



## Diagnosis and classification of inguinal hernias

### Accuracy of clinical, ultrasonographic, and laparoscopic findings

B. M. Kraft, H. Kolb, B. Kuckuk, S. Haaga, B. J. Leibl, K. Kraft, R. Bittner

Department of General and Visceral Surgery, Marienhospital Stuttgart, Böheimstrasse 37, D-70199 Stuttgart, Germany

Received: 17 December 2002/Accepted: 7 May 2003/Online publication: 28 October 2003

#### Abstract

**Background:** The aim of this prospective clinical study was to determine whether the presence of a hernia, its size, and its type can be established preoperatively by clinical and ultrasound examination.

**Methods:** The study population comprised 220 consecutive patients referred to our department for the surgical management of an inguinal hernia. On admission, both inguinal regions were examined clinically and by ultrasound. All patients were operated on laparoscopically.

**Results:** In regard to the intraoperative findings for both inguinal regions, clinical and ultrasound examination for the diagnosis of inguinal hernia yielded a high total rate of accuracy of 93% respective 94%. However, when the same methods were used to differentiate between lateral and medial hernia, the total rate of accuracy fell to only 54% respective 62%. In the determination of inguinal hernia size, it was even lower: 50% respective 53%.

**Conclusions:** Although a diagnosis of inguinal hernia can be established reliably by clinical and ultrasound examination, only an approximate classification is possible by these methods.

**Key words:** Diagnosis — Classification — Ultrasound — Inguinal hernia — Transabdominal preperitoneal (TAPP) hernioplasty

If we take the long view of the surgery of inguinal hernias, is undeniable that we cannot treat all hernia situations equally effectively and efficiently by a single surgical technique, especially when socioeconomic factors have to be taken into consideration [22]. The concept of an individually tailored surgical procedure, however, depends on a precise preoperative hernia

classification [29]. In the era when conventional open inguinal hernia surgery was the sole option, this was not a problem, because the surgeon could determine the type of hernia and the size of the hernia opening intraoperatively and then choose the optimal surgical technique for the circumstances at hand. However, following the introduction of laparoscopic and endoscopic repairs, a need arose for a precise preoperative classification.

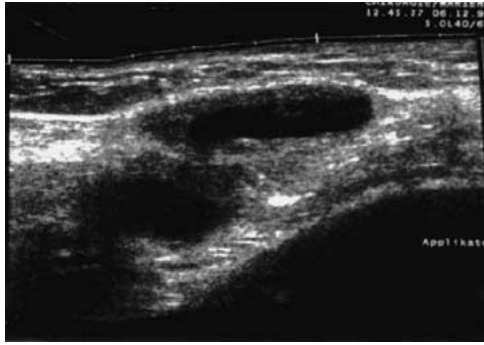
Laparoscopic hernioplasty via the transabdominal preperitoneal (TAPP) approach enables us to intraoperatively verify or rule out the presence of an inguinal hernia beyond any doubt. We can differentiate precisely between a spermatic cord lipoma, which is mobile within the inguinal canal, and a hernia formation, which protrudes into the inguinal canal. At the same time, we can classify the hernia correctly [29] and assess the size of its opening [2, 27].

The aim of this prospective study was to evaluate the accuracy of preoperative clinical and ultrasound examination vis a vis the later intraoperative laparoscopic findings, which were considered to be the gold standard for the proof and classification of an inguinal hernia.

#### Patients, materials, and methods

From June 1999 to February 2000, 220 patients drawn from a continuous patient population at Marienhospital, Stuttgart, Germany, and operated on consecutively were entered into a prospective study [5, 12]. There were no exclusion criteria, except for patients with uncertain inguinal findings in whom no hernia formation could be shown on either side, either by palpation or by ultrasonography [3]. There were 202 men (92%) and 18 women (8%). The median age was 59.3 years (range, 20–92).

With the aid of detailed anamnesis, we recorded the findings by the family physician that led up to the patient's admission, the preoperative ultrasound findings reported by the ward physician, and the ultrasound finding reported by one of our three experienced ultrasound examiners (each with 4,000–5,000 ultrasound examinations). Finally, we added the intraoperative findings, which had been reported by a total of 11 surgeons. At the time of the admission examination, as well as the preoperative ultrasound, the findings were classified [20, 29]. We distinguished the following types: medical, lateral, combined (mediolateral), and femoral hernias.



**Fig. 1.** Lateral (indirect) hernia.



**Fig. 2.** Medial (direct) hernia.

The ultrasound examination was performed with the High-End Sonographiesystem Sonoline Elegra with optional Siescape (Siemens, Erlangen, Germany). A 5-Mhz linear transducer and a 3.5-Mhz convex transducer with the option to expand the frequency range upward or downward were applied; frequencies between 2.8 and 7.2 Mhz are possible.

In a longitudinal section, a lateral hernia moves under the external oblique aponeurosis at the inner inguinal ring and then appears at the external ring (Fig. 1). A medial hernia moves straight toward the transducer from dorsal to ventral (Fig. 2) [10, 28]. The epigastric vessels can be visualized clearly and precisely on ultrasound, however, contrary to what is generally believed, their position relative to the hernia sac is not predictive for an ultrasonographic hernia classification because it changes in the course of the dynamic examination (Valsalva's maneuver), particularly in lateral hernias.

Omentum in the hernia sac appears rather echo-dense. Mobile or fixed, the small intestine is characterized by peristaltic waves, intestinal contents, and gas (Fig. 3). Spermatic cord lipomas move in front of the external inguinal ring during Valsalva's maneuver, but they do not migrate intraperitoneally from the inner inguinal ring and disappear.

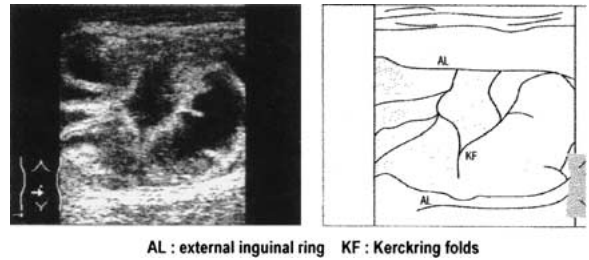
Lymph nodes or tumor, varicose nodes, ganglia, or hematoma, as well as funiculocoeles and hydroceles can be distinguished beyond any question from inguinal hernias by ultrasound [8].

All patients were operated on using the transabdominal preperitoneal (TAPP) technique [4, 5, 12, 13]. A 10 × 15 cm polypropylene mesh (PMN; Ethicon Nahtmaterialien, Norderstedt, Germany) was used to cover the defect. The mesh was fixed with a total of four to six titanium staples at Cooper's ligament, the medial pubic ramus, and the anterior abdominal wall, taking care to avoid the, "triangle of doom" and the "triangle of pain" [15].

All relevant data were recorded in an electronic database. Statistical analysis was done with the Mann-Whitney *U* test.

## Results

The 220 patients included in this study were referred to us by their general practitioners with a total of 260



**Fig. 3.** Incarcerate herina with small intestine in the herina sac.

hernias (40 patients had a bilateral hernia). However, the preoperative findings on palpation by the ward physician showed 54 bilateral hernias, for a total of 274 hernias (Table 1) and preoperative: ultrasonography showed 80 bilateral hernias, for a total of 300 hernias (Table 2).

Intraoperatively, we found a total of 289 inguinal hernias in the 220 patients (Tables 1 and 2), 69 bilateral and 151 unilateral. In 151 groins, no signs of a hernia were found intraoperatively (Tables 1 and 2). In each of the 220 patients, we found at least a unilateral hernia.

A sensitivity of 0.92 was found for the physical examination at admissions in regard to the diagnosis of inguinal hernia. Twenty-three of these inguinal hernias could not be palpated preoperatively. Eight preoperatively palpated hernias could not be confirmed intraoperatively, corresponding to a specificity of 0.92 (Table 1). The positive correctness was 0.97, the negative correctness was 0.86, and the total accuracy rate for the physical examination was 0.93 [2].

Preoperative ultrasound (Table 2) had already revealed 281 of the 289 inguinal hernias that were later diagnosed laparoscopically, meaning that eight inguinal hernias could not be recognized ultrasonographically (sensitivity, 0.97). A total of 19 hernias were newly discovered by ultrasound and later confirmed intraoperatively. Another 19 hernias, however, also shown by ultrasound, could not be confirmed intraoperatively. This corresponds to a specificity of only 0.87. The positive correctness and the negative correctness were both 0.94; the total accuracy rate for the preoperative ultrasound examination was 0.94 (Table 2).

Intraoperatively, we found 57% lateral, 34% medial, and 9% combined (medial lateral) inguinal hernias [21, 29]. In nine combined hernias that had not been identified by ultrasonography, an additional medial component was discovered intraoperatively. The total accuracy rate (number of positive concurrences) was 0.54 for the physical examination and 0.62 for preoperative ultrasonography.

The size of the hernia opening was assessed correctly in 53% of all patients by ultrasound as well as by preoperative palpation. In cases of false assessment, the intraoperative findings always showed a larger hernia opening than had been expected preoperatively.

For preoperative proof or exclusion of inguinal canal lipoma, we achieved a total accuracy rate of 0.64 for both the clinical and the ultrasound examinations.

**Table 1.** Results of preoperative examination

	Proves inguinal hernias	Sable groius	Total	
Positive clinical examination	266	8	274	Positively correct: 0.97
Negative clinical examination	23	143	166	Negatively correct: 0.86
Total	289	151	440	

Sensitivity, 0.92; specificity, 0.64; total rule of accuracy, 0.93

## Discussion

Our goal in this prospective study was to find out whether preoperative clinical and ultrasound examination of the inguinal region can provide accurate verification and classification of the inguinal hernia. If so, we would be able to plan an individualized surgical intervention based on those findings [2, 7, 16, 19, 20]. Given the wide spectrum of possible and applied surgical methods—ranging from simple closure of the hernia opening with a resorbable suture [18] to reinforcement of the inguinal region with a large nonresorbable patch—depending on the findings, the monomaniac application of one method would inevitably result in surgical over- or undertherapy of the condition, followed by either the subsequent formation of a recurrence or the acceptance of exorbitantly high risks or costs [1, 9, 17, 22–24, 26].

The TAPP method makes it possible to do a precise evaluation of both groins [5]. In conventional hernia surgery, and with the total extraperitoneal (TEP) method, this kind of evaluation is impossible, or at least highly problematic [11, 14].

Our results indicate that the preoperative accuracy of the diagnosis of inguinal hernia can be improved substantially when preoperative ultrasonography is included as an integral step in the examination protocol. Indeed, ultrasound equipment should be part of the armamentarium of every clinic. It is especially useful, however, in cases of uncertain inguinal findings.

Concerning the verification of the presence of inguinal hernia, we obtained in our study a sensitivity of 0.92 for the preoperative physical examination, but this figure was even further improved—to 0.97 when preoperative ultrasonography was added. A total of 19 inguinal hernias were newly identified on ultrasound and confirmed intraoperatively. Only eight hernias could not be visualized on preoperative ultrasound, due to relatively narrow hernia sacs that could not be seen during Valsalva's maneuver. The specificity of 0.87 for preoperative ultrasound was relatively low (in 19 of the bilateral hernias newly discovered by ultrasound, the intraoperative finding was unilateral hernia). In practically every case, this error was caused by the misinterpretation of an inguinal canal lipoma. As the respective experiences of the individual ultrasound examiners increase, we can reasonably expect even better results. However, we are convinced that a dedicated ultrasound examiner can also achieve a high level of accuracy on a routine basis in a clinical setting with fewer patients.

**Table 2.** Results of preoperative sonography

	Proven inguinal hernias	Sable groius	Total	
Positive sonography	281 <sup>a</sup>	19	300	(positively correct: 0.94)
Negative sonography	8	132	140	(negatively correct: 0.94)
Total	289	151	440	

Sensitivity, 0.97; Specificity, 0.87; total rule of accuracy, 0.94

<sup>a</sup> Nineteen hernias newly detected on ultrasound and confirmed intraoperatively

In regard to the classification of an inguinal hernia, the additional of ultrasonography also improved the accuracy from 0.54 to 0.62. In fully one-third of all patients, however, the preoperative classification did not coincide with the intraoperative findings.

## Conclusion

The growing demand for high-quality patient care by highly qualified medical practitioners can best be met by tailoring our treatment strategies to the individual patients, on a case-by-case basis, for optimal results. It was the goal of this prospectively controlled study to determine whether this concept can be applied to the surgery of inguinal hernias without increasing the risk of recurrence or incurring intolerably high surgical risks and costs. For this approach to work, the surgeon must be able to classify the inguinal hernia with great precision, based on the situation of the individual patient [29]. In the preoperative diagnosis of inguinal hernias, ultrasound examination of the inguinal region and the testicles plays an increasingly important role [6]. For definitive proof of the presence a hernia, the sensitivity of ultrasound is clearly higher than a mere physical examination; it can thus facilitate determination of the correct indication for the surgical intervention [27]. The final and definitive classification of hernias, however, can only be made intraoperatively; at best, the results of an ultrasound examination can help to orientate the surgeon [21].

The value of ultrasound for the assessment of the size of the hernia opening is equivalent to its value for the proof of spermatic cord lipoma and thus of limited value for this application. A stage-adjusted strategy for the management of inguinal hernias must therefore still be considered problematic at the present time.

## References

1. Amid PK, Shulman AG, Lichtenstein IL (1996) Open "tension free" repair of inguinal hernias: the Lichtenstein technique. *Eur J Surg* 162: 447–453
2. Babkova IV, Bozhko VV (1999) Ultrasound assessment in diagnosis of uncomplicated inguinal hernia. *Khirurgiia (Mosk)* 2: 46–50
3. Bau A, Atri M (2000) Acute female pelvic pain: ultrasound evaluation. *Semin Ultrasound CT MR* 21: 78–93
4. Bittner R (1995) Standardtechnik. In: Bittner R (Ed.) *Laparoskopische Hernioplastik* Hippokrates Verlag, Stuttgart, pp 81–97

5. Bittner R, Kraft K, Schmedt C-G, Schwarz J, Leibl B (1998) Risiko und Nutzen der laparoskopischen Hernioplastik (TAPP): 5 Jahre Erfahrung bei 3000 Hernienoperationen [in German]. *Chirurg* 69: 854–858
6. Chen KC, Chu CC, Chou TY, Wu CJ (1998) Ultrasonography for inguinal hernias in boys. *J Pediatr Surg* 33: 1784–1787
7. Chou TY, Chu CC, Diau GY, Wu CJ, Gueng MK (1996) Inguinal hernia in children: US versus exploratory surgery and intraoperative contralateral laparoscopy. *Radiology* 201: 385–388
8. Deitch EA, Soncrant MC (1981) Ultrasonic diagnosis of surgical disease of the inguinal–femoral region. *Surg Gynecol Obstet* 152: 319–322
9. Horgan LF, Shelton JC, O’Riordan DC, Moore DP (1996) Strengths and weaknesses of laparoscopic and open mesh inguinal hernia repair: a randomized controlled experimental study. *Br J Surg* 83: 1463–1467
10. Korenkov M, Paul A, Troidl H (1999) Color duplex sonography: diagnostic tool in the differentiation of inguinal hernias. *J Ultrasound Med* 18: 565–568
11. Leibl B, Däubler P, Schwarz J, Ulrich M, Bittner R (1995) Standardisierte laparoskopische Hernioplastik vs Shouldice-Reparation. Ergebnisse einer randomisierten Studie [in German]. *Chirurg* 66: 895–898
12. Leibl BJ, Schmedt CG, Schwarz J, Däubler P, Kraft K, Schlossnickel B, Bittner R (1998) A single-institution experience with transperitoneal laparoscopic hernia repair. *Am J Surg* 175: 446–452
13. Leibl BJ, Schmedt CG, Ulrich M, Kraft K, Bittner R (1999) Laparoscopic hernia repair—the facts, but no fashion. *Langenbeck’s Arch Surg* 384: 302–311
14. Leibl BJ, Däubler P, Schmedt CG, Kraft K, Bittner R (2000) Long-term results of a randomized clinical trial between laparoscopic hernioplasty and Shouldice repair. *Br J Surg* 87: 780–783
15. Leibl BJ, Schmedt DG, Kraft K, Bittner R (2000) Laparoskopische transperitoneale Hernioplastik (TAPP) — Effektivität und Gefahren [in German]. *Chir Gastroenterol* 16: 106–109
16. Leibl BJ, Schmedt CG, Kraft K, Ulrich M, Bittner R (2000) Scrotal hernias—a contraindication for an endoscopic procedure? Results of a single institution experience in transabdominal preperitoneal repair (TAPP). *Surg Endosc* 14: 289–292
17. Leibl BJ, Schmedt CG, Kraft K, Ulrich M, Bittner R (2000) Recurrence after endoscopic transperitoneal hernia repair (TAPP): causes, reparative techniques and results of the reoperation. *Am Coll Surg* (in press)
18. Leung WY, Poon M, Fan TW, Siu KW, Chung KW, Kwok WK, Kwok CH (1999) Testicular volume of boys after inguinal herniotomy: combined clinical and radiological follow-up. *Pediatr Surg Int* 15: 40–41
19. Moreno-Egea A, Girela E, Canteras M, Martinez D, Aguayo JL (2000) Accuracy of clinical diagnosis of inguinal and femoral hernia and its usefulness for indicating laparoscopic surgery. *Hernia* 4: 23–27
20. Neuhauser D (1977) Elective inguinal herniorrhaphy versus truss in the elderly. In: Bunker JP, Barnes BA, Mosteller F (Eds.) *Costs, risks and benefits of surgery*. Oxford University Press, New York, pp 223–239
21. Renzulli P, Frei E, Schafer M, Werlen S, Wegmuller H, Krahenbuhl L (1997) Preoperative Nyhus classification of inguinal hernias and type-related individual hernia repair: a case for diagnostic laparoscopy. *Surg Laparosc Endosc* 7: 373–377
22. Rutkow IM, Robbins AW (1993) Demographic, classification and socioeconomic aspects of hernia repair in the United States. *Surg Clin North Am* 73: 413–426
23. Rutkow IM, Robbins AW (1997) Hernioplastik mit der Netzplombe [in German]. *Chirurg* 68: 970–976
24. Schumpelick V, Arlt G (1996) Transinguinale präperitoneale Netzplastik (TIPP) beim Leistenbruch in Lokalanästhesie [in German]. *Chirurg* 67: 419–424
25. Schumpelick V, Treutner KH, Arlt G (1994) Inguinal hernia repair in adults. *Lancet* 344: 375–379
26. Stoppa R, Rives JL, Warlamont C, Palot JP, Verhaege PJ, Delattre JF (1984) The use of Dacron in the repair of hernias of the groin. *Surg Clin North Am* 64: 269–285
27. Van den Berg JC, de Valois JC, Go PM, Rosenbusch G (1999) Detection of groin hernia with physical examination, ultrasound, and MRI compared with laparoscopic findings. *Invest Radiol* 34: 739–743
28. Van den Berg JC, de Valois JC, Go PM, Rosenbusch G (2000) Radiological anatomy of the groin region. *Eur Radiol* 10: 661–670
29. Zollinger Jr RM (1999) A unified classification for inguinal hernias. *Hernia* 3: 195–200