R.Z. Abdalla · W.E. Mittelstaedt

The importance of the size of Hessert’s triangle in the etiology of inguinal hernia

Abstract The aim of this study was to compare the inguinal area, known as “Hessert’s triangle”, in patients undergoing surgical treatment for inguinal hernia with the area in fresh cadavers without hernia. The 73 cadavers, which were not fixed in formalin, were examined within 15 h post mortem. A total of 132 measurements were made in these cadavers and compared with 130 measurements in 115 hernia patients. The average age was 44.2 years for patients and 32.7 years for cadavers. The mean height and weight were 1.68 m and 69.9 kg for hernia patients and 1.67 m and 70.0 kg for the cadavers, respectively. The mean area of Hessert’s triangle was 8.97 cm² (range 2.28–29.62 cm²) in the hernia patients and 2.95 cm² (range 1.37–5.92 cm²) in the cadavers. This difference was statistically significant ($P < 0.001$). A larger triangle is created by a higher intersections of the internal oblique and transversus muscles and its aponeurosis to the rectus sheath. When these muscles contract, they move toward the inguinal ligament to occlude the triangle, but with a larger triangle, the occlusion is incomplete. Our anatomical measurements verified that the size of Hessert’s triangle is an important factor in the etiology of inguinal hernia.

Keywords Inguinal hernia · Etiology · Inguinal trigone · Anatomy · Hessert

Introduction

Surgeons naturally want to understand why some adults develop inguinal hernias and others do not. A patent processus vaginalis in a man or its correlate in a woman (Nuck’s duct) is often said to be a cause of hernia. However, necropsies have revealed that 15–35% of adults have this passage open throughout life without ever acquiring a hernia [5, 20]. Also, resection and ligation of the hernial sac as the sole operative treatment results in treatment failure and recurrence of the hernia [13]. A more likely cause of inguinal hernia is a weak floor of the inguinal region. Metabolic changes caused by aging or congenital determinants have been demonstrated by many in the collagen tissue and elastic fibers of hernia patients since Conner and Peacock [10] and Read [21] called general attention to this problem. Another cause of inguinal hernia is failure of the sphincter mechanism at the level of the internal ring [17], either because of collagen deficiency or preperitoneal fat pushing through the internal ring, or both [19].

However, there is also the aspect of functional anatomy to be considered. There is a weak point in the abdominal wall that is covered only by the fascia transversalis [6, 7, 8, 9]. Hessert [14] described this weak area as a triangle with the internal ring as its apex, the internal oblique and transversus abdominis muscles and the inguinal ligament as its sides, and the edge of the rectus abdominis muscle as its base. This weak area is closed by a mechanism that Keith [15] called the “inguinal shutter”, in which the internal oblique and transversus muscles and their aponeurotic extensions approach the inguinal ligament when they contract [1, 4, 15, 23]. When the intersection of the internal oblique and transversus muscles with the rectus sheath is higher than usual, the closure of this shutter may be incomplete [2, 16]. The higher intersection would make Hessert’s triangle larger.

To evaluate the size of Hessert’s triangle as a possible anatomic determinant of inguinal hernia in adults, we
measured and compared the area of the triangle in patients undergoing surgical treatment for inguinal hernia and in a control group of fresh cadavers without hernia.

**Material and methods**

The hernia group was composed of 115 patients who underwent open hernia repair at the Trauma and General Surgery Service of the Hospital das Clínicas, University of São Paulo, Brazil. Patients gave their informed consent to participate in this study. Patients with previous surgery or scar in the inguinal region were excluded. Hessert’s triangle was measured on both sides when there were bilateral hernias, giving a total of 130 area measurements. Control measurements of Hessert’s triangle were made during 73 necropsies. Measurements were made bilaterally, excluding sides affected by inguinal of abdominal trauma, scar, or hernia, giving 132 area measurements. The necropsies were performed at the Legal Medical Institute of São Paulo between 8 and 15 h from the moment of death. The bodies were not fixed in formalin. All measurements were made by the authors without interfering with the surgery or necropsy. When the measurements were made, the muscles of the inguinal region were in the same relaxed and motionless position in both groups due to the effects of general, spinal, or epidural anesthesia in the surgical patients and to the post-mortem lack of ATP in the cadavers, which keeps the actin and myosin filaments of the muscles permanently relaxed [11].

After dissecting the inguinal area of the patient or cadaver, we identified Hessert’s triangle and laid a piece of rayon fabric over the floor of the triangle against the fascia transversalis. Through the rayon we could see the anatomical sides of the triangle (the edge of the rectus abdominis muscle, the edges of the internal oblique and transversus abdominis muscles, and the inguinal ligament) which we traced using a permanent marker (Figs. 1 and 2). We took up the piece of rayon, laid it over a backlit surface, covering a test system with a set of regularly spaced points and a counting frame. To estimate the area of Hessert’s triangle, we counted all points hitting the traced profiles (Figs. 3 and 4), according to the stereological method described by Gundersen et al. (1988) [12], and multiplied that number by a known square centimeter area. This procedure was established in the biological morphometry method of Weibel [22].

The following statistical analyses were used. Student’s *t*-test (for individual samples) or the chi-squared test were used to compare the control and hernia groups with respect to age, weight, height, and sex. Student’s *t*-test was used to assess the relationship of the area of Hessert’s triangle to the variables of group (hernia or control), side of body (left or right), and sex. In the hernia group, the relationship of the area of Hessert’s triangle to the type of hernia (direct, indirect, or both) was evaluated in a one-way analysis of variance followed by multiple comparison tests. Scatter plots were made and Pearson correlation coefficients were calculated for the relationships between the area of Hessert’s triangle and age, weight, and height. All statistical tests were two-tailed. Multiple linear regression analysis was used to assess the joint effect of gender, age and group over the area measurements. A *P*-value less than 0.05 was considered statistically significant.

**Results**

The 115 hernia patients were significantly older than the 73 hernia-free cadavers (mean age 44.2 years versus 32.7 years, respectively; *P* < 0.001; Table 1). Weight and height were similar in the two groups. The male sex was similarly predominant in both groups: only nine (7.8%) of the hernia patients and six (8.2%) of the cadavers were female (*P* = 0.92, chi-squared test). The mean area of Hessert’s triangle was greater in the hernia group than in the control group (8.97 cm² versus 2.95 cm², respectively; *P* < 0.001, Student’s *t*-test; Table 2). The mean area of the triangle was also greater in males than in females. There was no statistically significant difference in the area of the triangle between the left and right sides of the body.

The mean area of the triangle was greater in patients with direct hernias or both direct and indirect hernias than in patients with only indirect hernias (Table 2). There was no significant relationship between the area of Hessert’s triangle and height or weight in either the

![Fig. 1 Right inguinal area](image-url)