International Journal of Anatomy and Research,
Int J Anat Res 2024, Vol 12(3):9011-16. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2024.163

Original Research Article

Is Low Lying Pubic Tubercle A Risk Factor for Inguinal Hernia?

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ABSTRACT

Introduction: Inguinal hernia is the most common clinical entity which one comes across in surgical practice. According to recent research, the anatomical structure of the inguinal region is crucial for the development of hernias. Variations in the position of the pubic tubercle, especially a low-lying pubic tubercle, may alter the tension and integrity of the inguinal canal, potentially facilitating the development of hernias. This study compares the pubic tubercle locations in people with and without inguinal hernias by a thorough investigation of patient anatomical data and, to find any statistically significant associations which may help guide clinical practice and advance our knowledge of the pathophysiology of inguinal hernias.

Methods: A hospital-based case control study carried out from October 2018 to October 2022 for a period of 24 months. 70 individuals who met inclusion criteria were selected for each group. In supine position of patient, the measurements of the perpendicular distance between the inter-spinal line and the pubic tubercle (PT line) and the distance between two anterior superior iliac spines (AA line) were taken and evaluated in all patients along with height, weight, BMI and pelvic circumference. The PT distance of 7cm and more was considered as low lying pubic tubercle.

Results: Right sided inguinal hernia was found in 47.2 % of the cases. And most of them were indirect inguinal hernia (71.4%). Among the patients with hernia, the mean PT line distance was found significantly greater (7.807+/- 1.143) compared to the control group (6.60+/- 0.7846) with p value <0.0001. In our study, 71.4 % of patients with hernia had PT line >7 cm whereas in 81.4% of controls, the PT line was under 7 cm.

Conclusion: Pubic tubercle being low i.e. more than 7 cm of PT line could be the risk factor for development of inguinal hernia owing to the widening of Hasselbach's triangle along with the alteration in the internal oblique muscle insertion resulting in less effective shutter mechanism.

KEY WORDS: Anterior superior iliac spine, Anthropological measurements Inguinal hernia, Low lying pubic tubercle, Risk factors.

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Access this Article online	Journal Information
Quick Response code	**International Journal of Anatomy and Research** ISSN (E) 2321-4287 | ISSN (P) 2321-8967 **https://www.ijmhr.org/ijar.htm** **DOI-Prefix:** https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2024.163	**Article Information**
	Received: 04 Jul 2024 — Accepted: 15 Aug 2024 Peer Review: 06 Jul 2024 — Published (O): 05 Sep 2024 Revised: 05 Aug 2024 — Published (P): 05 Sep 2024

INTRODUCTION

Hernia is one of the conditions which has been diagnosed and evaluated extensively over the ages. Hernia is defined as the abnormal protrusion of viscus or part of viscus lined sac through a defect in the cavity containing it [1]. Inguinal hernia is the most common form (80%) of abdominal wall hernia. Among inguinal hernias, indirect is more common than direct [2].

Hernia has a multifactorial aetiology. Anatomical characteristics in the groin, altered collagen metabolism, raised intra-abdominal pressure

and a combination of these factors can render the hernia defence mechanism ineffective [3]. In males a patent processus vaginalis, and in females *the duct of nuck* is said to be another reason for indirect inguinal hernia. However, cadaveric studies have shown up to 20% of individuals with a patent processus vaginalis who did not develop a hernia in their lifetime [4]. Other autopsy studies also showed that the excision of sac as a sole treatment of inguinal hernia was also associated with failure of treatment and recurrence [5]. As part of the evolutionary process of adopting an erect posture, a deficient posterior rectus sheath, stretched and thinned out tissues and tranversalis fascia and effect of gravity may all contribute to development of hernia [4,6].

The relatively weaker part of the abdominal wall (Hasselbachs triangle) is guarded by the shutter mechanism described by Kaith. The internal oblique and transversus abdominis muscles are pulled towards the inguinal ligament during contraction of the abdominal muscles. A low positioned pubic tubercle is associated with a narrow origin and low insertion of internal oblique, resulting in a larger diameter of the deep inguinal ring creating an inefficient shutter mechanism [7].

We studied the level of the pubic tubercle in normal individuals with no hernia compared to patients with hernia in an effort to study the significance of a low lying pubic tubercle as a risk factor for development of hernia.

METHODS

A case control study was conducted in the teaching hospitals of Kasturba Medical Mangalore under Department of General surgery for a period of 24 months between October 2018 to October 2022. Approval was obtained from the Institutional Ethics Committee of Kasturba Medical College, Mangalore.

Selection criteria:

Inclusion Criteria:

- Age: 18 to 50 years who were diagnosed to have inguinal hernia

- Both male and female

- Direct and indirect uncomplicated Inguinal Hernia

-Unilateral and bilateral inguinal hernia

Exclusion Criteria:

- Age <18 years or e" 50 years

- BMI <18 and > 25

-Previous surgery in inguinal region

- Recurrent hernia

- Long-term steroid use

- ASA grade 3 or more

- Chronic health conditions – tuberculosis, cirrhosis liver, benign hypertrophy of prostate, urinary out flow obstruction, chronic constipation

-Pelvic fracture or any anomaly related to pelvis

Controls were selected from the inpatients who were admitted due to different ailment who also matched the exclusion criteria.

Informed consent was obtained from all individual participants included in the study.

Sampling method: Convenient sampling

Sample size: 140 (70 cases and 70 controls)

Calculations: Calculated with 80% power, 95% confidence interval and an effect size (d) of 0.5 using G*power

Analysis: Statistical analysis was done using SPSS version 25.

Method: The subjects (of both groups) were asked to lie supine on a flat surface with legs straight to make both anterior superior iliac spine aligned to a straight line. Anterior superior iliac spine (ASIS) was palpated clinically; an imaginary line was drawn connecting both anterior superior iliac spines and the distance was measured in centimeters (Inter-spinal distance, AA Line). The pubic tubercle was identified clinically by palpation and marked (after reducing the hernia). A perpendicular line was drawn intersecting the AA Line (PT Line) clinically. Length of this line was measured on the both sides in centimeters. Various measurements such as weight in kilograms, height in centimeters and circumference in of the pelvis at the level of ASIS with hernia reduced and BMI (kg/ m2) were recorded. Similar measurements were taken among the control group as well. The measurements were compared and an attempt

was made to find any relationship between PT Line, AA Line, height, weight, BMI and pelvic circumference among case and control groups.

Figure 1. Below showing

A –Anterior superior iliac spine.

AA line – Inter-spinal line.

T- Pubic Tubercle.

PT line – Perpendicular distance from inter-spinal line to Pubic tubercle. [8]

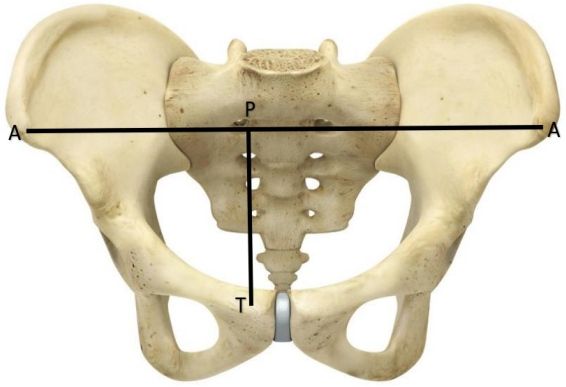

Fig. 1: Showing pelvic bone with AA line and PT line measurement.

RESULTS

A total of 140 patients were included in the study (70 cases and 70 age matched controls. (Table 1)

Table 1: Showing clinical distribution of inguinal hernia cases.

	Type of hernia	Frequency	Percent (%)
1	Bilateral direct hernia	1	1.4
2	Bilateral indirect hernia	5	7.1
3	Left direct hernia	6	8.6
4	Left indirect hernia	25	35.7
5	Right direct hernia	13	18.6
6	Right indirect hernia	20	28.6
	Total	70	100

Comparison of age between case and control group: The lowest age was 18 years and highest was 49 years. The highest incidence was noted in 31-40 years of age. Chi square test was performed, and the p value was 0.8, found to be not significant.

Comparison of various anthropometric values: The mean height among case group was 168cm compared to control group which was 165cm. The mean weight among cases was 65.4kg compared to control group which was 60.31kg. In the study population the mean BMI was 23.12kg/m^2 and in the control group it was 22.16kg/m^2. The circumference of pelvis at the level of anterior superior iliac spine was measured and the mean value was 23.12cm in the case group and 22.16cm in the control group with significant p value. (Table 2)

Table 2: Showing distribution of height, weight, BMI and Circumference of pelvis among case and control groups.

Variables	Groups	N	Mean	Std dev	p value
Height (cm)	Case	70	168.34	5.56	0.002*
	Control	70	165.09	6.71	
Weight (kg)	Case	70	65.09	6.29	0.0001*
	Control	70	60.44	8.12	
BMI (kg/m^2)	Case	70	23.12	2.25	0.029*
	Control	70	22.12	2.89	
Circumference of pelvis(cm)	Case	70	23.12	2.25	0.029*
	Control	70	22.16	2.89	

(*Significant)

Comparison of inter-spinal distance (AA Line) among case and control group: Among the cases the mean distance was found to be 23.12 cm with standard deviation of 2.25. Among the control group the mean distance was 22.16 cm with standard deviation of 2.89. p value was 0.029 which was found to be significant. (Figure 2)

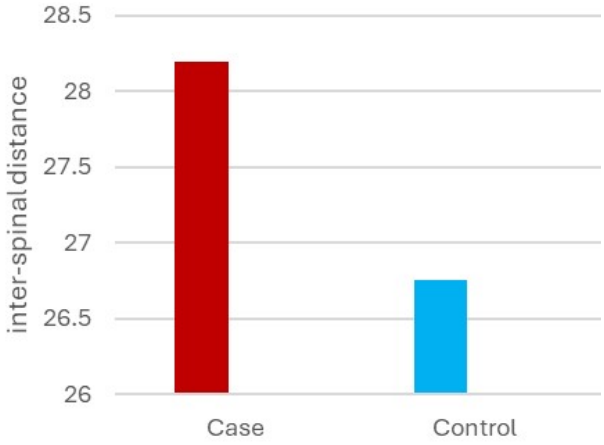

Fig. 2: Showing distribution of inter-spinal distance.

Comparison of perpendicular distance from inter-spinal line to pubic tubercle (PT Line):

An imaginary line was drawn connecting both anterior superior iliac spine. The perpendicular distance from the imaginary line to the pubic tubercle was measured among cases and control group. The mean distance among the cases was 7.807 +/- 1.143 cm.

Among the control group the mean distance was 6.60+/- 0.784 cm. The p value was found to be highly significant. (Table 3)

Table 3: Showing comparison of PT Line distance between case and control groups.

	N	Mean	Std. Deviation	95% Confidence Interval for Mean		t test p value
				Lower Bound	Upper Bound	
Cases	70	7.807	1.143	7.535	8.08	<0.0001*
Controls	70	6.6	0.7846	6.413	6.787	

(*Highly significant)

A Receiver Operating Characteristic (ROC) curve was drawn. The true positive rate (sensitivity) was plotted in function of the false positive rate (1- specificity). At PT value of 7.250 cm the sensitivity was 0.714 and specificity was 0.186, hence the cut off value of PT distance 7 cm was taken as low-lying pubic tubercle.

Following results were obtained after comparing PT distance between the cases and control group. (Table 4)

Table 4: Showing the distribution of low lying pubic tubercle (PT Line >7cm) among cases and controls.

	Group	
	Case	Control
>7 cm	50	13
	71.40%	18.60%
<= 7 cm	20	57
	28.60%	81.40%
Total	70	70
	100%	100%

Among the 70 cases with inguinal hernia 50 patients were found to have PT distance more than 7 cm and among the control group only 13 individuals had PT distance more than 7 cm.

In conclusion - considering the cut off of PT distance as 7 cm to define low lying pubic tubercle, the sensitivity was found to be 71.43 %, specificity was found to be 81.43%, positive predictive value was 79.37% and negative predictor value was 74.03 %. The overall accuracy was 76.43%. p value was <0.0001, highly significant.

DISCUSSION

The myopectineal orifice of Fruchaud is where most hernias emerge from. Inguinal hernia has a multifactorial aetiology including genetic factors, collagen weakness, patent processus vaginalis, defect in shutter mechanism, increased intra-abdominal pressure etc. Proper functioning of the protective mechanism of the inguinal canal depends on certain anthropometric characteristics in the inguinal region. The risk of inguinal hernia is related to the anatomical shape of the pelvis especially among patients having a wider and shorter pelvis [2].

In a study conducted by M. Lo´pez-Cano et al, on comparing the transverse diameter of deep inguinal ring, the value was found significantly higher in males compared to females [7]. With reference to the sphincter mechanism at the deep ring which was described by Lytle [9], the wider the diameter of the internal inguinal ring, the greater the sphincter dysfunction. Hence males may have greater risk to develop inguinal hernia in comparison to females. A study by Ponka concluded that males have a two-fold higher tendency to develop indirect inguinal hernia [10]. In our study 71.42 5 of the patients had an indirect inguinal hernia.

A higher incidence of inguinal hernia was noted in taller individuals reflecting changes in inguinal- pelvic measurements [12]. In studies done separately, in the US, Israel and Netherlands, a lower incidence was noted in patients with obesity and higher BMI [11-13]. To explain this phenomenon, there must be an existence of a protective effect due to presence of a higher quantity of adipose tissue in those patients or difficulty in diagnosing hernia in obese and overweight patients. But further detailed study is necessary to clarify this.

In our study the patients with inguinal hernia were found to be taller. Possible explanations for this:

· The tall stature altering the anthropometric characteristics of the pelvis, thus causing them more prone to develop inguinal hernia.

· This could also explain the failure of protective shutter mechanism

In contrast to the results of the US based study, in our study the patients with inguinal hernia were found to have a greater height, weight and higher BMI as compared to the control group. The patients who were overweight and had higher BMI tend to have other associated risk factors and medical condition making the hernia get detected earlier during medical evaluation. Further detailed research will be required with a larger sample size to get more proof for a stronger association.

In a study done by Sehgal et al based on the distance of the pubic tubercle from the line joining both the anterior superior iliac spine they classified subjects into two groups. Group 1 with PT distance less than or equal to 7.5 cm as high lying pubic tubercle and group 2 with PT distance more than 7.5 cm as low-lying pubic tubercle. In their study, 73% of the cases with hernia had a low-lying pubic tubercle. They concluded that the low-lying pubic tubercle was a risk factor for inguinal hernia [15].

Another study done by Lopez- Cano et al showed that the individuals with low pubic arch, that is the distance of pubic tubercle from line joining both anterior superior iliac spines more than 7 cm, showed a longer inguinal ligament. They also found that the low pubic arch was associated with a larger supra inguinal space. This could be an explanation for the defective shutter mechanism in the low pubic arch group leading to inguinal hernia [7,16].

In the study conducted by Thaer M Farhan 74 % of the patients with inguinal hernia had PT distance more than 7.5 cm. [14] In our study the mean circumference of the pelvis at the level of ASIS was found to be 78 cm compared to control group which was, 73 cm which was, highly significant. We also found that in the patients with inguinal hernia, 71% of them had a PT distance more than 7 cm.

Low lying pubic tubercle leads to alteration in the morphological features in inguinal region such as a longer inguinal ligament, along with a greater supra inguinal space. Low pubic arch is also associated with abnormal origin and insertion of the internal oblique muscle which leads to unsuccessful defense [17]. Increased diameter of the deep inguinal ring was also found associated with low pubic arch thus leading to higher incidence of hernia specifically in the presence of other risk factors [7].

Limitations of this study: We did not have female cases/controls in this study. The control group had only age matched controls. Ideally, we should have truly matched controls in terms of height, weight and BMI. The individuals in the control group with a low-lying pubic tubercle need to be followed up to see if they would develop a hernia. Hence the period of follow up for that cohort would need to be longer to derive more meaningful conclusion.

CONCLUSION

Through our study we found that a higher distance between ASIS is associated with higher risk of development of inguinal hernia by making the inguinal ligament longer. The individuals with a low-lying pubic tubercle are at a greater risk of development of inguinal hernia leading to the broadening of Hasselbach's triangle and distant insertion of internal oblique making it one of the risk factors.

By using simple and easy techniques of anthropometric measurements, the individuals with higher risk of groin hernia can be identified and advised for lifestyle changes. However further study is required on a larger study group to establish this fact in Indian population.

ABBREVIATIONS

ASIS – Anterior Superior Iliac Spine
AA line – Line connecting both Anterior superior iliac spine
PT line – Perpendicular line connecting AA line to Pubic tubercle
BMI – Body Mass Index
ROC curve – Receiver Operating Characteristic Curve

STATEMENT AND DECLARATIONS

Ethical approval: Approval was obtained from the ethics committee of Manipal academy of higher education, Manipal University. The procedures used in this study adhere to the tenets of the Declaration of Helsinki. (Reg No ECR/541/Inst/KA/2012/RR-20)

The authors have no relevant financial or non-financial interests to disclose.

Consent: Informed consent was obtained from all the participants. A signed informed consent regarding publishing reports related to the study was taken. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Author Contributions

All authors have read and approved the manuscript.

DCA: Data collection, data analysis, interpretation, study concept, writing and editing the paper.

HRK: Reviewing the article, study concept.

Conflicts of Interests: None

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How to cite this article: Deepika C. A , Harish Rao K. Is Low Lying Pubic Tubercle A Risk Factor for Inguinal Hernia?. Int J Anat Res 2024;12(3):9011-9016. **DOI:** 10.16965/ijar.2024.163