Acceleration of healing of the medial collateral ligament of the knee by local administration of synthetic microRNA-210 in a rat model

by Muhammad Sakti

Submission date: 19-Sep-2021 08:04AM (UTC+0700)
Submission ID: 1651626078
File name: cruciate_ligament_reconstruction_of_SouthSulawesi_population.pdf (200.97K)
Word count: 5521
Character count: 29584

International Journal of Surgery Open 21 (2019) 58–63

Contents lists available at ScienceDirect

International Journal of Surgery Open

journal homepage: www.elsevier.com/locate/ijso

Research Paper

Anthropometric parameters measurement to predict 4-strand hamstring autograft size in single bundle anterior cruciate ligament reconstruction of South Sulawesi population

Muhammad Sakti [a,*], Henry Yurianto [a], Padlan Pasallo [b], Syarif Hidayatullah [b], Arief Faisal [b], Erich Svante Subagio [b]

[a] Orthopaedy and Traumatology Department, Hasanuddin University School of Medicine, Indonesia
[b] Resident of Orthopaedy and Traumatology Department, Hasanuddin University School of Medicine, Indonesia

ARTICLE INFO

Article history:
Received 25 July 2019
Received in revised form
30 October 2019
Accepted 12 November 2019
Available online 19 November 2019

Keywords:
ACL reconstruction
Anthropometric parameter
Hamstring tendon graft

ABSTRACT

Introduction: Among many available autograft options for anterior cruciate ligament (ACL) reconstruction, hamstring tendon (HT) is the most popular graft. The ability to identify whether patient is at risk of inadequate HT autograft size prior to surgery is very important. Among some methods that have been done, anthropometric parameters are considered as an easy and cost effective method in predicting the size of HT autograft. In order to predict the length of semitendinosus tendon (ST), gracilis tendon (GT) and quadrupled HT graft diameter, a prospective study was conducted to determine the anthropometric parameters.

Method: Anthropometric parameters, including age, gender, height, weight, body mass index (BMI), true leg length (TLL), thigh circumference and thigh length of 60 patients with primary ACL reconstruction was measured before surgery. Using univariate analysis, independent-sample *t*-test, Pearson correlation test, and simple logistic regression to evaluate the correlation of these anthropometric variables on the size of the graft obtained.

Result: Average values for GT length (23.17 ± 3.01 cm), ST length (24.93 ± 2.85 cm), and 4-strand HT autograft diameter (7.36 ± 0.66 mm). 83.33% total patients had graft diameter of 7 mm and more. Height and TLL correlate to GT length and quadruple HT autograft diameter, while thigh circumference correlates to ST length.

Conclusion: Height and TLL can be predicting factor of GT length and quadruple HT autograft, while thigh circumference to ST length. Patients who are less than 155 cm in height and less than 76 cm in TLL are at risk of having 4-strand HT autograft diameter less than 7 mm.

1. Introduction

Anterior cruciate ligament (ACL) is the central ligament of human's knee. The main functional role of the ACL is to provide stability against anterior tibial translation and internal rotation [1]. Rupture of the ACL is one of the commonest seen knee injuries in sports [2]. Valgus and internal rotation mechanism in non-contact trauma are common and frequent mechanism of injury found in ACL rupture. The estimated incidence of acute ACL rupture is 78 per 100,000 persons with the mean age of 32 years in Sweden. The estimated incidence is higher in United States up to 84 per 100,000 persons [1].

Three types grafts commonly used in ACL reconstruction are autografts, allografts and synthetic grafts. The choice of graft types by surgeon is influenced by the perceived functional outcome, rehabilitation options, graft availability and donor site morbidity. Surgical techniques and surgeon experience also play important role in graft choosing. Am. Autograft, among the available graft types, is the most commonly used graft (Hamstring tendon and Bone-patellar tendon-bone), whereas hamstring tendon (HT) is the most popular autograft among surgeons [1,3].

* Corresponding author. Jl. Perintis Kemerdekaan KM 11, RS Universitas Hasanuddin Lantai 3, Makassar, 90245, Indonesia.
E-mail addresses: padlanpasallo@gmail.com (M. Sakti), padlanpasallo328@gmail.com (H. Yurianto), padlanpasallo@ymail.com (P. Pasallo), syarifortouh@yahoo.com (S. Hidayatullah), ariefortho@gmail.com (A. Faisal), erich.subagio@gmail.com (E.S. Subagio).

https://doi.org/10.1016/j.ijso.2019.11.005

Despite of having no difference in the functional outcome, bone-patellar tendon-bone (BPTB) graft has disadvantage of an increased incidence of knee osteoarthritis and anterior knee pain on its long-term follow-up [4,5]. Anterior knee pain is very disturbing for most of Indonesian people, who are moslems and have to kneel down during praying. These factors cause HT autograft become more popular among surgeons, indeed in our institution.

Identification of graft length and diameter before surgery is very important in preoperative planning, especially when patient is at risk of inadequate length and diameter of HT autograft. This should suggest surgeon to find alternative graft selection prior to surgery [6,7]. Some fixation methods and implants require a minimum graft diameter or length, as they might affect laxity and stability [8].

Among some methods that have been performed to explore the most ideal way to predict the graft size, anthropometric parameter are considered as an easy and cost effective method in predicting the size of HT graft [9–12]. In varied studies, pre-operative parameters such as age, gender, height, weight, BMI, leg length, thigh circumference have been reported as the predictive value [9–13,23–25].

We conducted a prospective study to predict the length of harvested tendons and diameter of quadrupled HT autograft in ACL reconstruction surgery by determining the anthropometric measurements such as age, gender, height, weight, BMI, TLL, thigh circumference and thigh length in our population. We also assessed the reliability of a mathematical equation in attempt to accurately predict the graft size.

To our knowledge, there has been no other publication regarding the relationship between anthropometric parameters to HT autograft size for ACL reconstruction in Indonesian population, especially in South Sulawesi population.

2. Materials and methods

2.1. Patients

After having granted approval from institution's ethical committee, we proceeded to evaluation of 60 consecutive patients (51 men, 9 women) with ACL tear who had undergone 4-strand HT autograft for primary ACL reconstruction between January 2016 and December 2018 in Wahidin Sudirohusodo Hospital, Makassar. All patients had signed their consent letter. We excluded patient who had undergone ACL reconstruction using other types of graft, had multi ligament knee injuries, came from other population groups, or had incomplete information. All authors independently collected anthropometric parameter, including age, gender, height, weight, BMI, TLL, thigh circumference and thigh length from all patients directly before surgery. While tendon harvesting and graft preparation were done by the first author.

Height was measured while subject stood bare feet against anthropometric instrument, weight was measured while subject stood over the scale with minimal movement and hands positioned their sides, shoes and excess clothing should be taken off, TLL was measured from the anterior superior iliac spine (ASIS) to the tip medial malleolus (MM), thigh length was measured from greater trochanter to lateral epicondyle, and thigh circumference was measured 15 cm proximal to superior pole of the patella in all patients. BMI was calculated using patient's weight and height according to standard formula [26].

2.2. Operation procedures

All patients undergone single bundle reconstruction under spinal anaesthesia. A vertical incision of 3 cm long was made at tibial insertion on the skin over hamstring tendon, on pes anserinus area. After exposed adequately, sartorius fascia was incised accompanying the superior edge. Gracilis tendon (GT) and semitendinosus tendon (ST). These tendons were harvested by using closed tendon stripper. Length of the ST and GT was defined as the measured end to end of the tendon after moving the superficial fascia and fat of the tendons and trimming the rough edge carefully. Tendons were prepared in a single bundle, 4-strand technique with each end of the tendon grafts whipstitched with a No. 2 nonabsorbable polyester suture. The final diameter of the graft was determined by the smallest diameter allowing smooth passage in 'sizing cylinder' of Smith and Nephew with increment of 0,5 mm. Graft diameter was obtained from the largest measured portion of the graft, and was placed within the femoral tunnel. Any difference in diameter for the trailing, were whipstitched at each ends and were handled by adjusting the diameter of the drilled tibial tunnel. HT graft total length was defined as the measured end to end length of the prepared graft. All grafts were of sufficient length, with a minimum 8 cm of total graft length after quadrupled preparation.

Finally, the prepared 4-strand HT autograft was implanted and fixed. Femoral fixation was achieved with Endobutton while tibial fixation was achieved with Bioscrew.

2.3. Statistical analysis

Statistical analysis was performed using SPSS version 22.0. Relationship between gender and intraoperative HT autograft size were identified by independent-sample *t*-test. Correlation coefficient (Pearson r) were used to identify the relationships between length of the ST and GT and diameter of the HT autograft and continuous variables (age, height, weight, BMI, TLL, thigh circumference and thigh length). Higher correlation coefficient shows stronger relationship between variables. Following the univariate analysis, a simple linear regression analysis was used to evaluate the influence of the anthropometric variables on the length of tendon and diameter of the 4-strand HT autograft that has been obtained. In order to improve the matching degree of the regression equation and real parameters, we have taken log of these continuous variables. P values less than 0.05 were considered as significant.

3. Results

This study consisted of 60 patients (51 mens and 9 womens) with an average age 27.23 ± 7.46 years. Preoperative measurement with average values for height (167.76 ± 7.11 cm), weight (71.9 ± 15.76 kg), BMI (25.42 ± 4.67 kg/m^2), TLL (86.65 ± 5.12 cm), thigh circumference (45.78 ± 6.86 cm), and thigh length (38.76 ± 3.78 cm). Intraoperative measurement, average values for GT length (23.17 ± 3.01 cm), ST length (24.93 ± 2.85 cm), and 4-strand hamstring autograft diameter (7.36 ± 0.66 mm) (Table 1). When sample were split by gender, the average values for GT length of men and women were 23.49 ± 2.90 cm and 21.33 ± 3.08 cm, respectively. The average values for ST length of men and women were 25.25 ± 2.89 cm and 23.11 ± 1.83 cm, respectively. The average value for 4-stranded HT autograft diameter of men and women were 7.39 ± 0.48 mm and 7.16 ± 0.82 mm, respectively. 3,33% of total patients had graft diameter more than 8 mm, 80% had graft diameter between 7 and 8 mm, and 16,67% had graft diameter less than 7 mm. Women has shorter length and smaller hamstring tendon graft diameter.

Correlation coefficient (Pearson r) were used to identify the magnitude of each data correlation (Table 2). It was found that height and TLL correlate moderately to GT length and 4-stranded HT autograft. While thigh circumference correlates moderately to ST length. Age, BMI, and thigh length did not correlate to any of the

Table 1
Subject Data (Mean ± SD) by Gender With Independent *t*-Test Result.

	Total	Men	Women	P value
4-stranded Hamstring Graft Diameter	7.36 ± 0.66	7.39 ± 0.63	7.16 ± 0.82	0.532
GT length (cm)	23.17 ± 3.01	23.49 ± 2.90	21.33 ± 3.08	0.047
ST length (cm)	24.93 ± 2.85	25.25 ± 2.89	23.11 ± 1.83	0.036
Age (year)	27.23 ± 7.46	26.47 ± 6.89	31.56 ± 9.43	0.059
Height (cm)	167.76 ± 7.11	169.38 ± 5.89	158.55 ± 6.61	0.000
Weight (kg)	71.93 ± 15.76	72.76 ± 15.86	67.22 ± 15.16	0.335
BMI (kg/m^2)	25.42 ± 4.67	25.22 ± 4.64	26.57 ± 4.95	0.429
TLL (cm)	86.65 ± 5.12	87.43 ± 4.43	82.22 ± 6.66	0.004
Thigh Circumference (cm)	45.78 ± 6.86	55.1 ± 79.8	34.3 ± 4.0	0.886
Thigh Length (cm)	38.76 ± 3.78	39.34 ± 3.62	35.44 ± 3.00	0.003

Table 2
Correlation coefficients for relationships between antropometric parameter and intraoperative measurements.

	GT length	ST Length	4-stranded Hamstring Graft Diameter
Age	−0.086	−0.050	−0.048
Height	0.432[a]	−0.027	0.320[a]
Weight	0.148	0.181	0.174
BMI	−0.023	0.250	0.044
TLL	0.405[a]	−0.011	0.292[a]
Thigh Circumference	0.054	0.255[a]	−0.007
Thigh length	0.194	−0.035	0.180

intraoperative measurement. The strongest correlation of anthropometric parameter to 4-stranded HT autograft diameter was height.

The simple linear regression analysis indicated that height and TLL have contributed approximately 18.6% and 16.4% of variance in GT length, respectively. Likewise, height and TLL have contributed approximately 10.2% and 8,5% of variance in 4-strand HT autograft diameter, respectively. While thigh circumference have contributed approximately 6.5% of variance in ST length.

Through regression analysis, we constructed the following predictive equations for GT length, ST length, and diameter of the 4-strand HT autograft base on the predictor were correlated significantly:

1. GT length
   GT length = −7.509 + 0.183 × (height (cm))
   GT length = 2.508 + 0.238 × (TLL (cm))
2. ST length
   ST length = −35.716 + 1.485 × (thigh circumference (cm))
3. 4-strand HT autograft diameter
   4-strand HT autograft diameter = 2.342 + 0.030 (height (cm))
   4-strand HT autograft diameter = 4.077 + 0.038 (TLL (cm))

Correlation analysis indicates that shorter height and shorter true leg length would have shorter GT length and smaller quadruple HT autograft diameters. While smaller thigh circumference would have smaller ST length.

4. Discussion

Hamstring tendon is still the most popular autograft used in ACL reconstruction because of some of its advantages over other graft types. This also applied at our institution. Despite of its popularity, there always be risk for having an inadequate graft size. Therefore, it always important to know the estimation of HT autograft size and put it as preoperative planning. To our knowledge, there has been no publication regarding the relationship between anthropometric parameters in the population of Indonesia, especially in South Sulawesi population.

In this study, the number of samples was 60 with the minimum length of the ST obtained was 20 cm and the minimum length of the GT was 16 cm, so that the graft length would become approximately 9 cm when using a quadruple graft. This length exceeds the minimum length of the HT autograft (8 cm) to avoid more complications [16].

The minimum diameter of quadruple HT autograft obtained was 6 mm with a minimum recommended diameter of 7 mm [27]. Despite Magnussen et al. [28] recommended HT autograft diameter should have diameter of 8 mm or more to avoid the risk of revision. Bear in mind that biomechanical consideration is an important factor that influence of the size of graft diameter, thus patients with inadequate risk of graft diameter and length were advised to use other autograft options, such as peroneus longus tendon (PLT) [29–31].

Grood el al. [32]. as in animal model showed the inverted relationship of anterior tibial translation with the diameter of graft. The clinical studies he performed did not affirm the current biomechanical data showing greater diameter will result in stronger and stiffer construct. There was no correlation found between graft size to ultimate knee stability, range of motion and patient satisfaction. It should be kept in mind that the goal remains to maximize the amount of tendon contact area within the femoral tunnel, despite the fact that the fixation system will require different HT length and different diameter to be effective. These needed the tendon graft size to be available to achieve proper fixation and allow the effective graft healing [20].

This study has found a significant statistical correlation between height, TLL and GT length (r = 0,432 and r = 0,405). Thigh circumference correlate to ST length (r = 0,255) while height and TLL have correlated to quadruple HT autograft diameter. Height remains the most statistically significant predictor of HT autograft size. Whereas age, gender, BMI, and thigh length have no correlation to graft size. In our study, we found that patients shorter than 155 cm in height and shorter in 76 cm in TLL are likely to have a quadrupled HT autograft diameter less than 7 mm in diameter.

Previous studies found that anthropometric measurements such as age, gender, height, weight, BMI, TLL, thigh circumference, thigh length, patient's *tegner* score and smoking status correlated with the length and diameter of the HT autograft (Table 3) [9–11,20,23,25].

This is relevant with study performed by Gupta el al. [10]. that leg length has strong correlation to ST length (r = 0,719) and height with GT length (r = 0,685), while height and leg length have strong correlation to quadrupled HT autograft (r = 0,685 and r = 680). Preoperative measurement of height and leg length can reliably predict ST and GT length and quadrupled HT autograft diameter ($p < 0.05$). The other studies also found that height is the most consistent parameter associated with HT autograft size [8–11,19,20,23,25].

The ability to predict graft diameter and length might be needed for some operation technique and preoperative planning. Tibia-sided fixation outside the tibial tunnel might require longer graft length. This will need the prediction to know if patient's HT autograft would be long enough for this fixation. Otherwise the surgeon might need to choose for another graft type. In revision surgery, a larger graft size might be needed for previous tunnel and fixation method. In this condition, estimation of HT autograft diameter will help in selecting graft size [33].

In this study it was not found that gender is not a predicting factor in smaller graft sizes. This is different from several previous

Table 3
Summary of previous study in anthropometric parameter measurement [9–11,19,20,23,25].

Treme et al., (Am J Sports Med, 2008)	Prospective, n = 50 (M:F = 29:21)	Age, gender, height, weight, BMI, leg length, thigh length, thigh circumference, Tegner score	In men alone weight, ipsilateral thigh circumference, and BMI independently relate moderately (R^2 = 0.36 −0.41) to diameter but height only weakly (R^2 = 0.12) also multiple regression analysis not done. Length of Gracilis and ST tendons relate to height and leg length (R^2 = 0.24–0.48, on simple linear regression); only in women. Error rate of 6.7% reported for the equation by Tuman et al. using height
Xie et al., (Am J Sports Med, 2012)	Cohort, n = 235 (M = 167, F = 68)	Height, Weight, BMI, Gender, Age, Tegner Score	Height and weight have strongest correlation to ST and GT length, and GT graft diameter Gender and weight have strongest correlation to ST graft diameter Height, weight and BMI can be use to predict ST and GT autograft diameter and length Small female sample Chinese Han population study Using quadruple ST and GT graft for double bundle ACL reconstruction
Thomas et al., (Arc Orthop Trauma Surg, 2012)	Cohort, n = 121 (M = 108, F = 13 female)	Age, Gender, Height, Weight, BMI	Height and gender have moderate correlation to graft diameter (r = 0,38 and r = 0,29, and r = −0,28, respectively) Height is the best predictor to graft diameter BMI and age not correlate to graft diameter Graft length correlation not studied Small female sample European population study
Goyal et al., (International (SICOT), 2015)	Prospective, n = 160	Height, weight, BMI, thigh length	Height and thigh length correlate weakly to both graft diameter and graft length (R^2<0.15) Graft diameter = 2.1 + 0.033 × (height) Gracilis = −0.408 + 0.203 × (thigh length)+ 0.103 × (height) SemiT = −1.165 + 0.164 × (thigh length)+ 0.129 × (height) Predicted diameter from equation may agree well with true diameter but with increased risk of over estimating thickness in up to 30% cases
Ho et al., (Acta Orthop Belg, 2016)	Cohort, n = 169 (M = 141, F = 28)	Age, Gender, Height, Weight, BMI, smoking status	Height and weight correlate moderately to hamstring graft diameter, while BMI correlate weakly to graft diameter Age and smoking status not correlate significantly to graft diameter Height and weight can be use to predict hamstring graft Graft length correlation not studied
Gupta et al., (J Orthop, 2017)	Phase I (Cohort), n = 123 (M = 108, F = 15) Phase II (blind prospective), n = 300 (M = 206, F = 94)	Height, Weight, Leg length, Thigh length, Thigh circumference	ST length has strong correlation to leg length (r = 0,719), while GT length with height (r = 0,685) Quadrupled hamstring graft have strong correlation to height and leg length (r = 0,685 and r = 680) Height and leg length preoperative measure can reliably predict ST and GT length and quadrupled hamstring graft diameter Indian population study Thigh circumference was contralateral
Ramkumar et al., (am J Sports Med, 2018)	Cross Sectional, n = 1681	Age, Height, Weight, BMI, Sex	Height is the greatest predictor Height, weight, 5 strand graft, sex related to graft size Age did not significant contribute
This study	Prospective, n = 60 (M = 51, F = 9)	Age, Gender, Height, Weight, BMI, TLL, Thigh circumference, Thigh length	Height and TLL correlate to GT length and 4-strand HT autograft diameter Thigh circumference correlate to ST length South Sulawesi Population

studies stating that gender is one of the predicting factors of graft size [8,14,19,20,25]. Although in this study the graft diameter in women (7.16 ± 0.82 mm) was smaller than of men (7.39 ± 0.63 mm), but not statistically significant ($p > 0.05$). Similarly with age, BMI, thigh length and thigh circumference not correlated significantly to the diameter of the 4-strand HT autograft. This is different from result study by Pinheiro et al. [14] were found that beside height and leg length, quadruple HT autograft diameter was related to sex, weight, thigh length, and thigh diameter.

We found that HT autograft is still the effective graft of choice for ACL reconstruction especially in primary reconstruction. One can predict the preoperative HT autograft size with the equations that were developed from this study, as this is one of the most important steps in preoperative planning. However, requires further study and more diverse samples from the Indonesian population using the results of this study to determine whether anthropometric measurements in this study can also be applied to Indonesian population.

The strength of our study is that all ACL reconstructions surgery were performed by one surgeon; with the same of harvesting graft

technique, the same fixation technique and the same rehabilitation protocol. Other strength of our study is that this is the first study to determine the association between anthropometric parameters and HT autograft size in Indonesian people especially South Sulawesi population.

The limitations in this study are the small sample size (especially women patients). This could lead to insufficient statistical power in detecting small correlation between the anthropometric parameter and length of the harvested tendon, and the diameter of HT autograft. Other limitation is that we did not include duration of injury and level activity, as in other study, these found to have correlation with diameter of graft.

5. Conclusion

Height and TLL correlate to GT length (r = 0,432 and r = 0,405) and thigh circumference correlates to ST length (r = 0,255), while height and TLL correlate to quadruple HT autograft diameter. Patients shorter than 155 cm in height and 76 cm in TLL are at a risk of having quadrupled HT autograft diameter less than 7 mm. Furthermore, quadruple HT autograft diameter can be predicted with measurements of height and TLL and GT and ST length with thigh circumference. Although these calculations are not precise, we feel that the preoperative graft data obtained may be valuable for preoperative planning for ACL reconstruction with HT autograft.

Financial support and sponsorship

Nil.

Ethical approval

This study was approved by the ethical board of Hasanuddin University of Makassar. Our patients has signed terms of consent to participate in the research of this original article. The institutional ethical committee has approved the publication of this original article.

Funding

This study was funded independently.

Author contribution

Ruksal Saleh: concepts, design, surgeon, definition of intellectual content, literature research, clinical studies, data collections, data analysis, manuscript editing & review.

Henry Yurianto: concepts, design, surgeon, definition of intellectual content, literature research, clinical studies, data collections, data analysis, manuscript editing & review.

Padlan Pasallo: concepts, design, surgeon, definition of intellectual content, literature research, clinical studies, data collections, data analysis, manuscript editing & review.

Syarief Hidayatullah: concepts, design, definition of intellectual content, literature research, clinical studies, data collections, data analysis, manuscript writing.

Arief Faisal: concepts, design, definition of intellectual content, literature research, clinical studies, data collections, data analysis, manuscript writing.

Erich Svante Subagio: literature research, clinical studies, experimental studies, data collections, data analysis, manuscript writing.

Guarantor

Padlan Pasallo.
Erich Svante Subagio.

Research registration number

None.

Declaration of Competing Interest

There are no conflicts of interest.

Acknowledgement

Nil.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijso.2019.11.005.

References

[1] Shaerf DA, Pastides PS, Sarraf KM, Willis-Owen CA. Anterior cruciate ligament reconstruction best practice: a review of graft choice. World J Orthop 2014;5(1):23–9. https://doi.org/10.5312/wjo.v5.i1.23.
[2] Woo SL, Wu C, Dede O, Vercillo F, Noorani S. Biomechanics and anterior cruciate ligament reconstruction. J Orthop Surg Res 2006;1:2. https://doi.org/10.1186/1749-799X-1-2.
[3] Kapoor B, Clement DJ, Kirkley A, Maffuli N. Current practice in the management of anterior cruciate ligament injuries in the United Kingdom. Br J Sports Med 2004;38(5):542–4. https://doi.org/10.1136/bjsm.2002.002568.
[4] Sajovic M, Stropnik D, Skaza K. Long-term comparison of semitendinosus and gracilis tendon versus patellar tendon autografts for anterior cruciate ligament reconstruction: a 17-year follow-up of a randomized controlled trial. Am J Sports Med 2018;46(8):1800–8. https://doi.org/10.1177/0363546518768768.
[5] Poehling-Monaghan KL, Salem H, Ross KE, Secrist E, Ciccotti MC, Tjoumakaris F, et al. Long-term outcomes in anterior cruciate ligament reconstruction: a systematic review of patellar tendon versus hamstring autografts. Orthop J Sports Med 2017;5(6). https://doi.org/10.1177/2325967117709735. 2325967117709735.
[6] Laxdal G, Kartus J, Hansson L, Heidvall M, Ejerhed L, Karlsson J. A prospective randomized comparison of bone-patellar tendon-bone and hamstring grafts for anterior cruciate ligament reconstruction. Arthroscopy 2005;21(1):34–42. https://doi.org/10.1016/j.arthro.2004.09.014.
[7] Stanczak K, Zielinska M, Synder M, Domzalski M, Polguj M, Sibinski M. Comparison of hamstring and patellar tendon grafts in anterior cruciate ligament reconstruction: a prospective randomized study. J Int Med Res 2018;46(2):785–91. https://doi.org/10.1177/0300060517722696.
[8] Tuman JM, Diduch DR, Rubino LJ, Baumfeld JA, Nguyen HS, Hart JM. Predictors for hamstring graft diameter in anterior cruciate ligament reconstruction. Am J Sports Med 2007;35(11):1945–9. https://doi.org/10.1177/0363546507304667.
[9] Goyal S, Matias N, Pandey V, Acharya K. Are pre-operative anthropometric parameters helpful in predicting length and thickness of quadrupled hamstring graft for ACL reconstruction in adults? A prospective study and literature review. Int Orthop 2016;40(1):173–81. https://doi.org/10.1007/s00264-015-2818-3.
[10] Gupta R, Malhotra A, Masih GD, Khanna T. Equation-based precise prediction of length of hamstring tendons and quadrupled graft diameter by various anthropometric variables for knee ligament reconstruction in Indian population. J Orthop Surg 2017;25(1). https://doi.org/10.1177/2309499017690997. 2309499017690997.
[11] Ho SWL, Tan TJL, Lee KT. Role of anthropometric data in the prediction of 4-stranded hamstring graft size in anterior cruciate ligament reconstruction. Acta Orthop Belg 2016;82(1):72–7.
[12] Mardani-Kivi M, Karimi-Mobarakeh M, Mirbolook A, Keyhani S, Saheb-Ekhtiari K, Hashemi-Motlagh K, et al. Predicting the hamstring tendon diameter using anthropometric parameters. Arc Bone Jt Surg 2016;4(4):314–7.
[13] Ma CB, Kefa E, Dunn W, Fu FH, Harner CD. Can pre-operative measures predict quadruple hamstring graft diameter? The Knee 2010;17(1):81–3. https://doi.org/10.1016/j.knee.2009.06.005.
[14] Pinheiro Jr LF, de Andrade MA, Teixeira LE, Bicalho LA, Lemos WG, Azeredo SA, et al. Intra-operative four-stranded hamstring tendon graft diameter

evaluation. Knee Surg Sports Traumatol Arthrosc 2011 2011;19(5):811–5. https://doi.org/10.1007/s00167-010-1387-7.
[15] Papastergiou SG, Konstantinidis GA, Natsis K, Papathanasiou E, Koukoulias N, Papadopoulos AG. Adequacy of semitendinosus tendon alone for anterior cruciate ligament reconstruction graft and prediction of hamstring graft size by evaluating simple anthropometric parameters. Anat Res Int 2012;2012:8. https://doi.org/10.1155/2012/424158.
[16] Challa S, Satyaprasad J. Hamstring graft size and anthropometry in south Indian population. J Clin Orthop Trauma 2013;4(3):135–8. https://doi.org/10.1016/j.jcot.2013.09.005.
[17] Celiktas M, Golpinar A, Kose O, Sutoluk Z, Celebi K, Sarpel Y. Prediction of the quadruple hamstring autograft thickness in ACL reconstruction using anthropometric measures. Acta Orthop Traumatol Turcica 2013;47(1):14–8. https://doi.org/10.3944/AOTT.2013.2814.
[18] Schwartzberg RS. Prediction of semitendinosus and gracilis tendon lengths and diameters for double bundle ACL reconstruction. Am J Orthoped 2014;43(1):E1–6.
[19] Xie G, Huangfu X, Zhao J. Prediction of the graft size of 4-stranded semitendinosus tendon and 4-stranded gracilis tendon for anterior cruciate ligament reconstruction: a Chinese Han patient study. Am J Sports Med 2012;40(5):1161–6. https://doi.org/10.1177/0363546511435627.
[20] Treme G, Diduch DR, Billante MJ, Miller MD, Hart JM. Hamstring graft size prediction: a prospective clinical evaluation. Am J Sports Med 2008;36(11):2204–9. https://doi.org/10.1177/0363546508319901.
[21] Beyzadeoglu T, Akgun U, Tasdelen N, Karahan M. Prediction of semitendinosus and gracilis autograft sizes for ACL reconstruction. Knee Surg Sport Traumatol Arthrosc 2011;20(7):1293–7. https://doi.org/10.1007/s00167-011-1770-z.
[22] Park SY, Oh H, Park S, Lee JH, Yoon KH. Factors predicting hamstring tendon autograft diameters and resulting failure rates after anterior cruciate ligament reconstruction. Knee Surg Sport Traumatol Arthrosc 2013;21(5):1111–8. https://doi.org/10.1007/s00167-012-2085-4.
[23] Ramkumar PN, Hadley MD, Jones MH, Farrow LD. Hamstring autograft in ACL reconstruction: a 13-year predictive analysis of anthropometric factors and surgeon trends relating to graft size. Orthop J Sports Med 2018;6(6). https://doi.org/10.1177/2325967118779788. 2325967118779788.
[24] Janssen RPA, van der Velden MJF, van den Besselaar M, Reijman M. Prediction of length and diameter of hamstring tendon autografts for knee ligament surgery in Caucasians. Knee Surg Sport Traumatol Arthrosc 2017;25(4):1199–204. https://doi.org/10.1007/s00167-015-3678-5.
[25] Thomas S, Bhattacharya R, Saltikov JB, Kramer DJ. Influence of anthropometric features on graft diameter in ACL reconstruction. Arch Orthop Trauma Surg 2013;133(2):215–8. https://doi.org/10.1007/s00402-012-1648-7.
[26] Nuttal FQ. Body mass index: obesity, BMI, and health: a critical review. Nutr Today 2015;50(3):117–28. https://doi.org/10.1097/NT.0000000000000092.
[27] Maeda A, Shino K, Horibe S, Nakata K, Buccafusca G. Anterior cruciate ligament reconstruction with multistranded autogenous semitendinosus tendon. Am J Sports Med 1996;24(4):504–9. https://doi.org/10.1177/036354659602400416.
[28] Magnussen RA, Lawrence JTR, West RL, Toth AP, Taylor DC, Garret WE. Graft size and patient age are predictors of early revision after anterior cruciate ligament reconstruction with hamstring autograft. Arthroscopy 2012;28(4):526–31. https://doi.org/10.1016/j.arthro.2011.11.024.
[29] Kerimoğlu S, Aynaci O, Saraçoğlu M, Aydin H, Turham AU. Anterior cruciate ligament reconstruction with the peroneus longus tendon. Acta Orthop Traumatol Turcica 2008;42(1):38–43. https://doi.org/10.3944/AOTT.2008.42.1.038.
[30] Liu CT, Lu YC, Huang CH. Half peroneus longus tendon graft augmentation for unqualified hamstring tendon graft of anterior cruciate ligament reconstruction. J Orthop Sci 2015;20(5):854–60. https://doi.org/10.1007/s00776-015-0744-2.
[31] Nazem K, Barzegar M, Hosseini A, Karimi M. Can we use peroneus longus in addition to hamstring tendons for anterior cruciate ligament reconstruction? Adv Biomed Res 2014;3:115. https://doi.org/10.4103/2277-9175.132696.
[32] Grood ES, Walz-Hasselfeld KA, Holden JP, Noyes FR, Levy MS, Buttler DL, et al. The correlation between anterior-posterior translation and cross-sectional area of anterior cruciate ligament reconstructions. J Orthop Res 1992;10(6):878–85. https://doi.org/10.1002/jor.1100100617.
[33] Schwartzberg R, Burkhart B, Lariviere C. Prediction of hamstring tendon autograft diameter and length for anterior cruciate ligament reconstruction. Am J Orthoped 2008;37(3):157–9.

Acceleration of healing of the medial collateral ligament of the knee by local administration of synthetic microRNA-210 in a rat model

ORIGINALITY REPORT

24%	14%	21%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Jeffrey M. Tuman, David R. Diduch, L. Joseph Rubino, Joshua A. Baumfeld, Henry S. Nguyen, Joseph M. Hart. "Predictors for Hamstring Graft Diameter in Anterior Cruciate Ligament Reconstruction", The American Journal of Sports Medicine, 2017 Publication	3%
2	Ravi Gupta, Anubhav Malhotra, Gladson David Masih, Tanu Khanna. "Equation-based precise prediction of length of hamstring tendons and quadrupled graft diameter by various anthropometric variables for knee ligament reconstruction in Indian population", Journal of Orthopaedic Surgery, 2017 Publication	2%
3	www.fisiocenterpuebla.com Internet Source	2%
4	www.pure.ed.ac.uk Internet Source	2%

5	Guoming Xie, Xiaoqiao Huangfu, Jinzhong Zhao. "Prediction of the Graft Size of 4-Stranded Semitendinosus Tendon and 4-Stranded Gracilis Tendon for Anterior Cruciate Ligament Reconstruction", The American Journal of Sports Medicine, 2012 Publication	1 %
6	Karya Triko Biakto, M. Andry Usman, William Limoa, Luky Tandio Putra. "Comparison between short segment pedicle screw fixation and long segment pedicle screw fixation for treatment of neglected single level thoracolumbar burst fracture", International Journal of Surgery Open, 2020 Publication	1 %
7	www.wjgnet.com Internet Source	1 %
8	www.actaorthopaedica.be Internet Source	1 %
9	Submitted to Wesley College Student Paper	1 %
10	Seong Su Hwang, Hae Hiang Song, Jun Hyun Baik, So Lyung Jung, Seog Hee Park, Kyu Ho Choi, Young Ha Park. " Researcher Contributions and Fulfillment of ICMJE Authorship Criteria: Analysis of Author Contribution Lists in Research Articles with	1 %

	Multiple Authors Published in ", Radiology, 2003 Publication	
11	ir.unilag.edu.ng Internet Source	1 %
12	ACL Injury and Its Treatment, 2016. Publication	<1 %
13	www.thieme-connect.com Internet Source	<1 %
14	Submitted to University of Glamorgan Student Paper	<1 %
15	www.tandfonline.com Internet Source	<1 %
16	"Posters", Knee Surgery, Sports Traumatology, Arthroscopy, 2016 Publication	<1 %
17	pubmed.ncbi.nlm.nih.gov Internet Source	<1 %
18	Sunil Kumar, Harish Kumar, Prashant P Singh, Pranav Sharma, Amit K Rai Sharma, Mohit K Singh, Rajendra Kumar. "Quadrupled Hamstring Graft Diameter Adequacy in Anterior Cruciate Ligament Reconstruction Using Patient Anthropometry: A Prospective Cohort Study in Indian Males", Cureus, 2021 Publication	<1 %

19	www.researchsquare.com Internet Source	<1%
20	Dr Nuthan Jagadeesh, Dr Vishwanath M Shivalingappa, Dr Tushar Dhawan, Dr Arjun Mandri. "Correlation of measurements of hamstring graft used in ACL reconstruction with preoperative anthropometric measures among Indian males- A prospective study", Journal of Arthroscopy and Joint Surgery, 2020 Publication	<1%
21	Tarun Goyal, Souvik Paul, Lakshmana Das, Arghya Kundu Choudhury. "Correlation between anthropometric measurements and activity level on length and diameter of semitendinosus tendon autograft in knee ligament surgery: A prospective observational study", SICOT-J, 2020 Publication	<1%
22	Daniel A Shaerf. "Anterior cruciate ligament reconstruction best practice: A review of graft choice", World Journal of Orthopedics, 2014 Publication	<1%
23	Submitted to Universiti Kebangsaan Malaysia Student Paper	<1%
24	M. Hofbauer. "Rotational and translational laxity after computer-navigated single- and double-bundle anterior cruciate ligament	<1%

reconstruction", Knee Surgery Sports Traumatology Arthroscopy, 11/28/2009
Publication

---

25 Prem N. Ramkumar, Michael D. Hadley, Morgan H. Jones, Lutul D. Farrow. "Hamstring Autograft in ACL Reconstruction: A 13-Year Predictive Analysis of Anthropometric Factors and Surgeon Trends Relating to Graft Size", Orthopaedic Journal of Sports Medicine, 2018 <1%
Publication

---

26 Submitted to University of Nairobi <1%
Student Paper

---

27 Andrew Hanna, Katharine Hollnagel, Kelley Whitmer, Christopher John, Brent Johnson, Jonathan Godin, Thomas Miller. "Reliability of Magnetic Resonance Imaging Prediction of Anterior Cruciate Ligament Autograft Size and Comparison of Radiologist and Orthopaedic Surgeon Predictions", Orthopaedic Journal of Sports Medicine, 2019 <1%
Publication

---

28 Jinshen He, Qi Tang, Sara Ernst, Monica A. Linde, Patrick Smolinski, Song Wu, Freddie Fu. "Peroneus longus tendon autograft has functional outcomes comparable to hamstring tendon autograft for anterior cruciate ligament reconstruction: a systematic <1%

	review and meta-analysis", Knee Surgery, Sports Traumatology, Arthroscopy, 2020 Publication	
29	Pallav Mishra, Ajay, Ankit Goyal, Nitin Mehta, Hitesh Lal, Sanjeev kumar. "Comparison of semitendinosus tendon length and diameter in sports and non-sports group for ACL reconstruction", Journal of Clinical Orthopaedics and Trauma, 2020 Publication	<1 %
30	es.scribd.com Internet Source	<1 %
31	icjr.net Internet Source	<1 %
32	kundoc.com Internet Source	<1 %
33	mafiadoc.com Internet Source	<1 %
34	publications.lsmuni.lt Internet Source	<1 %
35	scholarcommons.sc.edu Internet Source	<1 %
36	www.edp-open.org Internet Source	<1 %
37	Andri M.T. Lubis, Dina Aprilya, Kanya Tania. "Combined hamstrings and peroneus longus	<1 %

tendon for undersized graft in anterior cruciate ligament reconstruction: A report of two adolescence female patients", International Journal of Surgery Case Reports, 2020
Publication

---

38 Balgovind S Raja, Kshitij Gupta, Abdusamad V, Sukhmin Singh, Subhajit Maji. " Assessment of thickness of autograft tendons around the knee and its correlation with anthropometric data, thickness of patella and anterior cruciate ligament tibial foot print diameter ", Anatomy & Cell Biology, 2021 <1%
Publication

---

39 Goris Nazari, Kristen I. Barton, Dianne Bryant, Alan Getgood, Charles H. Brown. "Five- and six-strand hamstring grafts consistently produce appropriate graft diameters for anterior cruciate ligament reconstruction", Knee Surgery, Sports Traumatology, Arthroscopy, 2020 <1%
Publication

---

40 S. Thomas, R. Bhattacharya, J. B. Saltikov, D. J. Kramer. "Influence of anthropometric features on graft diameter in ACL reconstruction", Archives of Orthopaedic and Trauma Surgery, 2012 <1%
Publication

41	Sports Injuries, 2015. Publication	<1 %
42	www.genourob.com Internet Source	<1 %
43	www.ncbi.nlm.nih.gov Internet Source	<1 %
44	Chengliang Dai, Fei Wang, Xiaomeng Wang, Ruipeng Wang, Shengjie Wang, Shiyu Tang. "Arthroscopic single-bundle anterior cruciate ligament reconstruction with six-strand hamstring tendon allograft versus bone-patellar tendon-bone allograft", Knee Surgery, Sports Traumatology, Arthroscopy, 2015 Publication	<1 %
45	Supradeeptha Challa, Jonnalagedda Satyaprasad. "Hamstring graft size and anthropometry in south Indian population", Journal of Clinical Orthopaedics and Trauma, 2013 Publication	<1 %
46	Luis Rodriguez-Mendez, Jose Martinez-Ruiz, Ruben Perez-Manzo, Jorge Corona-Hernandez et al. "Preoperative Ultrasonographic Prediction of Hamstring Tendon Diameter for Anterior Cruciate Ligament Repair", The Journal of Knee Surgery, 2016 Publication	<1 %

47	Niu, Yingzhen, Chao Niu, Xiaomeng Wang, Junhang Liu, Pengkai Cao, Fei Wang, and Jinghui Niu. "Improved ACL reconstruction outcome using double-layer BPTB allograft compared to that using four-strand hamstring tendon allograft", The Knee, 2016. Publication	<1 %
48	Ravi Gupta, Anil Kapoor, Ashwani Soni, Sourabh Khatri, Gladson David Masih, Naveen Mittal. "Does hamstring tendon graft diameter affect the outcome of anterior cruciate ligament surgery?", Sports Orthopaedics and Traumatology, 2019 Publication	<1 %
49	Soo Yeon Park, Hoon Oh, Sua Park, Jung Hwan Lee, Sang Hak Lee, Kyoung Ho Yoon. "Factors predicting hamstring tendon autograft diameters and resulting failure rates after anterior cruciate ligament reconstruction", Knee Surgery, Sports Traumatology, Arthroscopy, 2012 Publication	<1 %

Exclude quotes	On	Exclude matches	< 5 words
Exclude bibliography	On		