

The Quantified Human Gracilis-A Guide to Improve Aesthetic and Functional Outcomes

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ABSTRACT

Background: A functioning gracilis muscle is considered the ideal flap to improve the functional/aesthetic outcome with minimal donor site morbidity. This graceful and slender muscle with special attributes is increasingly being used for covering soft tissue defects, repair of urogenital fistulas and restoration of anal function. Only some studies describing the quantification of this muscle are available and population attributes of the muscle have not been taken into consideration. The present study quantifies the human gracilis muscle in a North Indian population. **Methods:** The morphometry of gracilis was studied in 50 inferior extremities obtained from 25 phenol embalmed adult North Indian cadavers with known age and sex. The length and width of the aponeurotic origin, the length of the muscle belly, length of the distal tendon of insertion were measured. The muscle, tendon ratios were derived. **Results:** The mean estimates for various morphological features of gracilius muscle were standardized for North Indians. All the origins and insertions for the muscle correlated with the standard textbook descriptions. No variation was found from a standard textbook pattern in the present sample. The reconstructive procedures should take the local population profile into consideration. **Conclusion:** The results will aid the clinician in choosing an appropriate muscle and tendon lengths in surgeries. This definitely will lead to better functional and aesthetic outcomes in restorative procedures.

Keywords: Aesthetic, Gracilis, Morphometry.

INTRODUCTION

Gracilis means slender or graceful and is the most superficial muscle on the medial side of the thigh. It is thin and flattened, broad above and narrow and tapering below. The gracilismyocutaneous flap is the favorite of reconstructive surgeons as many patients do not want abdominal, buttock or back scars. Donor site scars are well concealed and it gives the additional benefit of a thigh lift.

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The use of the gracilis muscle in reconstructive surgery was first described by Pickrell in 1952 for rectal sphincter reconstruction.^[1] Since then, this

aesthetic muscle has been used for reconstructive purposes at various sites in the body to achieve optimal results.

The use of the musculocutaneous variant was first reported by Orticochea^[2] in 1972 as a cross-legged flap, before McCraw used a pedicled gracilis musculocutaneous flap for vaginal reconstruction in 1976.^[3] In the same year Harii et al. reported the first gracilis free flap for reconstruction of the head and neck and lower extremity.^[4] Since the late seventies the gracilis myocutaneous flap has been used for soft tissue reconstruction of the breasts^[5], head and neck^[6], upper and lower extremity^[7] and the genitoperineal region.^[8] It has also been used as a free functioning muscle transfer for restoration of elbow flexion^[9], dynamic analplasty^[10] and facial reanimation.^[11] Recently, gracilis tendon auto-grafts have gained popularity in repair of anterior cruciate ligament of knee joint.^[12]

The muscle anatomy has been described and documented by some authors and measurements vis-a-vis the length of the muscle belly, its tendon with

number and origin of various vascular pedicles have been attempted, but all these provide uncertain and unclear data about the anatomical characteristics of the muscle in a particular sex or population for which reparative surgery is being planned. The present study has been undertaken to re-explore the metrical and nonmetrical parameters of this muscle. It is envisaged that these parameters will help the reconstructive surgeon in assessing the length of muscle belly or tendon available for reparative procedures before undertaking surgery in a particular patient.

MATERIALS AND METHODS

Fifty inferior extremities from twenty five phenol embalmed adult cadavers obtained from the Department of Anatomy, Government Medical College, Amritsar comprised the material for this study. The cadavers were labelled from 1 to 25 with suffix R (Right) or L (Left). The gracilis was quantified from adult North Indian cadavers with known age and sex. A total of twenty-three male inferior extremities and two female inferior extremities were utilized in the study. The age range of the cadavers was 50-70 years. The length and width of the aponeurotic origin, the length of the muscle belly, and length of the distal tendon of insertion were measured.

The gracilis muscle belonging to the medial compartment of the thigh was exposed and its origin and insertion was traced on the bones as per the dissection steps provided by Cunningham’s Manual of Practical Anatomy.^[13] The gracilis muscle was isolated taking care to preserve the nerve supplying it. The origin of muscle from the lower half of the body of the pubis, close to the symphysis, and from the anterior part of the inferior pubic ramus were traced. The muscle was then followed upto its insertion to the upper part of the tibia. The length of aponeurosis was taken from the ischiopubic origin upto the point where fleshy fibers commenced. The width of the aponeurosis of muscle on the body of the pubis and anterior part of inferior ramus was measured. The length of fleshy part and tendinous part of the muscle was taken by an unbraided silk thread. The nerve supply to the muscle was traced upto its parent nerve.

RESULTS

The results are depicted in Tables 1-4. Table 1 depicts the values for the total sample i.e. 50 limbs from 25 cadavers. Table 2 depicts the values for 46 male limbs (23 cadavers). Table 3 depicts the values for 4 female limbs (2 cadavers).

Table 1: Mean values and standard deviations of the parameters of Gracilis.

S.No.	Parameters	Mean values	Standard deviation
1	Length of Fleshy belly	29.528	3.001567
2	Length of Tendon	15.236	2.524473
3	Length of the aponeurosis	3.514	0.622703
4	Width of the aponeurosis	3.816	0.565815

Table 2: Mean values and standard deviations of various parameters of Gracilis in males.

S. No.	Parameters (males)	Mean values	Standard deviation
1	Length of Fleshy belly	29.69348	2.943498
2	Length of Tendon	15.48043	2.477779
3	Length of the aponeurosis	3.521739	0.575389
4	Width of the aponeurosis	3.83913	0.536026

Table 3: Mean values and standard deviations of parameters of Gracilis in females.

S.no.	Parameters (females)	Mean values	Standard deviation
1	Length of Fleshy belly	27.625	3.455792
2	Length of Tendon	12.425	0.741058
3	Length of the aponeurosis	3.425	1.164403
4	Width of the aponeurosis	3.55	0.903696

Table 4: The Quantified muscle tendon ratio for Gracilis in North Indian population.

Sex	Muscle tendon ratio	Standard deviation
Males	1.918130	1.187958
Females	2.2233	4.663321
Males and Females	1.93804	1.1889875

Table 4 depicts the average muscle tendon ratio for either sex and also for all cadavers in the present study.



Figure 1: Measurement of length (left image) and width of aponeurosis (right image) of Gracilis muscle.



Figure 2: Measurement of fleshy belly (left image) and tendon length (right image) of Gracilis muscle.

DISCUSSION

Gracilis is a versatile, slender muscle. It is widest and thickest superiorly and narrows to end as a rounded tendon to be inserted in the medial aspect of the upper part of the tibia. It is supplied by the anterior division of obturator nerve and it has been its vascular anatomy

has been described in the literature that the vascular anatomy follows the type II pattern.^[14] Only few structural and morphometric studies of this muscle have been conducted.^[15-17]

The mean length of the fleshy part of Gracilis in our study came out to be 29.5 ± 3.0 cms. This is comparable to the mean length of fleshy belly 29.1 ± 1.3 cms in males and 24.6 ± 0.76 cms in females observed by Harbans et al^[15] in Jammu region. The mean value of the fleshy belly was observed to be 27.9 ± 0.2 cms by Giordano et al^[15] in the French population. The mean length of aponeurosis in our study came out to be 3.51 ± 0.62 cms while the mean length of aponeurosis was 2.5 ± 0.2 cms in males and 1.65 ± 0.16 in females in study by Harbans et al.^[16] The mean length of distal tendon was measured to be 11.5 ± 2.8 cms in males and 10.9 ± 0.03 in females by Harbans et al^[16] in Jammu region. In the present study, the mean length of the distal tendon came out to be 15.48 cms for males and 12.42 cms for females. This indicates that there exists a wide variation of the morphometric parameters in populations.

All above comparisons in populations indicate that the morphometric profile of the muscle belly, proximal aponeurosis and distal tendon has a population specificity and so the reconstructive procedures should take the local population profile into consideration. When this is done, the results of procedures are bound to improve. This population specificity is due to the impact of diet, genetic, cultural and environmental factors which vary from region to region. The average muscle, tendon ratio came out to be 1.94. The present study is the pioneer study, which has determined this ratio for the gracilis muscle. A higher ratio was obtained in females (2.2) than for males (1.9) which indicate that muscle growth and development like bone is regulated under the influence of hormones.

The quantified profile for gracilis created by the present study will aid the reconstructive surgeon in the attainment of better results for patients in whom reparative surgery using this muscle as a free or pedicled graft is being planned. The study reveals variations for different components of the muscle design in individuals and also provides population and sex specific muscle tendon ratios. The present study has been undertaken to re-explore the qualitative and quantitative parameters for this muscle. All the origins and insertions for the muscle correlated with the standard textbook descriptions. No variation was found from a standard textbook pattern in the present sample.

It is envisaged that the parameters standardized for North Indians will help the reconstructive surgeon in assessing the length of muscle belly or tendon available for reparative procedures before undertaking surgery in a particular patient.

The gracilis muscle is used widely in reconstructive surgery, as a pedicled or as a free microsurgical flap, for soft tissue coverage or as a functioning muscle transfer.^[18] The reason why this muscle has been favored by reconstructive surgeons is that it has reliable vascular and neurological pedicles and the minimal donor-site morbidity. The functional and aesthetic outcomes at the donor site at the inner thigh are minimal, compared to alternative transfers for such defects, while the reconstructive features of the gracilis muscle flap are excellent.^[19] This muscle can also be easily harvested and its multi-fascicular innervation allows safe muscular debulking preserving contractility.

Like other studies, the present study too has its limitations. The main limitation the authors feel, is the small size of the female sample. With only four female limbs the comparison with 46 male limbs is disproportionate. So, the quantification for muscle belly length, width and length of proximal aponeurosis, and length of the distal tendon in males is more reliable than in females. Similarly, the muscle, tendon ratio of 1.9 for males has higher predictive value than a higher value of 2.2 determined for females. The authors intend to remove these drawbacks by extending the study sample with inclusion of more female limbs. Nevertheless, there is no denying the fact that the slender, aesthetic and graceful gracilis has enviable utility in reconstruction and as such the present study provides benchmark baseline data with which results of bigger similar studies can be compared.

CONCLUSION

The results will aid the clinician in choosing an appropriate muscle and tendon lengths in surgeries. This definitely will lead to better functional and aesthetic outcomes in restorative procedures.

REFERENCES

- Pickrell KL, Broadbent TR, Masters FW, Metzger JT. Construction of a rectal sphincter and restoration of anal continence by transplanting the gracilis muscle; a report of four cases in children. *Ann Surg.* 1952;135(6):853–862.
- Orticochea M. The musculo-cutaneous flap method: an immediate and heroic substitute for the method of delay. *Br J Plast Surg.* 1972;25(2):106–110.
- McCraw JB, Massey FM, Shanklin KD, Horton CE. Vaginal reconstruction with gracilismyocutaneous flaps. *Plast. Reconstr. Surg.* 1976;58(2):176–183.
- Harii K, Ohmori K, Sekiguchi J. The free musculocutaneous flap. *Plast. Reconstr. Surg.* 1976;57(3):294–303.
- Wechselberger G, Schoeller T. The Transverse Myocutaneous Gracilis Free Flap: A Valuable Tissue Source in Autologous Breast Reconstruction. *Plast. Reconstr. Surg.* 2004;114(1):69.
- Huemer GM, Bauer T, Wechselberger G, Schoeller T. Gracilis muscle flap for aesthetic reconstruction in the head and neck region. *Microsurgery.* 2005;25(3):196–202.
- Eom JS, Sun SH, Hong JP. Use of the upper medial thigh perforator flap (gracilis perforator flap) for lower extremity reconstruction. *Plast. Reconstr. Surg.* 2011;127(2):731–737.
- Wexner SD, Ruiz DE, Genua J, Noguera JJ, Weiss EG, et al. Gracilis muscle interposition for the treatment of rectourethral, rectovaginal, and pouch-vaginal fistulas: results in 53 patients. *Ann Surg.* 2008;248(1):39–43.
- Berger A, Hierner R. Free functional gracilis muscle transplantation for reconstruction of active elbow flexion in posttraumatic brachial plexus lesions. *Oper Orthop Traumatol.* 2009;21(2):141–156.
- Lewis M. Gracilis-muscle transplant for the correction of anal incontinence: report of a case. *Dis Colon Rectum.* 1972;15(4):292–8.
- Bianchi B, Copelli C, Ferrari S, Ferri A, Bailleul C, et al. Facial animation with free-muscle transfer innervated by the masseter motor nerve in unilateral facial paralysis. *J Oral Maxillofac Surg.* 2010;68(7):1524–1529.
- Pichler W, Tesch NP, Schwantzer G, Fronhöfer G, Boldin C, Hausleitner L, Grechenig W. Differences in length and cross-section of semitendinosus and gracilis tendons and their effect on anterior cruciate ligament reconstruction: a cadaver study. *J Bone Joint Surg Br.* 2008;90(4):516–9.
- Romanes GJ. Muscles of thigh. In: Cunningham's Textbook of Anatomy, 10th Edn. London – New York – Toronto: Oxford University Press;1964.
- Nayak BB, Mohanty N. Muscle conserving free gracilis transfer (mini-gracilis free flap). *Indian J Pl Surg.* 2012;45(1):130–133.
- Giordano PA, Abbes M, Pequignot JP. Gracilis blood supply: Anatomical and clinical re-evaluation. *Br J Plast Surg.* 1990;43:266–72.
- Singh H, Kaur R, Gupta N. Morphometric study of Gracilis Muscle and its Role in Clinical Reconstruction. *J. Anat. Soc.* 2011;60(2):202–206.
- Vitago, Enrico. The clinical role of the gracilis muscle: an example of multidisciplinary collaboration. *Pelviperrineology.* 2007;26:149–151.
- Macchi V, Vigato E, Porzionato A, Tiengo C, Stecco C, Parenti A et al. The gracilis muscle and its use in clinical reconstruction: an anatomical, embryological, and radiological study. *Clin Anat.* 2008; 21(7):696–704.
- Vranckx, Jeroen J. The gracilis free muscle flap is more than just a "graceful" flap for lower-leg reconstruction. *J rec microsurg.* 2004;20(2): 143–148.

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