Original Research Article

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Anatomical variations of the inguinal morphometric features in patients with inguinal hernia and its association with the type of inguinal hernia: a prospective clinical study

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ABSTRACT

Background: Variations of inguinal canal and inguinal nerves are not uncommon. Knowledge about those variations is important to avoid inadvertent injury to the vital structures and to prevent recurrence.

Methods: This prospective clinical study included all patients undergoing open inguinal hernia repair. Laparoscopic hernia repair, emergency surgery for complication and recurrent inguinal hernia were excluded. Parameters studied include interspinous distance, length and obliquity of inguinal ligament, attachment of conjoint tendon, condition of transversalis fascia and position and variations of ilioinguinal nerve.

Results: The study included 192 patients. The mean interspinous distance (ISD) was 22 ± 3.45 cm (CI: 30-32). ISD was not significant different among the two types of hernia. The mean length of internal oblique on inguinal ligament from anterior superior iliac spine was significantly longer in patients with indirect inguinal hernia (4 ± 0.791 vs. 4.27 ± 1.34 ; p=0.000). Significant patients in the direct hernia had weak transversalis fascia ((95% vs. 43%). 80% of the patients with direct hernia had defect in the transversalis fascia compared to only 8.8% in the indirect hernia. The difference is statistically significant. The nerve variation was present in only 1.3% in direct hernia group compared to 3.5% in the indirect hernia group.

Conclusions: It was observed that the type of hernia did not significantly influenced by the length of inguinal ligament, the mean distance of midinguinal point, obliquity of the inguinal ligament. The nerve variation was present in only 1.3% in direct hernia group compared to 3.5% in the indirect hernia group.

Keywords: Morphometry, Inguinal hernia, Midinguinal point, Ilioinguinal nerve, Hernia risk factors

INTRODUCTION

An abdominal wall hernia is a protrusion of the abdominal contents through an opening or area of weakness in the abdominal wall. Inguinal hernia surgery is the most common elective procedure among hernia surgeries. Variations of inguinal canal and inguinal nerves are not uncommon. Knowledge about those

variations of inguinal structures is important while doing hernia surgery to avoid inadvertent injury to the vital structures, to choose the appropriate surgical management and more importantly to prevent recurrence.²

The morphometric surgical anatomy and variations in inguinal structures quoted in various text books and

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journals are largely of cadaveric studies.^{3,4} The cadaveric morphometric assessment has a limitation of distorted anatomy due to dissection, loss of pliability due to formalin fixed tissue, shrinkage of the cadaver over a period of time leading to imprecise measurements. Also the maintenance of cadaver requires dedicated facility adding to the cost and risk of exposure to harmful chemicals used for embalming make the cadaveric studies less attractive method than in vivo studies for anatomical morphometric studies.

Studies on anatomical assessment of inguinal canal, incidence and pattern of variations of the inguinal structures and the association of these with inguinal hernia are sparse. Assessment of anatomical variations in inguinal hernia patients also has the advantage of lesser cost involved and availability of larger number of patients for studying the anatomical variations. Hence this study was undertaken to gain knowledge of the variations in the morphometric features of inguinal canal with the different types of hernia, the outcome of which can have implications in formulating the surgical treatment plan.

METHODS

The study was carried out in the department of surgery, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry, India, over a period of two years from October 2015 to September 2017. Institute Ethics Committee approval was obtained for the study. The nature, methodology and risks involved in the study were explained to the patient and informed consent was obtained. All the information collected was kept confidential and patient was given full freedom to withdraw at any point during the study. All provisions of the Declaration of Helsinki were followed in this study.

The study was designed as prospective clinical descriptive study, involving one group of patients. Sampling population included all patients aged more than 18 years admitted in department of general surgery for elective open inguinal hernia repair under general/regional/ local anaesthesia over a period of two years, selected by convenient sampling technique. Hernia repair done by laparoscopy, surgery done in emergency for irreducible, obstructed, strangulated hernia hernia and recurrent inguinal hernia were excluded from the study.

The sample size was calculated for the objective of estimating the proportion of subjects with common variations in the inguinal canal. It was calculated using OPEN EPI[®] software. The common variations observed in inguinal canal were around 12% (Ndiaye et al). We used an absolute precision of 5% the sample size was calculated as 192.

Study procedure

Patients with direct/ indirect inguinal hernia planned for surgery are recruited for the study after assessing the inclusion/ exclusion criteria. Informed written consent is obtained from all the patients included in the study. The detailed history was taken for all the patients. Significant past medical history with comorbidities and associated habits like smoking and consuming alcohol were noted. All details of the patients were obtained according to the specified proforma following admission including the demographic profile like age, gender, occupation. Details of the possible contributing factors for hernia such as obesity, physical exercise, associated disease like chronic cough, chronic constipation, micturition problem, previous abdominal surgery (for weakness of abdominal wall), in females number of pregnancies were also recorded.

Detailed clinical examination was carried out for all patients especially for height, weight and body mass index (BMI). The duration of symptom and presence of pain and its duration were noted. Then ASA class, type of anaesthesia and other anaesthetic issues were obtained from the pre anaesthetic check-up records and details of the operating procedures were recorded such as duration of the procedure, type of surgery.

Parameters studied

Preoperative measurements including the type of hernia, Side, size, extension, complications, and reducibility of hernia were recorded. Interspinous distance, length and obliquity of inguinal ligament were measured. Interspinous distance measured between Anterior superior iliac spine (ASIS) of both sides by using an inch tape, length of inguinal ligament measured from ASIS to pubic tubercle and obliquity of inguinal ligament measured by using protractor.

Intraoperative parameters were taken by using a sterile divider and a metal scale under aseptic precaution including the following

- Interspinous distance,
- Inguinal ligament,
- Obliquity of the inguinal ligament,
- Distance of internal oblique (from ASIS on inguinal ligament),
- Attachment of conjoint tendon,
- Condition of transversalis fascia,
- Position and variations of ilioinguinal nerve.

Statistical analysis

Statistical analysis was done by using SPSS software version 20.0 for windows. The categorical variables such as, distance of internal oblique, attachment of conjoint tendon, condition of transversalis fascia, and position and variations of ilioinguinal nerve were summarised as frequency and proportion.

All continuous variables such as interspinous distance and length and obliquity of inguinal ligament were

summarised as mean and standard deviation if data follows normal distribution and median and IQR was used to summarise the data with non-normal distribution. Difference in morphometric details between the types of hernia was tested using Chi-square test. A p value of less than 0.05 was considered as statistically significant.

Ethical approval

Institute Ethics Committee approval was obtained for the study (JIP/IEC/SC/2014/8/601).

RESULTS

The study included a total of 192 patients with age ranging from 18 years to 85 years with mean age of

51.55±15.60 years. Considering the type of inguinal hernia indirect inguinal hernia was the most common type with the frequency of nearly 60%. On comparing the type of hernia in both genders, indirect hernia was the common type of hernia in both men and women in our study population.

Interspinous distance

Interspinous distance between the two types of hernia was compared which did not show any significant difference among the two groups. The mean ISD was 22±3.45 cm (CI: 30-32). Interspinous distance (ISD) among the study population and comparison of Interspinous distance (ISD) between direct and indirect hernia in the study group is shown in Table 1.

Table 1: Interspinous distance (ISD) among the study population and comparison of Interspinous distance (ISD) between direct and indirect hernia in the study population.

Type of hernia (no. of	Interspinous distance (ISD)				CD	050/ CT	Duolus
patients)	Min	Max	Mean	Median		95% CI	P value
Study population (192)	19	34	22	28	3.45	30-32	
Direct hernia (78)	20	34	26.65	28	3.36	25.90-27.41	P=0.720
Indirect hernia (114)	19	34	27.45	28	3.49	26.80-28.09	$(x^2=0.129)$

Table 2: Length of inguinal ligament hernia in the study population and comparison of length of inguinal ligament between direct and indirect hernia in the study population.

Type of hernia (no. of	Length of inguinal ligament				■ SD	95% CI	P value
patients)	Min	Max	Mean	Median	SD	95% CI	r value
Study population (192)	7	22	11.32	11	1.96	12.50-13.57	
Direct hernia (78)	7.50	15	10.84	11	1.86	10.42-11.26	P=0.604
Indirect hernia (114)	7	22	11.65	12	1.96	11.29-12.02	$(x^2 = 0.270)$

Table 3: Obliquity of inguinal ligament in the study population and comparison of obliquity of inguinal ligament between direct and indirect hernia in the study population.

No of motionts	Obliquity of inguinal ligament				CD	050/ CI	Danalara
No. of patients	Min	Max	Mean	Median	SD	95% CI	P value
Study population (192)	28	60	30	38	5.64	42-45	
Direct hernia (78)	30	60	37.44	38	5.74	36.14-38.73	P=0.750
Indirect hernia (114)	28	48	38.5	38.50	5.56	37.5-39.5	$(x^2 = 0.102)$

Table 4: Comparison of length of internal oblique on inguinal ligament from ASIS between direct and indirect hernia in the study population.

Type of hernia (no. of	Length of internal oblique on IL from ASIS				SD	95% CI	P value
patients)	Min	Max	Mean	Median			
Direct hernia (78)	3	7	4	4	0.791	3.82- 4.18	P=0.000
Indirect hernia (114)	2.50	12	4.27	4	1.34	4.03- 4.52	$(x^2 = 22.741)$

Inguinal ligament

The mean length of inguinal ligament in the study population was 11.32 cm with range of 7 to 22 cm. Comparison of inguinal ligament length with respect to

type of hernia did not show any significant difference in the length of inguinal ligament among the two types. The mean distance of MIP (midinguinal point) was 6.6 ± 0.5 cm and the mean distance of midpoint of inguinal ligament was 5.62 ± 0.8 cm. Length of inguinal ligament

hernia in the study population and comparison of length of inguinal ligament between direct and indirect hernia in the study population is shown in Table 2.

Obliquity of the inguinal ligament

Obliquity of the inguinal ligament in the hernia patients ranged from 28° to 60° with the mean of 30°. Comparison of obliquity between direct and indirect hernia did not find any significant difference between the two types. Obliquity of inguinal ligament in the study population and comparison of obliquity of inguinal ligament between direct and indirect hernia in the study population is shown in Table 3.

Internal oblique muscle

The mean Length of internal oblique on inguinal ligament from ASIS was significantly longer in patients with indirect inguinal hernia $(4\pm0.791 \text{ vs. } 4.27\pm1.34;$ p=0.000). Distance from inguinal ligament to summit of muscular arch in the study population was 4.03 cm. Comparison of length of internal oblique on inguinal ligament from ASIS between direct and indirect hernia in the study population with complete hernia is shown in Table 4.

Conjoint tendon

The type of hernia and the attachment of conjoint tendon were compared with respect to the three types of attachment. In majority of the patients the attachment of conjoint tendon was partially to rectus and partly to pubic crest. However, the pattern of attachment did not significantly differ in the two types of hernia. Comparison of attachment of conjoint tendon between direct and indirect inguinal hernia in the study population with complete hernia is shown in Table 5.

Table 5: Comparison of attachment of conjoint tendon between direct and indirect inguinal hernia in the study population.

	Hernia type			
Conjoint tendon	Direct hernia	Indirect hernia	Total	- P value
	N (%)	N (%)	N (%)	r value
Totally attaching to rectus	13 (16.7)	25 (21.9)	38	
Partially attaching to rectus and pubic crest	64 (82.1)	80 (70.2)	144	P=0.0670
Totally attaching to pubic crest	1 (1.3)	9 (7.9)	10	$(x^2=5.407)$
Total	78 (100)	114 (100)	192	

Table 6: comparison of condition and defect of transversalis fascia between direct and indirect inguinal hernia in the study population.

	Hernia type			
Transversalis fascia	Direct hernia	Indirect hernia	Total	— Dwalna
	N (%)	N (%)	N (%)	— P value
Weak	74 (94.9)	49 (43)	123	P=0.0000
Strong	4 (5.1)	65 (57)	69	$(x^2 = 54.163)$
Defect present	63 (80.8)	10 (8.8)	73	P=0.0000
Defect absent	15 (19.2)	104 (91.2)	119	$(x^2 = 101.874)$
Total	78 (100)	114(100)	192	

Table 7: Comparison position of ilioinguinal nerve in relation to spermatic cord between direct and indirect inguinal hernia in the study population- complete hernia.

Devision of the transfer of the same to the same	Hernia type			
Position of ilioinguinal nerve in relation to spermatic cord	Direct hernia	Indirect hernia	Total	– D volue
spermatic coru	N (%)	N (%)	N (%)	P value
Anterior	24 (30.8)	17 (14.9)	41	
Anteromedial	38(48.7)	61 (53.5)	99	$P=0.0207 (x^2=$
Anterolateral	16 (20.5)	36 (31.6)	52	7.753)
Total	78 (100)	114(100.0)	192	

Transversalis fascia

95% the study population in the direct hernia had weak transversalis fascia compared to only 43% in the indirect

hernia which is statistically significant. 80% of the patients with direct hernia had defect in the transversalis fascia compared to only 8.8% in the indirect hernia patients. The difference is statistically significant.

Comparison of condition and defect of transversalis fascia between direct and indirect inguinal hernia in the study population with complete hernia is shown in Table 6.

Inguinal nerves

Spermatic cord and the ilioinguinal nerve relationship were assessed. The nerve to cord had three types of course which includes anterior, anteromedial and anterolateral. The anteromedial course over the cord was the common course in both direct and indirect hernia. Anterolatral course was the second common course in indirect hernia, whereas the anterior course was the second common in the direct hernia (Table 7). The difference is statistically significant.

Variations in the inguinal nerves including ilioinguinal, ilehypogastric and genital branch of genitofemoral nerves were assessed. The nerve variation was present in only 1.3% in direct hernia group compared to 3.5% in the indirect hernia group; however the difference is not statistically significant. Figure 1 shows comparison of variation of ilioinguinal nerve between direct and indirect inguinal hernia in the study population with complete hernia.

DISCUSSION

Morphometric assessment generates vital information regarding the characteristics of the study race/ gender and helps in understanding the anatomical basis for the development of hernia and appropriate surgical management.¹⁻⁴ Important morphometric data were assessed and analysed for our study population. The Interspinous distance between direct and indirect hernia patients did not vary significantly indicating that body contour has no influence on the development of particular type of hernia. Farhan in his morphometric study compared the interspinous distance between inguinal hernia patients and normal adults found a significantly greater in the hernia patients.⁶ The mean length of inguinal ligament (distance between ASIS and pubic tubercle) was 11.245 cm. however, the length of inguinal ligament did not significantly vary between the direct and indirect type of hernia in our study population. Obliquity of the inguinal ligament also did not significantly differ between the two types of hernia. Sanjay et al in an attempt to define the deep ring in patients with inguinal hernia found the length of inguinal ligament to be 12.5 cms.7

Traditionally the surface marking for deep ring is marked half an inch above the mid-inguinal point (MIP- midway between ASIS and symphysis pubis). Few authors disagree with that and propose mid-point of the inguinal ligament (MIL) as an accurate point. Controversies exist for ages as to which of the point to be considered for marking deep ring. In our study population the mean distance of mid-inguinal point was 6.6±0.5 cm and the

mean distance of midpoint of inguinal ligament was 5.62±0.8 cm. there was a discrepancy of a centimetre between the two point and when the deep ring was measured Intraoperatively, the distance was more closure to the mid-point of the inguinal ligament (4.14±1.57 cm). Koliyadan et al measured the deep ring location to be midway between MIP and MIL and demonstrated a centimetre variation between the two.⁸ Similar to the study by Koliyadan et al and Sanjay et al, in our study also the femoral pulse was felt at the MIP in majority of the cases and the deep ring invariably was located medial to the artery.

95% of our study population in the direct hernia had weak transversalis fascia compared to only 43% in the indirect hernia which was statistically significant. 80% of the patients with direct hernia had defect in the transversalis fascia compared to only 8.8% in the indirect hernia patients. Development of direct hernia has multifactorial cause. 9-12 Increased intra-abdominal pressure along with weak abdominal wall muscle proposed to be an important predisposing factor. Many other studies also observed the deficient transversalis fascia in patients with direct hernia. 1,2,9-12

In the present study, it was observed that in two third of the cases, the spermatic cord coursed over the sac anteromedialy. Anterolateral course was the second common course in indirect hernia. The understanding of the relationship is of paramount importance to prevent inadvertent injury to the cord structure during the hernia surgery. Chronic groin pain is a distressing problem in the postoperative hernia patients that occurs due to the partial nerve injury during the operation. Studies have shown that failure to demonstrate the nerves during the hernia repair is associated with postoperative groin pain which reported in the range of 6-30% in the literature. Five of our patients had variations in the course of inguinal nerves.

The nerve variation was present in only 1.3% in direct hernia group compared to 3.5% in the indirect hernia group. Two patients had absent ilioinguinal nerve. In two patients, the ilioinguinal nerve perforated the external oblique aponeurosis. Accessory ilioinguinal nerve was found in one patient. Ndiaye et al demonstrated two ilioinguinal nerves during the cadaveric dissection to document the variation of inguinal nerves. Bachul et al demonstrated an absent ilioinguinal nerve along with an atypical course of genital branch of genitofemoral nerve. These variations should be kept in mind when hernia repair being carried out to avoid the postoperative paresthesia and chronic groin pain.

CONCLUSION

In this prospective descriptive analytical study to evaluate the anatomical variations of inguinal canal related to the type of hernia in patients who underwent elective inguinal hernia repair, it was observed that the type of hernia did not significantly influenced by the length of inguinal ligament, the mean distance of midinguinal point, obliquity of the inguinal ligament.

It was observed that no significant difference in the pattern of attachment of conjoint tendon between direct and indirect hernia. However, the significantly high number of patients of direct hernia had weak transversalis fascia and defect in the transversalis fascia compared to indirect hernia patients. Anterolateral course of ilioinguinal nerve in relation to spermatic cord was common in indirect hernia, whereas the anterior course was the common in the direct hernia. The nerve variation was present in only 1.3% in direct hernia group compared to 3.5% in the indirect hernia group; however the difference is not statistically significant.

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