

Variation in Tendinous Intersections of Rectus Abdominis Muscle in North Indian Population with Clinical Implications

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ABSTRACT

Aim of the study: Incisions through the abdominal wall are based on anatomical principles and Rectus abdominis muscle provides an excellent myocutaneous flap. The present work was proposed to identify variations in numbers and location of tendinous intersections of the Rectus Abdominis muscle in the cadavers as a guide to the surgical procedures.

Materials and Methods: The study was conducted on 54 cadavers of North Indian origin allotted to undergraduate medical student for Anatomy dissection classes. Manual dissection was done to identify tendinous intersections of the Rectus Abdominis muscle with reference to number and location.

Results: In the present study one cadaver had five tendinous

intersections (1.85%), one cadaver had four tendinous intersections (1.85%) and 52 cadavers had three tendinous intersections (96.29%).

Conclusion: The present study is an effort to provide data about the anatomical variation in numbers and location of tendinous intersections of the Rectus Abdominis muscles. Rectus abdominis muscle provides an excellent myocutaneous flap because the muscle belly is separated from surrounding tissue within the rectus sheath. This study is representative of a small study of the human population and only serves to illustrate the variations in the anatomy of the tendinous intersections. More extensive studies are required to establish a definitive pattern among local populations to serve as a guide for surgical procedures.

Keywords: Breast reconstruction, Surgical Flaps, TRAM Flaps

INTRODUCTION

Rectus abdominis is a long, strap-like muscle that extends along the entire length of the anterior abdominal wall on either side of the midline, separated by the linea alba. The muscle is enclosed by a fibrous sheath which covers the entire muscle anteriorly and only upper two-third of the muscle posteriorly. The sheath in which the rectus lies is formed, to a large extent, by the aponeurotic expansions of the lateral abdominal muscles [1].

The somite structures that invade the somatopleure of the abdominal and thoracic wall, is dermomyotome and myotome, that give the muscle blastemata for the intercostal muscles and muscles of anterior abdominal wall [2].

The rectus muscle usually has three transverse tendinous intersections one just below the costal margin, one at umbilical level and the other between these two. In muscular individuals, their positions can be seen on the abdominal wall because they adhere to the anterior layer of the sheath (but not to its posterior layer) and appear to divide the muscle into segments [3]. These intersections pass transversely or obliquely across the muscle in a zigzag manner. They are rarely full thickness and may extend only half way through the body of the muscle. They usually fuse with the fibres of the anterior lamina of the sheath of the muscle. Sometimes, one or two incomplete intersections are present below the umbilicus. The intersections may occur during development or may represent the myosepta delineating the myotomes that form the muscle [4].

Incisions through the abdominal wall are based on anatomical principles. The intra-abdominal pressure is considerable, and the surgeon aims at leaving the abdominal wall as strong as possible after operation, otherwise there exists a very real fear that portions of the abdominal contents may protrude out from the abdominal cavity through the weak area which is caused by a badly placed

incision, resulting in a condition known as scar, incisional, or ventral hernia. Above the umbilicus, the tendinous intersections prevent retraction of the rectus muscle after it has been divided [5].

Rectus abdominis provides an excellent myocutaneous flap either pedicled or free because of the excellent vascularity provided by the epigastric vessels and because the muscle belly is separated from surrounding tissue within the rectus sheath. The upper half of the muscle may be used for breast reconstruction or augmentation of tissue loss on the anterior thorax. The lower half may be used in the region of the thigh and may be rotated on its lower attachments passed through the pelvis and delivered into the perineum for reconstruction after radical pelvic and perineal resections [4].

Reconstruction of the breast can be accomplished reliably with infraumbilical skin and adipose tissue based on both rectus muscles. The Transverse Rectus Abdominis Myocutaneous (TRAM) flap, when based on the superior epigastric vessel and including the infraumbilical skin, has become a workhorse for autologous tissue breast reconstruction. The inferior epigastric artery is the more dominant pedicle, supplying approximately 2/3 of the blood supply to the flap, while the superior epigastric artery only supplies about 1/3 [6].

The present study was undertaken to study variations in number and location of tendinous intersection in rectus abdominis muscle because of their considerable clinical implications since their anatomy forms the basis of reconstructive surgery and abdominal incisions with its complications.

MATERIALS AND METHODS

The study was conducted on formalin fixed 54 cadavers (37 male and 17 female) of North Indian origin allotted to undergraduate medical students for anatomy dissection classes at Katihar Medical

college, Katihar, Nalanda Medical College, Patna and Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly between 2008-2015.

In each case manual dissection was done following skin reflection; rectus sheath was opened anteriorly by vertical incision bilaterally to identify tendinous intersections of rectus abdominis muscle. Number and location of tendinous intersections were studied and documented. Distance of tendinous intersections from pubic symphysis, umbilicus and xiphisternal joint was measured by measuring tape on both the sides.

OBSERVATION AND RESULT

In the present study, in 54 cadaver, five tendinous intersection was found in one case (1.85%), four tendinous intersection found in one case (1.85%) and three tendinous intersection found in 52 case (96.29%).

In the cadaver having five intersections the location of tendinous intersection was as follows:-

I (First) – At the xiphisternum.

II (Second) – At the costal margin.

III (Third) - In between xiphisternum and umbilicus.

IV (Fourth) - At the umbilicus.

V (Fifth) - In between umbilicus and pubic symphysis.

Shape was zigzag in manner, complete and of partial thickness in all the tendinous intersections.

The distance of the tendinous intersection from various landmarks (pubic symphysis, the umbilicus and the Xiphisternum) on the anterior abdominal wall was measured [Table/Fig-1], which was identical on both sides [Table/Fig-2].

Location of tendinous intersection	Distance from (in Cm)		
	Xiphisternum	Umbilicus	Symphysis Pubis
I At the Xiphisternum	0	20.5	37.2
II At the costal margin	4.1	15.2	32.5
III In between Xiphisternum and umbilicus	11.2	8.1	25.2
IV At the Umbilicus	19.1	0	18.1
V In between Umbilicus & pubic symphysis	24.1	7.1	12.2

[Table/Fig-1]: Distance of the tendinous intersection from various landmarks



[Table/Fig-2]: Location of tendinous intersections

I At the Xiphisternum, II At the costal margin, III In between Xiphisternum and umbilicus, IV At the Umbilicus, V In between Umbilicus & pubic symphysis

[Table/Fig-3]: Location of tendinous intersections

I At the costal margin, II In between Xiphisternum and umbilicus, III At the Umbilicus, IV In between Umbilicus & pubic symphysis

In the cadaver having four intersections the location of tendinous intersection was as follows:

I (First) – At the costal margin.

II (Second) - In between xiphisternum and umbilicus.

III (Third) - At the umbilicus.

IV (Fourth) - In between umbilicus and pubic symphysis.

Shape was zig-zag in manner and of partial thickness in all the tendinous intersections and fourth tendinous intersections was incomplete bilaterally.

The distance of these four intersections from various landmarks (pubic symphysis, the umbilicus and the Xiphisternum) were measured as depicted in [Table/Fig-3]. They were found to be bilaterally equal [Table/Fig-4].

In the cadaver having three intersections the Location of tendinous intersection was as follows:

I (First) - Just below xiphisternum.

II (second) - In between xiphisternum and umbilicus.

III (Third) - At the umbilicus.

The mean distance of the tendinous intersection from various landmarks (pubic symphysis, the umbilicus and the Xiphisternum) on the anterior abdominal wall was measured. These are shown in the [Table/Fig-5].

Location of tendinous intersection	Distance from (in Cm)		
	Xiphisternum	Umbilicus	Symphysis Pubis
I At the costal margin	4.1	15.2	29.1
II In between Xiphisternum and umbilicus	10.2	8.2	24.2
III At the Umbilicus	16.1	0.0	17.2
IV In between Umbilicus & pubic symphysis	21.2	6.2	12.2

[Table/Fig-4]: Distance of the four intersections from various landmarks

Location of tendinous intersection	Distance from (in Cm)								
	Xiphisternum			Umbilicus			Symphysis Pubis		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
I At the costal margin	2.9	4.0	3.5	14.6	16.1	15.1	31.6	33.1	32.2
II In between Xiphisternum and umbilicus	9.9	11.1	10.3	7.9	9.0	8.3	25.1	26.5	25.9
III At the Umbilicus	17.9	19.0	18.6	0.0	0.0	0.0	16.8	18.1	17.6

[Table/Fig-5]: Mean distance of the tendinous intersection from various landmarks
Max-Maximum, Min-Minimum, Mean-Mean

DISCUSSION

Rectus abdominis approximate chest and pubis and flex the thoracic and lumbar vertebrae. The long muscle is divided and bound by tendinous intersections thus increasing its strength and efficiency [7].

The tendinous intersections represent lines of fusion of myotomes. The tendinous intersection interchange fibres to blend inseparably with the anterior rectus sheath and do not penetrate to the posterior surface of the muscle. The contracting rectus abdominis can be seen bulging between the tendinous intersections in an individual who is not too fat [8].

In upper abdominal wall linea alba is well developed, right and left recti separated and both the layers of rectus sheath are present [9].

Z Ash Aktan Ikiz, Hulya Ucerler reported a case of bilateral absence of the tendinous intersection of the rectus abdominis muscle. In 64-year-old male cadaver both rectus muscle right and left were symmetrical but there were no tendinous intersection on them [10].

Whereas, in present study tendinous intersections were found in all cases.

Wetzel and Hung dissected 14 adult cadavers to study the arterial vascular anatomy of the tendinous intersections of the rectus abdominis muscle. The superior epigastric artery commonly supplied the superior and middle intersections (about upper 2\3 of Rectus abdominis muscle) and the inferior epigastric artery commonly supplied the inferior intersection (about lower 1\3 of Rectus abdominis muscle). Three to four tendinous intersections could be identified in each rectus abdominis muscle. Twelve out of fourteen muscles had three intersections. The tendinous intersections were commonly seen at the level of the costal margin (superior), halfway between the costal margin and umbilicus (middle) and in the region of the umbilicus (inferior). The inferior intersection was frequently incomplete, extending from one-half to three fourths of the transverse distance across the rectus abdominis muscle. Two recti had a small rudimentary fourth intersection below the inferior transsection [11]. In present study the location of tendinous intersection in rectus muscle with five intersection were at the xiphisternum (first), at the costal margin (second), in between xiphisternum and umbilicus (third) at the umbilicus (fourth) in between umbilicus and pubic symphysis (fifth). Location of tendinous intersection in rectus muscle with four intersections were, at the costal margin (First), in between xiphisternum and umbilicus (second) at the umbilicus (third) in between umbilicus and pubic symphysis (fourth). Location of tendinous intersection in rectus muscle with three intersections was, at the costal margin (first), in between xiphisternum and umbilicus (second), at the umbilicus (third).

Meenakshi S, Manjunath KY studied 82 recti, they found 21.95% had four intersections, 60.97% had three intersections and 14.63% had two intersections and only two had single inscription (2.44%) [12]. The fourth intersection is always below the umbilical scar.

In the present study one cadaver had five tendinous intersections (1.85%), one cadaver had four tendinous intersections (1.85%) and 52 cadavers had three tendinous intersections (96.29%).

Rectus abdominis muscle provides an excellent myocutaneous flap because the muscle belly is separated from surrounding

tissue within the rectus sheath. Reconstruction of the breast can be accomplished reliably with infraumbilical skin, adipose tissue and rectus abdominis muscles. The Transverse Rectus Abdominis Myocutaneous (TRAM) flap has become a workhorse for autologous tissue breast reconstruction.

CONCLUSION

The present study shows unusual anatomical variation in numbers and location of tendinous intersections of the Rectus Abdomini muscles. More extensive studies are required to establish a definitive pattern among local populations to serve as a guide for surgical procedures.

REFERENCES

- [1] Ellis H, Mahadevan V. Part 2 The abdomen and pelvis, Clinical anatomy: applied anatomy for students and junior doctors, 13th edition, 2013 John Wiley & sons Ltd, United Kingdom, 61-167.
- [2] Standing S. chapter – 44, Development of back, Gray's Anatomy The Anatomical Basis of clinical practice, Spain, Elsevier Limited, 40th Edition. 2008. 763-73.
- [3] Mc Minn R MH, Rosse PG, Hutchings RT, Logan BM. Chapter –19 Abdomen and Pelvis. Mc Minn's Functional and clinical Anatomy, Chicago, Mosby Comp. 19th edition. 1995. pp. 243- 311.
- [4] Standing S. chapter – 61, Anterior Abdominal wall, Gray's Anatomy The Anatomical Basis of clinical practice, Spain, Elsevier Limited, 40th Edition. 2008. 1055-68.
- [5] McGregor AL, Decker G, du Plessis DJ. Chapter-9. The Anatomy of Abdominal Incisions. A Lee McGregor's Synopsis of surgical Anatomy, Bombay (India), Varghese Publishing House, 12th edition. 1986. 113 – 18.
- [6] Greer SE, Benhaim P, Lorenz HP, Chang J, Hedrick MH. Chapter –100, Breast Reconstruction of Mastectomy, Hand Book of Plastic surgery, New York edition 2004, Marcel Dekker. 2004. pp. 585-96.
- [7] Grant, Basmajian JV, Chapter–13, Anterior Abdominal wall and scrotum, Grant's Method of Anatomy, U.S.A. The Williams & Wilkins company. 8th Edition. 1972, 185-99.
- [8] Last RJ, Sinnatamby CS., Chapter 5, The Abdomen, R.J. Last Anatomy Regional and Applied, China, Elsevier, 7th Edition, 1985, 221-325.
- [9] Skandalakis LJ, Chapter–4 Abdominal wall and Hernias, surgical Anatomy and Technique, New York, Springer, 2nd Edition 2002. pp. 123-228.
- [10] Jkiz ZAA, Ucerler H. Bilateral absence of the tendinous intersection of the rectus abdominis muscle. *Anatomy*. 2009;3:69-71.
- [11] Whetzel TP, Huang H. The vascular anatomy of the tendinous intersections of the rectus abdominis muscle. *Plast Reconstr Surg*. 1996;98(1):83-89.
- [12] Meenakshi S, Manjunath KY. The tendinous intersection of rectus abdomines muscle. *Journal of Mahatma Gandhi Institute of Medical Sciences*. 2008;13(1):34-39.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Mar 17, 2015**
Date of Peer Review: **Apr 24, 2015**
Date of Acceptance: **Apr 28, 2015**
Date of Publishing: **Jun 01, 2015**