33%
3-6 Months	10	33.33%
More Than 6 Months	4	13.33%

Table-1: Socio-demographic variables of study participants

Most of the patients in our study belong to the age group of 17-31 years (66.66%) Out of 30 Patients evaluate in our study, most were predominantly male (96.66%). Our patient's Right knee (66.33%) was more commonly injured than the left knee (36.66%). The common mode of injury in our study was due to RTA (66.66%) followed by Sports injury. Most patients 55.33% presented to us 1-3 Months after their injury.

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Spearman's rho		Weight (Kg)	BMI	Thigh Length (cm)	Leg Length (cm)	Thigh Circumference (cm)	Predict tendon length (TL)1	Predict quadruple diameter (QD)1	Predict tendon length (TL)2	Predict quadruple diameter (QD)2	Tendon Length (cm)	Quadruple Diameter (cm)
Height (cm)	Correlation Coefficient	0.292	-0.328	0.725	0.716	0.664	0.375	0.559	0.933	0.692	0.301	0.428
	p-value	0.117	0.077	0.000	0.000	0.000	0.041	0.001	0.000	0.000	0.106	0.018
	N	30	30	30	30	30	30	30	30	30	30	30
Weight (Kg)	Correlation Coefficient		0.737	0.302	0.219	0.154	0.113	0.237	0.384	0.729	-0.310	0.045
	p-value		0.000	0.105	0.246	0.417	0.553	0.207	0.036	0.000	0.096	0.814
	N		30	30	30	30	30	30	30	30	30	30
BMI	Correlation Coefficient			-0.112	-0.250	-0.382	-0.088	-0.107	-0.199	0.258	-0.439	-0.188
	p-value			0.557	0.183	0.037	0.645	0.575	0.292	0.168	0.015	0.321
	N			30	30	30	30	30	30	30	30	30
Thigh Length (cm)	Correlation Coefficient				0.717	0.537	0.565	0.574	0.856	0.818	0.220	0.462
	p-value				0.000	0.002	0.001	0.001	0.000	0.000	0.242	0.010
	N				30	30	30	30	30	30	30	30
Leg Length (cm)	Correlation Coefficient				1.000	0.552	0.470	0.453	0.744	0.665	0.154	0.416
	p-value				.	0.002	0.009	0.012	0.000	0.000	0.418	0.022

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	N					30	30	30	30	30	30	30
Thigh Circumference (cm)	Correlation Coefficient						0.408	0.585	0.648	0.531	0.343	0.397
	p-value						0.025	0.001	0.000	0.003	0.064	0.030
	N						30	30	30	30	30	30

Table-2: Correlation between Graft length and Graft Diameter with Parameters

Most patients presented to us with an isolated ACL tear. This study showed a strong correlation between height and graft length (r=0.41, p<0.001) and quadruple diameter (r=0.3, p<0.001). A statistically weekly significant correlation between weight and graft length (r=0.34, p=0.096) and the relation between weight and quadruple diameter (r=0.34, p=0.814) is completely insignificant and was also noted. BMI didn't show any correlation with the graft parameters. Thigh length was found to be significantly correlated with graft length (r=0.44, p=0.001) and quadruple diameter (r=0.35, p=0.001).

	Mean	**Std. Deviation**	**Std. Error Mean**	**T**	**p-value**	**Mean difference**	**SD difference**
Predict tendon length (TL)1	26.63	1.11	0.20	2.390	0.024	0.419	0.961
Predict tendon length (TL)2	26.21	0.84	0.15				
Predict tendon length (TL)1	26.63	1.11	0.20	-11.256	0.000	-2.934	1.428
Tendon Length (cm)	29.57	1.46	0.27				

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Predict tendon length (TL)2	26.21	0.84	0.15	-13.381	0.000	-3.353	1.372
Tendon Length (cm)	29.57	1.46	0.27				
Predict quadruple diameter (QD)1	10.48	13.36	2.44	1.014	0.319	2.472	13.355
Predict quadruple diameter (QD)2	8.01	0.13	0.02				
Predict quadruple diameter (QD)1	10.48	13.36	2.44	0.918	0.366	2.216	13.224
Quadruple Diameter (cm)	8.27	0.47	0.09				
Predict quadruple diameter (QD)2	8.01	0.13	0.02	-3.152	0.004	-0.255	0.444
Quadruple Diameter (cm)	8.27	0.47	0.09				

Table-3: Predict tendon length and quadruple diameter

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Most of the patients (86.66%) had Excellent Lysholm scores at 9 month follow up. 93.33% of them were able to return to their pre injury activity level.

	No. of Patients	Percentage
Pre-Op Lysholm Score		
Excellent (>90)	0	0.00%
Good (84-90)	0	0.00%
Fair (65-83)	6	20.00%
Poor (<65)	24	80.00%
Post-Op Lysholm Score (9 Months)		
Excellent (>90)	26	86.66%
Good (84-90)	4	13.33%
Fair (65-83)	0	0.00%
Poor (<65)	0	0.00%
Return to Pre-Injury Activity Level		
Yes	28	93.33%
No	2	6.66%

Table-4: Pre and Post-Op Lysholm Score

The functional outcome was not affected by the age, sex, side or the associated injury.

	Pre-Op Mean	Pot-Op Mean	Improvement
IKDS Subjective Score	51.7	95.4	45.80%

Table-5: IKDC Score Pre-op and Post-Op (9 Months)

The Mean pre-op IKDC score was 51.7 and the Mean post-op IKDC score was 95.4. there was average improvement of 43.7 (45.80%).

Complications	No. of Patients	Percentage
Graft Failure	0	0.00%
Neuropraxia	6	20.00%

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Knee Effusion	3	10.00%
Knee Pain	8	26.66%
Extensor Leg	3	10.00%
Septic Arthritis	0	0.00%

Table-6: Complications among study participants

A small proportion of patients developed minor complications like knee effusion in 3(10%),knee pain in 8 (26.7%) and extensor leg in 3(10%) . Aspiration of knee was required in 2 patients, in one it healed without any intervention. Knee pain and extensor leg healed with post operative medications and physiotherapy.

Discussion

The average age of patients at the time of surgery in the present study was 29 years whereas that of Johma et at[3] , D Choudhary et al[4], Railey et al[5,] and Kumar et al[6] were 26, 27, 33, and 27 years respectively. This age group, representing young adults, is generally more exposed to activities and predisposing factors of an ACL injury.

Out of the 30 patients included in this study, 29 patients were male, and 1 patient was female. Choudhary et al[4], Jomha et al[3] , Riley et al[5] and Ashok et al[6] conducted their studies on 59 (73% male), 100 (93% male), 85(59% male), and 34 (97.1% male) patients respectively. Choudhary et al[4] and Jomha et al[3] used bone patella bone tendon grafts, Riley et al[5] used quadrupled hamstring grafts and Kumar et al[6] used both BPTB and quadrupled hamstring grafts in their studies. This observation is in opposition to theoretical literature according to which females are anatomically more predisposed to ACL injuries but can be explained by more involvement of the male gender in outdoor activities and sports.

The most commonly injured knee was right knee 19 patients (66.3%) which are the dominant side in the majority of the population. However, no difference in the final functional outcome was seen in patients with either knee injury.

Out of 30 patients, 20 (66.7%) have sustained knee injury because of RTA followed by sports injury in 9 (30%) and fall-in 1(3.3%). Joshi et al[7] conduct their studies over 237 patients and found RTA was the most common cause of ACL injury at 38.8% Based on the profession of the patients, RTA (43.47%) was the most common injury in an office worker, followed by sports injuries and falls. The RTA is the most common mode because office workers mostly travel by motorcycle and are more prone to accidents.

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In our study, out of 30 patients , mostly 16 (55.33%) presented to us within 1-3 months after their injury. According to Stephanie Evans et al[8] , the study suggested that ACL reconstruction be performed at least 3 weeks after the injury in order to avoid arthrofibrosis. Most important than time alone, objective criteria including perioperative swelling, edema, hypothermia, and range of motion are important indicators of when surgery should perform.

Autograft selection is important for ACL reconstruction. Pre-operative selection should normally consider autograft volume, strength, donor site morbidity, availability, patient activity level, lifestyle, and personal preferences. The ability to predict the length of the hamstring graft preoperatively is of great importance and may help the surgeon in the decision-making to achieve an acceptable diameter for the autograft in ACL reconstruction.

Hamstring tendon grafts are one of the most popular autograft choices in ACL reconstruction. But their length and diameter may be unpredictable. Biomechanical studies have shown increased strength and stiffness of hamstring grafts with increased graft diameter.[9,10] Height is the most predictable indicator of graft diameter and length in the literature.[11-14]

This study showed a strong correlation between height and graft length ($r=0.41$, $p<0.001$) and quadruple diameter ($r=0.3$, $p<0.001$). A statistically weekly significant correlation between weight and graft length ($r=0.34$, $p=0.096$) and the relation between weight and quadruple diameter ($r=0.34$, $p=0.814$) is completely insignificant and was also noted.

BMI didn't show any correlation with the graft parameters. Leg length has been found to have a role in predicting the graft parameters in the literature [15,16]Thigh length was taken as an anthropometric parameter in this study, which has been rarely described in previous studies.[17,18] It was found to be significantly correlated with graft length ($r=0.44$, $p=0.001$) and quadruple diameter ($r=0.35$, $p=0.001$). Thus, thigh length might be an easy to measure and a sensitive tool for the prediction of graft length and diameter. Naiyer et al[19] had shown thigh circumference as a predictive parameter, which also has been replicated in this study.

We found that height and thigh length have a positive correlation with Semitendinosus graft length. Thigh length is the anthropometric parameter that was first studied as a predictor of semitendinosus autograft size is also a strong predictor of semitendinosus autograft diameter and length. One of the advantages of using semitendinosus autografts in ACL reconstruction, where the minimum size to avoid revision surgery is considered 7 mm. In addition, autograft size is considered as an

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important factor that influences the outcome of surgery. The latest study considered that the autograft diameter of no<8 mm is considered acceptable.[20]

Ravi Gupta et al[21] , in their research project, observed that the patient variable like height, weight, thigh circumference, and leg length were in significant positive correlation with ST and gracills diameter. However, after further analysis, they concluded that the ST diameter was strongly dependent upon leg length and gracillis was dependent on height. Tarun Goyal et al[22] concluded that height and thigh length could be relayed upon to predict graft dimension, but they lacked a strong association. After multiple regression analyses, they noticed only height was significantly associated with graft dimension in their study population. They mentioned a height of less than 147cm as being at risk of graft diameter <7mm.

There are differences between authors regarding the relationship of gender to autograft size, there were some statistically significant differences in age, weight, BMI, and thigh length, in this study. It can't be identified that gender also affects the diameter and length of the semitendinosus autograft.

The average Lysholm score at the end of the study of D Choudhary et al[4] was 92, Jomha et al[3] were 94, Railey et al[5] were 91, Kumar et al [6] 2016 was 90 and in our study of 30 patients average Pre-Op Lysholm Score was observed as Poor (<65) in 80% (24 patients)and Fair (65-83) in 20% (6 patients). After a follow-up for a period of 9 months the Post-Op Lysholm Score was observed as Excellent (>90) in 86.66% (26 patients) and Good (84-90) in the remaining patients.

The Mean pre-operative IKDC score in this study was 51.7 whereas the Mean post-operative score was 95.4. There was a significant improvement in post-operative IKDC score when compared with the preoperative score (45.80%). The mean pre-operative IKDC score in the study by Kumar et al[6] was 55.63 whereas the post-operative scores were 89.38. Rest did not use the IKDC score in their studies.

Conclusion

Anterior cruciate ligament injuries are commonly seen in younger individuals and males are found to be more prone for ACL injuries, probably due to more active lifestyle and involvement in outdoor activities and sports. Most common presenting symptom are knee instability which is easily confirmed clinically using Lachmann test and anterior drawer test. Arthroscopic anterior cruciate ligament reconstruction with hamstring graft was found to be an excellent treatment option for anterior cruciate ligament injuries. It provides a stable knee with minimal complications. Most patients were able to return to their pre-injury activity levels by 9 months.

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This study demonstrated that anthropometric parameters had a positive correlation with the hamstring graft length and diameter in our patients. Our study reveals that height and thigh length are strongly correlated with graft diameter and graft length. Hence, these results provide preliminary support for the use of these anthropometric measurements in the pre-operative planning and prediction of the hamstring graft length and diameter in ACL reconstruction surgery, resulting in a more prompt and accurate surgical strategy. The functional outcome of anterior cruciate ligament reconstruction with quadrupled hamstring autograft is excellent to good in most of the cases at the end of 9 months and most of the patients were able to return to the preinjury level of activity.

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