

# Morphometric study of patella and patellar ligament of knee with its clinical significance

Meghana H Joshi<sup>1</sup>, Vasant H Vaniya<sup>2\*</sup>

<sup>1</sup>Department of Anatomy, Parul Institute of Medical Sciences and Research, Parul University, Vadodra, Gujarat, INDIA.

<sup>2</sup>Department of Anatomy, Government Medical College Baroda, The Maharaja Sayajirao University of Baroda, Gujarat, INDIA.

Email: [mhjoshi67@gmail.com](mailto:mhjoshi67@gmail.com)

## Abstract

**Background:** Patella is largest sesamoid bone in humans. It forms component of knee joint and embedded in tendon of quadriceps femoris. Morphometric parameters of patella and patellar ligament reported important in designing patellar implant for the success of functionality of knee arthroplasty procedure and in various other surgical procedures of knee. **Aims and objectives:** To observe morphometric linear measurements of patella and patellar ligament of knee joint and to evaluate bilateral and sexual dimorphism in cadavers. **Materials and methods:** Total ninety lower limb including both sexes dissected for morphometric analysis of patella and patellar ligament. Mean length, width, thickness of patella and patellar ligament, width of medial and lateral articular facet of patella were measured by digital vernier calliper and analyzed statistically. **Results:** Mean length, width, thickness of patella measured 38.37, 48.95, 18.68mm on right sided and 37.40, 47.40, 18.40mm on left sided respectively. Mean Length, width and thickness of patellar ligament in proximal and distal part measured 59.82, 28.33, 4.044, 4.222mm on right sided respectively and 61.93, 28.95, 4.400, 3.977 on left sided respectively. Mean width of lateral and medial articular facet on right and left sided measured 27.00, 22.57, 27.00, 26.00mm respectively. **Conclusion:** The morphometric knowledge of patella, patellar ligament and their interrelationship can help to orthopaedic surgeons for knee arthroplasty procedure. Patellar ligament morphometric knowledge can be of great significant to the surgeons, as patellar tendon graft is choice of graft in anterior and posterior cruciate ligament reconstruction procedure using "Bone-patellar tendon-bone" autograft harvest.

**Key Words:** ACL reconstruction, knee Arthroplasty, Knee Joint, Morphometry, Patella, Patellar tendon.

## \*Address for Correspondence:

Dr. Vasant H Vaniya, Department of Anatomy, Government Medical College Baroda, The Maharaja Sayajirao University of Baroda, Gujarat.

Email: [mhjoshi67@gmail.com](mailto:mhjoshi67@gmail.com)

Received Date: 04/07/2021 Revised Date: 10/08/2021 Accepted Date: 24/09/2021

This work is licensed under a [Creative Commons Attribution-NonCommercial 4.0 International License](https://creativecommons.org/licenses/by-nc/4.0/) 

## Access this article online

Quick Response Code:



Website:

[www.medpulse.in](http://www.medpulse.in)

DOI:

<https://doi.org/10.26611/10012012>

## INTRODUCTION

The patella (knee cap) is flattened and triangular shaped bone, embedded within the tendon of quadriceps femoris muscle. It forms part of the knee joint situated in front of the lower end of the femur approximately one cm above the knee joint. It has a thick superior border and distally converging medial and lateral borders<sup>1</sup>. It has a rough

anterior surface and posterior surface has upper three fourth (smooth and articulating) and lower one fourth (rough and non-articulating). Upper posterior surface is divided into medial and lateral articular facets separated by a vertical ridge. Each facet is further divided by faint horizontal lines into equal thirds. Between narrow strips along the medial border of the patella presents a seventh odd facet<sup>1</sup>. The patellar ligament is tendinous insertion of quadriceps femoris muscle, attached above to the margins and rough posterior surface of apex of patella and below to the smooth upper part of tibial tuberosity<sup>[1]</sup>. The morphometric knowledge of patella, patellar ligament and their interrelationship in different population group and gender is often utilized for the functionality of implant design. A disproportional patellofemoral joint implant would result in an ineffective lever support, limitation of range of motion, excessive wear of the patella with associated knee pain. Furthermore, knowledge is crucial in various other surgical procedures of knee such as the

harvesting technique of patellar ligament grafts during the reconstruction of the anterior cruciate ligament and posterior cruciate ligament<sup>1</sup>. Patella is involved in various sitting and squatting positions and hence shows cultural and gender variables.<sup>2,3,4</sup> Therefore, present study was aimed to measure morphometric linear measurements of patella and patellar ligament of knee joint and to evaluate bilateral and sexual dimorphism in cadavers.

**METHODOLOGY**

This was an observational study carried out after obtaining approval from Institutional Ethics Committee for Human Research, Medical College and S.S.G. Hospital Baroda, Gujarat. Ninety properly embalmed and formalin fixed lower limb of adult cadavers (62 males and 28 females) were selected for the study. All the available

specimens, did not have any visible external abnormalities in their lower limb were included. Any cadavers with previously operated in lower limb knee region, established osteoarthritis related changes to knee, signs of patellofemoral disease, physical signs of deformity of patella which may prevent the morphometric analysis of patella and patellar ligament were excluded from the study. Observations were made after dissecting the cadavers. An incision was made on the medial aspect of knee. Initially skin, overlying fascia and fat surrounding the knee joint was removed. The quadriceps femoris muscle and patellar tendon were freed from the surrounding structures. The patellar bone was exposed. The infrapatellar pad of fat was removed. Patellar tendon was cleaned and exposed after removal of parapatellar sheath.



**Figure 1:** Showing morphometric measurements of patella of knee in cadavers– present study.

A- Anterior aspect of dissected knee. B- Length of patella. C- Width of patella. D- Thickness of patella. E- Width of lateral articular facet.



**Figure 2:** Showing morphometric measurements of patellar ligament of knee in cadavers– present study.

F- Patellar ligament in dissected knee. G- Length of patellar ligament. H- Width of patellar ligament. I and J- Thickness of patellar ligament in proximal and distal part.

**Table 1:** Shows description of various measurements of patella and patellar ligament of knee

Measurements	Description
Length of patella	Linear distance between superior border and apex of patella.
Width of patella	Linear distance between medial border and lateral border of patella.
Thickness of patella	Linear distance between anterior surface and median ridge on posterior surface of patella.
Width of lateral articular facet	Maximum width from lateral border to median ridge of patella.
Width of medial articular facet	Maximum width from medial border to median ridge of patella.
Patellar Ligament Length	Linear distance between apex (non-articular posterior surface) of patella and tibial tuberosity.
Patellar Ligament Width	Linear distance between two margins/borders of patellar ligament.
Patellar Ligament Thickness	Linear distance between anterior and posterior surface of patellar ligament at proximal and distal part.

**Statistical analysis:** The data was measured by using digital vernier calliper in millimetres (mm). It shows mean, standard deviation (SD), Standard error of mean (SEM), t-value and p-value of all parameters of both male and female sexes and right and left side. Data was statistically analyzed by Statistical product and Service Solution (SPSS) in Microsoft Excel.

**Ethical Issues:** No ethical issues were involved.

## RESULT

Total ninety cadaveric knee joints were dissected (Right = 45, Left = 45) with known gender. All measurements were taken in the Department of Anatomy from various colleges, and data was measured by digital vernier callipers. Data is enlisted in table 2 and 3 in detail.

**TABLE 2:** Statistical data of different parameters of patella and patellar ligament of knee right sided and left sided.

MEASUREMENTS	RIGHT SIDED (N=45)		LEFT SIDED (N=45)		t- value	P-value
	Mean $\pm$ SD (in mm)	SEM	Mean $\pm$ SD (in mm)	SEM		
Length of patella	38.37 $\pm$ 0.554	0.083	37.40 $\pm$ 0.542	0.081	1.197	0.230
Width of patella	48.95 $\pm$ 0.724	0.109	47.40 $\pm$ 0.485	0.073	1.115	0.260
Thickness of patella	18.68 $\pm$ 0.171	0.025	18.40 $\pm$ 0.170	0.172	0.913	0.360
Width of lateral articular facet	27.00 $\pm$ 0.194	0.028	27.00 $\pm$ 0.178	0.026	<0.001	0.500
Width of medial articular facet	22.57 $\pm$ 0.224	0.033	26.00 $\pm$ 0.168	0.025	1.488	0.070
patellar ligament Length	59.82 $\pm$ 0.712	0.106	61.93 $\pm$ 0.638	0.116	0.196	0.422
patellar ligament Width	28.33 $\pm$ 0.535	0.079	28.95 $\pm$ 0.436	0.065	0.647	0.259
patellar ligament	4.044 $\pm$ 0.928	0.138	4.400 $\pm$ 0.687	0.102	2.064	0.020
Thickness (Proximal Part)						
Patellar ligament	4.222 $\pm$ 1.412	0.210	3.977 $\pm$ 1.177	0.175	0.891	0.187
Thickness (Distal Part)						

**TABLE 3:** Statistical data of different parameters of patella and patellar ligament of knee in males and females.

MEASUREMENTS	MALE (N= 62)		FEMALE (N= 28)		t- value	P-value
	Mean $\pm$ SD (in mm)	SEM	Mean $\pm$ SD (in mm)	SEM		
Length of patella	39.54 $\pm$ 0.506	0.064	33.82 $\pm$ 0.427	0.080	5.199	0.001
Width of patella	48.00 $\pm$ 0.687	0.087	48.22 $\pm$ 0.407	0.055	0.299	0.382
Thickness of patella	18.62 $\pm$ 0.175	0.222	18.35 $\pm$ 0.168	0.031	0.688	0.246
Width of lateral articular facet	22.69 $\pm$ 0.188	0.023	23.32 $\pm$ 0.219	0.041	1.388	0.084
Width of medial articular facet	16.69 $\pm$ 0.187	0.023	16.96 $\pm$ 0.181	0.034	0.639	0.262
patellar ligament Length	60.24 $\pm$ 0.625	0.079	59.96 $\pm$ 0.614	0.116	0.196	0.422
patellar ligament Width	29.06 $\pm$ 0.455	0.057	27.75 $\pm$ 0.549	0.103	1.186	0.119
patellar ligament	4.177 $\pm$ 0.820	0.104	4.321 $\pm$ 0.862	0.163	0.758	0.225
Thickness (Proximal Part)						
Patellar ligament Thickness (Distal Part)	4.338 $\pm$ 1.447	0.183	3.571 $\pm$ 0.634	0.119	2.683	0.004

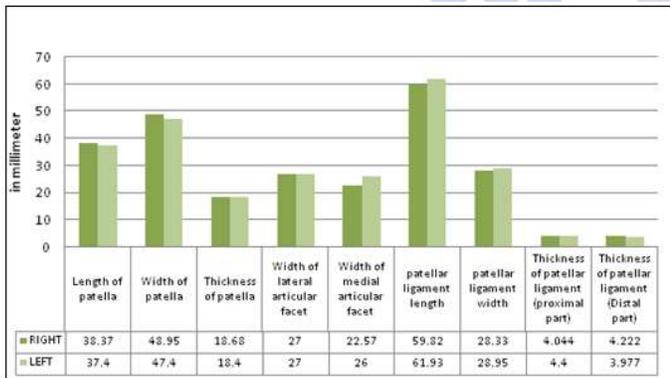
## DISCUSSION

In the treatment of knee joint degenerative diseases, knee joint arthroplasty procedure has become popular. The proper use of morphometric matched prosthesis is the key to success for knee arthroplasty procedure. It is therefore very important to have knowledge of reliable morphometric data for designing and selection of implant size of prosthesis. The morphometric knowledge on patellar ligament can be of great significant to surgeon, as patellar tendon graft is the choice of graft in anterior cruciate ligament reconstruction procedures using “Bone-patellar tendon-bone” autograft harvest. For present study data was recorded from cadaveric study by direct observation. Morphometric study on patella and patellar ligament was usually done by dry bone study, CT-scan study or intra-operative study as per the author’s record. The present study results were compared with the studies done by other authors and it is elicited in Table no.4 below.

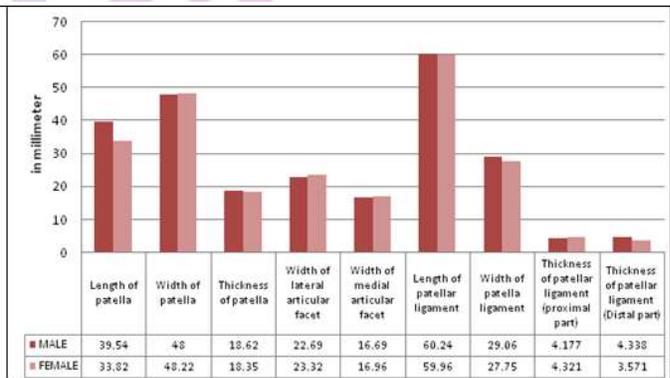
**Table 4:** Shows comparison of morphometric measurements of patella among various authors.

Measurements	Peng shang <i>et al.</i> <sup>[5]</sup> (2014)	I. Kayalvizhi <i>et al.</i> <sup>[6]</sup> (2015)	Rupa Chhparwal <i>et al.</i> <sup>[7]</sup> (2018)	Sudipa Biswas <i>et al.</i> <sup>[8]</sup> (2019)	Shaifuzain Ab Rahman <i>et al.</i> <sup>[9]</sup> (2020)	Present study
Length of patella (in mm)	R- 39.98	R- 42.90	R- 36.61	R- 39.45	R- 31.41	R-38.37
	L- 39.90	L- 41.70	L- 36.72	L- 40.53	L- 31.24	L-37.40
Width of Patella (in mm)	R-44.12	R- 42.10	R- 38.80	R- 40.54	R- 40.67	R-48.95
	L-44.15	L- 41.30	L- 38.53	L- 41.21	L- 40.85	L-47.40
Thickness of patella (in mm)	R-22.65	R- 19.70	R- 19.21	R- 19.39	R- 20.82	R-18.62
	L-22.79	L- 20.70	L- 19.31	L- 19.79	L- 20.65	L-18.35
Width of lateral articular facet (in mm)	R-25.21	R- 30.50	R- 22.73	R- 19.75	R- 21.30	R-27.00
	L-25.06	L- 26.40	L- 23.97	L- 20.16	L- 21.30	L-27.00
Width of medial articular facet (in mm)	R-18.92	R- 22.10	R- 20.94	R- 14.78	R- 19.22	R-22.57
	L-19.15	L- 22.40	L- 20.44	L- 15.60	L- 19.55	L-26.00

Result found in study by Poonam Vohra *et al.*<sup>3</sup> was little smaller as compared to present study. Present study results for morphometric measurements of patella were almost similar to the study conducted by Peng Shang *et al.*<sup>5</sup>, I. Kayalvizhi *et al.*<sup>6</sup> In present study results observed for width of patella measured highest in comparison with other authors and results observed in mean values of right and left sided patella were to be similar. Although the right patellar width showed somewhat larger values than the left patella, but it was not statistically significant. In the present study, the mean value of patellar ligament length was measured on the right side 59.82±0.712 and on the left side 61.93±0.638 respectively. The result was much higher than found in Jae Ho Yoo *et al.*<sup>11</sup>, Oladiran Olateju OI *et al.*<sup>12</sup> and less than the result found in Zooker Chad *et al.*<sup>13</sup> Mean value of width of patellar ligament was measured 28.33±0.535 on right side and 28.95±0.436 on left side, the data was measured similar in other studies by authors Jae HO Yoo *et al.*<sup>11</sup>, Oladiran Olateju OI *et al.*<sup>12</sup> and Zooker, Chad *et al.*<sup>13</sup> Mean value for thickness of patella was measured in proximal and distal parts and found similar as by Jae HO Yoo *et al.*<sup>11</sup> Furthermore mean values of male and female specimen for sex dimorphism was also found to be similar. Although the length of patella and patellar ligament were insignificantly observed higher in males than females. The difference in results may be due to the difference in build and stature of females.



**Graph 1**



**Graph 2**

**Graph 1:** Morphometric linear measurements of patella & patellar ligament of knee right sided vs. left sided; **Graph 2:** Morphometric linear measurements of patella & patellar ligament of knee in males vs. females

**CONCLUSION**

The present study aids morphometric knowledge in patellar bone and patellar ligament and established data with sex and right and left pattern. Knowledge can be utilized for implant design in replacement and reconstructive surgeries of knee and various other surgical procedures involving knee. The data can significantly help in orthopaedic surgery, Forensic

evaluation, anthropology, comparative anatomy, and evolutionary biology of humans.

**Acknowledgement:** Authors are thankful to the teaching and non-teaching staff of department of Anatomy, especially Medical College Baroda, GMERS Medical College Vadodara, J. S. Ayurveda Mahavidhyalaya, Dr.N.D.Desai Faculty of Medical Sciences and Research for their full co-operation and support as and when required.

## REFERENCES

1. Susan Standring, Gray's Anatomy, 41<sup>st</sup> Edition.
2. Ahmed Al-Imam, Zaid Al-Zamili, and Rawan Omar; Surface Area of Patellar Facets: Inferential Statistics in the Iraqi Population; *Anatomy Research International* Volume 2017, 1-8.
3. Vohra P.; Morphometric Study Of Patella And Its Role In Sex Determination. *International Journal Of Anatomy Physiology And Biochemistry* 2017;4(3):6-9.
4. Ahmed Al-Imam, Zaid Al-Zamili, and Rawan Omar; Surface Area of Patellar Facets: Inferential Statistics in the Iraqi Population; *Anatomy Research International* Volume 2017, 1-8.
5. Shang Peng, Linan Zhang, Zengtao Hou, Bai, Xueling Xin Ye, Zhaobin Xu and Huang Xu; Morphometric Measurement Of The Patella On 3D Model Reconstructed From CT Scan Images For The Southern Chinese Population; *Chin Med J* 2014;127 (1)96-101.
6. I. Kayalvizhi, Arora S., B. Dang, Bansal Swati, Narayan R. K.; Sex Determination By Applying Discriminant Functional Analysis On Patellar Morphometry; *IJSR*; 2015;4(11);1511-1515.
7. R Chhapparwal, S Hiware, P Chhapparwal, N Chhapparwal; Morphometric Study Of Knee Cap (Patella). *Ann. Int. Med. Den. Res*;2018;4(6):AT05-AT09.
8. Biswas Sudipa, Sharma Suranjali; Morphometric Study Of Patellar Measurement: An Overview From Eastern Zone Of India. *International Journal of Contemporary Medical Research* 2019;6(3):C5-C9.
9. Rahman Shaifuzain Ab, Shokri Ahmed Amran, Ahmad Muhammad Rajaie, Ahmad Filza Ismail, and Nur Syahida Termizi; Intraoperative Patella Dimension Measurement In Asian Female Patients And Its Relevance In Patellar Resurfacing In TKA. *Advances in Orthopedics*: 2020:1-6.
10. Murugan Magi, Ambika Sri, Nim Virendar Kumar. Knee Cap: A Morphometric Study. *Int J Anat Res* 2017;5(1):3556-3559.
11. Yoo Jae Ho, Seung Rim Yi and Jin Hong Kim; The Geometry Of Patella And Patellar Tendon Measured On Knee MRI; *Surgical and Radiologic Anatomy*; 2007; 29;623-628
12. Oladiran Olateju OI, Philander I, Bidmos MA; Morphometric Analysis Of The Patella And Patellar Ligament Of South Africans Of European Ancestry; *S Afr J Sci.* 2013;109(9/10).
13. Chad Zooker, Pandarinath, Rajeev; Kraeutler, Matthew J; Ciccotti, Michael G; Cohen, Steven B.; and Deluca, Peter F; "Clinical Measurement Of Patellar Tendon: Accuracy And Relationship To Surgical Tendon Dimensions." 2013; Rothman Institute. Paper 32.

Source of Support: None Declared  
Conflict of Interest: None Declared