Arcuate Line Position: Current Perspective and Revised Ansari Classification

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Abstract

A novel classification of position of Arcuate line of Douglas was proposed earlier (Ansari MM. Int J Sci Res 2017 June; 6 (6): 2348-2363). More focused discussion with revised classification is presented here. Laparoscopic total extraperitoneal preperitoneal (TEPP) hernia repair was successfully carried out through posterior rectus sheath approach with 3-midline-port technique in 60 adult male patients with primary inguinal hernias (Unilateral 52; Bilateral 8). Arcuate line of Douglas was present in only 79.4% of the 68 TEPP hernioplasties and was found situated within the classical normal range (Mean U-AL distance 5.26 cm±SD0.95; Range 3-6.5cm) in 88.9%, high (Mean U-AL distance 2.5 cm±SD0.0; Range 2.5-2.5) in 5.6% and low (Mean U-AL distance 10.0 cm±SD1.80; Range 8-11.5cm) in 5.6%. Average arcuate line was located at a distance of 5.37±SD1.62 cm (range 2.5-11.5 cm) from umbilicus, corresponding to the 1/3rd of umbilico-pubic distance. High arcuate line was significantly more common in overweight/obese patients, and incidence of non-mirror anatomy on the contra-lateral side was higher in older patients as compared to young adults. Revised Ansari Classification of the arcuate line position was found more logical with fusiform nomogram, possibly representing normal distribution of its different types in the general population.

Keywords

Arcuate Line Position; Arcuate Line Classification; Arcuate Line Anatomy; TEPP Anatomy

Introduction

Arcuate line of Douglas used to be a relevant anatomic landmark during reconstruction of the abdominal wall after the harvest of the rectus abdominis musculocutaneous flap, and knowledge of the relation between the arcuate line and surface anatomic landmarks facilitated the proper pre-operative planning [1, 2]. However, problem lies in the fact that ‘The shape and position of the arcuate line were neither symmetrical nor constant’ [3]. However, very little information is available in the literature regarding the arcuate line despite extensive work on the rectus sheath in the gross cadaveric studies [4]. Moreover, no study on the live surgical anatomy of the arcuate line is reported in the literature to the best of our knowledge, although the arcuate line has recently attained paramount importance as a valuable surgical landmark during the laparoscopic total extraperitoneal preperitoneal (TEPP) hernioplasty through posterior rectus sheath approach. The author has recently reported a comprehensive study on the laparoscopic live surgical anatomy of the arcuate line in terms of its morphology, topography and morphometry [5]. The

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present report discussed in a more focussed manner the level/position of the primary arcuate line in relation to the umbilicus, along with revision of the original Ansari Classification of the arcuate line position.

Materials and Methods

The present study was part of a prospective doctoral research for award of PhD (Surgery) conducted in the Department of Surgery, Jawaharlal Nehru Medical College, Aligarh Muslim University, Aligarh, India w.e.f. April, 2010 to November, 2015 in adult patients with inguinal hernia who underwent laparoscopic total extraperitoneal preperitoneal (TEPP) hernia repair through the posterior rectus sheath approach under a written informed consent and Institutional Ethics Committee’s clearance. The study was carried out at the place of Jawaharlal Nehru Medical College Hospital, AMU, Aligarh. Recruitment/ selection/ inclusion/ exclusion criteria and surgical technique were consistently same as reported earlier [5-8]. Selection criteria were (1) Patient’s choice under the informed consent, (2) Patient’s good financial status for the higher cost of the laparoscopic procedure as compared to the open surgery, and (3) Pre-operative feasibility of laparoscopic hernioplasty through the pre-anaesthetic check-up (PAC) in out-patient department. Inclusion Criteria were (1) Patients with age equal to or more than 18 years, (2) Patients with uncomplicated fully reducible primary inguinal hernia, (3) Patients with ASA grade I-II (American Society of Anesthesiologists) and (4) Written informed consent for the laparoscopic repair of inguinal hernia. Exclusion criteria were (1) Patient’s age less than 18 years, (2) Patients in ASA grade III-V (severe co-morbid disease), (3) Recurrent inguinal hernia, (4) Complicated inguinal hernia (Irreducible/ inflamed/ obstructed/ strangulated), (5) Femoral or other groin hernia, (6) History of lower abdominal surgery, and (7) Patient’s refusal for the laparoscopic hernioplasty.

The U-AL distance criteria (from the umbilicus to the arcuate line) were slightly changed from (U-AL <3 cm, 3-6 cm and >6 cm) to (U-AL <3 cm, 3-6.5 cm and >6.5 cm) in order revise the original Ansari Classification. Body mass index (BMI) was calculated by the Deurenberg’s formula [9]. Data analysis was done in terms of Mean±SD (Standard Deviation) through the Statistical Package for Social Sciences (SPSS version 21) and a p-value of <0.05 was taken as significant.

Results

Sixty six patients (63 males and 3 females) were selected. The three female patients were excluded due to one or more exclusion criteria, and three male patients were also excluded due to early conversion to the TAPP (Transabdominal pre-peritoneal) or Open repair. Therefore, total extraperitoneal pre-peritoneal (TEPP) hernioplasty was performed successfully in 60 patients with the inguinal hernia (Unilateral 52 and Bilateral 8).

In 54 out of 68 cases of TEPP hernioplasty, the posterior rectus sheath was found incomplete with formation of a well-defined or ill-defined primary arcuate line at its lower end, and in the remaining 14 cases, the posterior rectus sheath extended upto pubic bone without formation of a classical arcuate line. Data analysis included only the observations about the primary arcuate line and is presented herein. Secondary arcuate line (n=10) observed in the present study were not included here for data analysis for seven reasons, namely, firstly they are secondary in nature, secondly they were often multiple, thirdly they occurred in both the incomplete posterior rectus sheath and complete posterior rectus sheath, fourthly their position was highly variable, and fifthly their incidence was quite low in the present study, sixthly which one of the double/multiple secondary arcuate lines should be considered for target measurement, and seventhly their documentation here is likely to create severe constraints and confusion in data analysis of the primary arcuate line, and hence require separate data analysis sometime later.

Level of the Arcuate Line

The Arcuate line was found situated at less than 3 cm of the umbilicus in 3 out of 54 cases, within 3-6 cm of the umbilicus in 41 out of 54 cases, within 6-6.5 in 7 out of 54 cases, and at more than 6.5 cm in 3 cases only. Mean umbilico-pubic distance (U-PS) in the present study was found 15.74±s.d 1.41 cm (range 13.0 to 18.0 cm). Average position of the arcuate line was found situated at a mean level of 5.37±SD1.62 cm (range 2.5-11.5 cm) from the umbilicus.

Thus under the original criteria of the arcuate line classification reported earlier [5], the primary arcuate line was found situated within the Classical normal range (Umbilicus-to-Arcuate line distance, U-AL, 3-6 cm) in only 41 out of 54 cases, High (U-AL <3 cm) in 3 cases and Low (U-AL >6 cm) in the remaining 10 cases (Table 1).

Table 1: Position of Arcuate Line from Umbilicus in the Original and Revised Classifications

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Arcuate Line</th>
<th>Original Ansari Classification</th>
<th>Revised Classification Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Position</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>U-AL Distance (mean±SD) (cm)</td>
<td>U-AL Distance (mean±SD) (cm)</td>
</tr>
<tr>
<td>1</td>
<td>Classical AL</td>
<td>41 75.9 4.91±0.88 (3.0-6.0)</td>
<td>48 88.9 5.26±0.95 (3.0-6.5)</td>
</tr>
<tr>
<td></td>
<td>High AL</td>
<td>3 5.6 2.5±0.0 (2.5-2.5)</td>
<td>3 5.6 2.5±0.0 (2.5-2.5)</td>
</tr>
<tr>
<td>2</td>
<td>Low AL</td>
<td>10 18.5 7.55±1.89 (6.5-11.5)</td>
<td>3 5.6 10.0±1.80 (8-11.5)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>54 %</td>
<td>54 %</td>
</tr>
</tbody>
</table>

*Classification of arcuate line positions reported earlier (Ansari MM. Int J Sci Res 2017 June; 6: 2348-2363); AL, primary arcuate line; U-AL, umbilicus-to-primary-arcuate-line distance; SD, standard deviation;

Figure 1: Diagrammatic representation of the 3 groups of the primary arcuate line positions (High, Classical, and Low) and absence of arcuate line with the relative position of their lateral ends with respect to their medial ends: Number on the arcuate line indicates its count/frequency; **High**, umbilicus-to-arcuate line distance <3 cm; **Classical**, umbilicus-to-arcuate line distance 3-6.5 cm; **Low**, umbilicus-to-arcuate line distance >6.5 cm; **Absent**, arcuate line situated at pubic bone *(i.e., the posterior rectus sheath was complete, extending up to the pubic bone)*.
Figure 2: Correlation between the Arcuate Line levels (AL) and the Patients’ Occupation (Adapted with permission from Ansari, MM. PhD (Surgery) Thesis titled - “A Study of Laparoscopic Surgical Anatomy of Infraumbilical Posterior Rectus Sheath, Fascia Transversalis & Pre-Peritoneal Fat/Fascia during TEPP Mesh Hernioplasty for Inguinal Hernia,” Aligarh Muslim University, Aligarh, India, 2016)

Figure 3: The positions of the arcuate line (N=68) and its lateral end: AL, primary arcuate line; At Pubis, both lateral and medial ends at pubic bone, i.e., absent primary arcuate line; (Adapted with permission from Ansari, MM. PhD (Surgery) Thesis titled - “A Study of Laparoscopic Surgical Anatomy of Infraumbilical Posterior Rectus Sheath, Fascia Transversalis & Pre-Peritoneal Fat/Fascia during TEPP Mesh Hernioplasty for Inguinal Hernia,” Aligarh Muslim University, Aligarh, India, 2016)
Under the revised criteria of the arcuate line classification, the primary arcuate line was found situated within the classical normal range (U-AL 3-6.5 cm) in only 48 out of 54 cases, high (U-AL <3 cm) in 3 cases, and low (U-AL >6.5 cm) in the remaining 3 cases (Table 1). Average location of the arcuate line remained at the same level of 5.37±SD1.62 cm (range 2.5-11.5 cm) from the umbilicus.

Thus the position of the arcuate line was found highly variable in different patients, and it varied from high level (n=3; U-AL <3 cm) to classical level (n=48; U-AL 3-6.5 cm) to low level (n=3; U-AL >6.5) (Figure 1). Age & occupation of the individuals did not, in general, significantly affect the position of the arcuate line (p >0.05) (Figure 2), but BMI (body mass index) was significantly higher in patients with high arcuate lines (p<0.05), the extensive details of which have already been reported separately [5].

Level of Lateral End of the Arcuate Line

Due to pressure artefact effects (overstretching, straightening and anterior curvaturing, etc.) of CO2 insufflation required at the pressure of 12 mmHg during the TEPP hernioplasty, shape of the arcuate lines could not be properly ascertained in the present study. However, we tried to assess the level of the lateral end of the arcuate line with respect to its medial end. The lateral end was highly variable and it was found equal in 25 cases, lower in 18 cases, and higher in 11 cases with respect to medial end the arcuate line (Figure 1, 3 and 5).

**Symmetry of Arcuate Line Level**

Arcuate line level was found symmetrical on the two sides of the body in only 4 out of 8 cases of bilateral TEPP hernioplasty performed in the present study (Table 2). The mean age of the patients with the mirror levels of the primary arcuate line on the two sides of the body was significantly different (p <0.05) from that of the patients with the non-mirror levels of the primary arcuate line, and patients with non-mirror levels of the primary arcuate line were significantly much older in age than those with the mirror levels of the primary arcuate line. However, the BMI and occupation did not affect the symmetry of the primary arcuate line (p >0.05).

**Table 2:** Bilateral Level of Primary Arcuate Line in the Patients With Bilateral Hernias (N=8)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Position of Arcuate Line on Two Sides of Body</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left Side</td>
</tr>
<tr>
<td>1.</td>
<td>Classical</td>
</tr>
<tr>
<td>2.</td>
<td>Classical</td>
</tr>
<tr>
<td>3.</td>
<td>Absent</td>
</tr>
<tr>
<td>4.</td>
<td>Classical</td>
</tr>
<tr>
<td>5.</td>
<td>Classical</td>
</tr>
<tr>
<td>6.</td>
<td>Classical</td>
</tr>
<tr>
<td>7.</td>
<td>Classical</td>
</tr>
<tr>
<td>8.</td>
<td>Classical</td>
</tr>
</tbody>
</table>

Star (*) indicates asymmetry on the two sides of the body;
Discussion

Revised distance criteria for the classification of the primary arcuate line positions resulted in the formation of a fusiform nomogram when absent arcuate lines were excluded (Figure 4), reflecting its normal distribution in the general public, and thus representing a better classification (<3 cm, 3-6.5 cm and >6.5 cm) as compared to the initial proposed plan of categorization (<3 cm, 3-6 cm and >6 cm). The average location of the arcuate line remained almost same in the original as well as in the revised classification, thus avoiding any confusion.

**Figure 4:** Fusiform Nomogram formed by the positions of the arcuate lines including the actually present primary arcuate lines (N=54) and the absent primary arcuate lines (N=14): Distance from the umbilicus to the arcuate line was measured in cm. (Adapted with permission from Ansari, MM. PhD (Surgery) Thesis titled - "A Study of Laparoscopic Surgical Anatomy of Infraumbilical Posterior Rectus Sheath, Fascia Transversalis & Pre-Peritoneal Fat/Fascia during TEPP Mesh Hernioplasty for Inguinal Hernia," Aligarh Muslim University, Aligarh, India, 2016)

Average Level of Primary Arcuate Line

Skandalakis et al [10] observed that the typical location of the line is debatable. We are taught in the anatomy classroom that arcuate line is generally situated at 1/4th to 1/2 of the umbilico-pubic distance [1, 2, 11-13], although wide variations are known to occur since long [1, 3, 14-16]. Recent observations documented the average position of the arcuate line at about 1/3rd of the umbilico-pubic distance [4, 17], and this location was confirmed in the present study also, although the arcuate line level was variable beyond the average position in 24% of our patients.

Average position of the arcuate line was reported at the 1/4th of the U-PS distance by Cunningham et al [1]. In the present study, average level of the primary arcuate line was found situated at the 1/3rd of the U-PS distance (Mean U-AL 5.37±SD1.62 cm; Mean U-PS 15.74±s.d 1.41 cm). Our observations are in full agreement with those of Loukas and associates [4]. Average location of the primary arcuate line at the 1/3rd of the U-PS distance was recently ratified by Rosen et al [17] in the 41st edition of the Gray’s Anatomy.
It was observed by a number of investigators [1, 18] that the overweight/obese patients tend to have high position of the arcuate line, and there used to be no correlation with the age of the subjects. Our findings confirmed these observations.

### Lateral End of Primary Arcuate Line

Level of lateral and medial ends of arcuate line is reported to be one of the most fundamental observations for describing the topographical anatomy of the arcuate line [19]. Loukas et al [4] beautifully depicted the actual anatomic disposition of the arcuate lines in a diagrammatic illustration (Figure 5) that showed that a little more than 50% of the arcuate lines had their lateral end higher than their medial end, and both the lateral and medial ends were almost at equal level in about 30% of cases while the lateral end was lower than the medial end in about 15% of cases. In the present study, majority of (46.3%) of the primary arcuate lines had their lateral end at level with their medial end, while the lateral end was lower than the medial end in 33.3% and higher in 20.4% of the primary arcuate lines (Figure 1, 3 and 5).

### Symmetry of Arcuate Line Level

Monkhouse and Khalique [3] documented that asymmetry of the arcuate line on the two sides of the body is a common phenomenon and its symmetry is a rarity. Loukas and associates [4] documented arcuate

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**Figure 5:** Diagrammatic representation of the 4 groups of the Arcuate Line Levels (Classical, High, Low and Absent) with the Relative Positions of their Medial and Lateral Ends, and their Comparative Evaluation with those of Monkhouse and Khalique (1986): **Number** on the arcuate line indicates its count/frequency; **U-PS**, distance from umbilicus to pubic symphysis; **High**, arcuate line at <3 cm of U-PS distance; **Classical**, arcuate line within 3-6.5 cm of U-PS distance; **Low**, arcuate line at >6.5 cm of U-PS distance; **Absent**, arcuate line situated at pubic bone (i.e., the posterior rectus sheath was complete, extending up to the pubic bone). **Note:** Arcuate line shape in the present study was distorted due to the pressure effect and hence its diagrammatic representation cannot be compared with the exact shapes documented by Monkhouse and Khalique (1986) [3] (redrawn with permission).
line asymmetry in 79% of cadavers, and did not find any significant correlation with the age, sex or race of the subjects (p >0.05). Present study recorded arcuate line asymmetry in a lower incidence of 50% and observed its significant correlation with the patients' age, asymmetry being more common in our older patients (p <0.05).

**Classification of Primary Arcuate Lines**

For the first time, Monkhouse and Khalique [3] tried to classify the levels of the arcuate line and recorded 3 major positions of the arcuate line-classical (~50%), high (~35%) and low (~15%). However, no objective criteria were laid down by these investigators. No other study is reported in the literature, to the best of our knowledge, for the arcuate line classification. In the author's first report [5], objective criteria (U-AL <3 cm, 3-6 cm, and >6 cm) were laid down based on the current consensus opinion [4, 17] of the average location of the primary arcuate line at the 1/3rd of the umbilico-pubic distance. In the present study, these criteria were modified a little (U-AL <3 cm, 3-6.5 cm and >6.5 cm), and the revised classification was found more logical and typical representation of the general distribution of the arcuate line level in the population as represented by the fusiform nomogram (Figure 3).

**Conclusions**

The Arcuate line of Douglas was present in only 79.4% of the cases of TEPP hernioplasty and was found situated within the classical normal range (Mean U-AL distance, 5.26 cm±SD0.95 ; Range 3-6.5cm) in 88.9%, high (Mean U-AL distance, 2.5 cm±SD0.0 ; Range 2.5-2.5) in 5.6% and low (Mean U-AL distance, 10.0 cm±SD1.80 ; Range 8-11.5cm) in 5.6% of cases. Average Arcuate line was located at a distance of 5.37±SD1.62 cm (range 2.5-11.5 cm) from the umbilicus, corresponding to the 1/3rd of the umbilico-pubic distance. High arcuate line was significantly more common in overweight/obese patients, and incidence of the non-mirror anatomy on the contralateral side was higher in the older patients as compared to the young adults. Revised classification of the arcuate line was found more logical, possibly representing the normal distribution of its different types in the general population.

Present study confirmed not only the wide variations in the arcuate line position previously reported in cadaveric studies [1-4, 14, 15] but also its recently reported average location at the 1/3rd of the umbilico-pubic distance [4, 17]. Future Scope warrants more laparoscopic studies on live surgical anatomy of the arcuate line and use of preoperative imaging by high definition ultrasound, dynamic MRI and multi-detector CT even under the limitation of cost-effectiveness for a common minor procedure like inguinal hernia repair was proved by Coulier [20].

**References**


