Hernia (2010) 14:165–169
DOI 10.1007/s10029-009-0589-8

ORIGINAL ARTICLE

The effects of inguinal hernia repair on testicular function in young adults: a prospective randomized study

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Received: 13 June 2009 / Accepted: 6 November 2009 / Published online: 24 November 2009

Abstract
Purpose The two most common procedures for open tension-free groin hernia repair with prosthetic mesh are the Lichtenstein operation and the mesh plug (Rutkow–Robbins) technique. Our study evaluated these two techniques on testicular blood flow and volume, and sperm function in young adults.
Methods We randomized operation types with a systematic sampling method, and handled consecutive patients of age 20–30 years having unilateral inguinal hernia repair at our institution from March to August 2008. The study subjects were divided into the Lichtenstein group (LG) and the mesh plug group (MPG). All subjects received color Doppler ultrasonography to determine testicular volume and resistive index (RI) the day before surgery and 3 months postoperatively by a physician blinded for the type of planned or performed operation. Spermiograms done preoperatively and at 3 months postoperatively measured sperm concentration and the rate of progressive motility.
Results Sixty-four patients met the study criteria, with 32 patients each in the LG and MPG. RI levels were elevated postoperatively in both the LG ($P = 0.027$) and MPG ($P = 0.012$); there was no significant alteration in terms of testicular volume and spermiogram in the LG and MPG.
Conclusion The Lichtenstein and mesh plug techniques in unilateral inguinal hernia increase the RI level significantly in the early postoperative period, but do not have a significant effect on sperm concentration and the rate of progressive motility.

Keywords Resistive index · Inguinal hernia · Lichtenstein · Mesh plug · Rutkow–Robbins

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Introduction

Hernia repair is one of the most common operations performed by general surgeons. Studies that considered recurrence as a criterion for the success of a particular surgical technique recognized that tension in a repair is the principal cause of recurrence after hernia surgery. As a result, prosthetic materials are now more frequently being used in surgical practice for avoiding the recurrence of hernia and its complications [1]. The aims of using prosthetic material are to create a fibroblastic tissue response and to form a strong mesh–aponeurosis complex in place of weak natural tissue.

Two of the most frequently performed procedures for open tension-free groin hernia repair with prosthetic mesh are Lichtenstein's operation and mesh plug hernia repair (Rutkow–Robbins). Similar results for complications and recurrence rates are reported in the literature for both techniques [2, 3]. Several recent prospective randomized trials have shown minimal recurrence rates of between 0 and 3.5% [2–4].

Rare but important vascular complications of inguinal hernia repair range from testicular hypoperfusion to testicular infarctus [5, 6]. In addition to vascular injury, fibrotic tissue formed secondary to the perimesh reaction may affect testicular flow [7]. These complications may cause infertility [8].

Our study evaluated the effects of the two most common hernia repair techniques, the Lichtenstein operation and mesh plug technique (Rutkow–Robbins), on testicular blood flow, testicular volume, and sperm function in young adults.

Patients and methods

After approval from the local ethics committee, we randomized operation types with a systematic sampling method, and we handled consecutive patients of age 20–30 years who were in military service, having unilateral inguinal hernia repair at our institution from March to August 2008. Patients were informed, and a written consent was taken. Patients with a history of ipsilateral or contralateral hernia surgery, bilateral inguinal hernia, testicular surgery for varicocele, undescended testes, and patients who refused to participate in the study were excluded.

Ultrasonographic evaluation

Color Doppler ultrasonography (GE Logiq 500 Pro, Pyramid Medical, USA) to determine testicular volume and resistive index (RI) was applied to all patients the day before and 3 months after the operation by a physician who was blinded for the type of planned or performed operation. RI was calculated indirectly: RI = (Systolic peak velocity − end diastolic peak velocity)/systolic peak velocity.

Spermiogram

Testicular function was evaluated via a spermiogram of the ejaculate obtained after 72 h of sexual abstinence. Spermiograms were done preoperatively and at 3 months after the operation. The spermiograms measured sperm concentration and the rate of progressive motility.

Surgical technique

Patients were randomized with a systematic sampling method and were stratified into two groups: patients who received the Lichtenstein procedure (Lichtenstein group [LG]) and patients who underwent the mesh plug technique (mesh plug group [MPG]). All operations were performed by the same surgical team under spinal anesthesia. One dose of first-generation cephalosporin was applied at anesthesia induction for prophylactic antibiotherapy.

The Lichtenstein operation was performed as described by Amid et al. [9]. A 7.5 × 15-cm polypropylene mesh was fixed on the inguinal floor and secured by 2.0 polypropylene. After closure of the external oblique and Scarpa's fascia, the skin was closed with a running suture.

The mesh plug operation was performed as described by Robbins and Rutkow [10]. A polypropylene plug was placed into the internal inguinal ring and secured with interrupted sutures, after which a 7.5 × 15-cm polypropylene mesh was fixed on the inguinal floor and secured by 2.0 polypropylene. After closure of the external oblique and Scarpa's fascia, the skin was closed with a running suture.

Statistical analysis

Student's *t*-test was used to compare Doppler flow, testicular volume, and spermiogram parameters in the preoperative and postoperative periods. The Mann–Whitney *U*-test was used to compare complication rates. Significance was determined at $P < 0.05$.

Results

There were 64 patients who met the study criteria, with 32 patients each in the LG and MPG. The patient characteristics are summarized in Table 1. There were no complications during the follow-up period, except for two seromas in the LG that spontaneously improved with aspiration.

Comparison of preoperative and postoperative values in the LG showed a statistically significant increase in the postoperative RI ($P = 0.027$), and there is no statistically significant alteration in the testicular volume and sperm concentration, nor in the other parameters either (Table 2).

Comparison of the preoperative and postoperative values in the MPG found a statistically significant increase in the postoperative RI ($P = 0.012$), and there is no statistically significant alteration in the testicular volume and sperm concentration, nor in the other parameters either (Table 3).

Table 1 Patient characteristics

	LG ($n = 32$)	MPG ($n = 32$)	*P*-value
Hernia site			
Left side	15	14	NS
Right side	17	18	NS
Median age (years)	22 (20–28)	23 (20–30)	NS
Type of hernia (Nyhus hernia classification)			
Type 2	14	17	NS
Type 3A	8	6	NS
Type 3B	10	9	NS
Postoperative complication	–	–	
Seroma	2	–	

NS not significant

Table 2 Lichtenstein group

	Preoperative	Postoperative	*P*-value
Testicular volume (cm^3)	18.92 ± 1.05	18.75 ± 1.26	0.620
RI	0.64 ± 0.06	0.80 ± 0.06	0.027*
SC (million/ml)	88.65 ± 10.30	65.48 ± 8.22	0.070
ROPM (%)	52.79 ± 2.35	55.54 ± 2.26	0.430

RI resistive index; *SC* sperm concentration; *ROPM* rate of progressive motility

* Statistically significant

Table 3 Mesh plug group

	Preoperative	Postoperative	*P*-value
Testicular volume (cm^3)	19.37 ± 1.06	18.21 ± 1.68	0.237
RI	0.60 ± 0.04	0.75 ± 0.08	0.012*
SC (million/ml)	75.27 ± 7.03	58.87 ± 7.73	0.150
ROPM (%)	51.64 ± 2.60	48.53 ± 2.96	0.461

RI resistive index; *SC* sperm concentration; *ROPM* rate of progressive motility

* Statistically significant

Discussion

Although there has been broad acceptance of meshes in hernia surgery and observed advantages in the clinical management of incisional and recurrent hernias, an increasing number of published reports are describing local wound disturbances and other complications [11]. The incidence of infertility is higher in patients who have undergone a groin inguinal hernia operation than in the general population. It is suggested that the reason is fibroblastic response to the mesh.

The inflammatory reaction to the physiological wound contraction of meshes causes them to shrink. It is possible for the area of a mesh to shrink to 60% of its original size, or even to 10% of the original size in the case of mesh plugs [12]. This result can affect testicular vessels negatively in the long term.

Preserving testicular volume and function is crucial in hernia surgery. The most important factor in preserving testicular volume and testicular function is the maintenance of arterial circulation [13]. The best way to assess whether or not the testicular volume and testicular function is affected is by measuring the RI. The testicular arteries, with a diameter of ~1.5 mm, are the main vessels of the testicles [14]. Their RI is measured by Doppler ultrasonography, and gives a good measure of testicular blood flow. Pinggera et al. demonstrated that the RI can be an indicator for detecting male subfertility [15]. The normal range of the RI in the distal portion of the testicular artery is 0.63–1 [16]. An increasing RI implies an increase in vascular impedance. A decrease in diastolic blood flow with an increase in the RI identifies testicular ischemia [17]. Iles found the proportion of testicular atrophy to be 1% in 28,760 cases [18].

It is known that the infertility rate after inguinal hernia surgery is higher than in the general population. Yavetz et al. reported a 6.65% incidence of hernioplasty with or without subsequent testicular atrophy in 8,500 patients [19]. There is no difference in the RI resulting from direct or indirect inguinal hernia. Since there is no difference between postoperative 3- and 6-month follow-up, it is inferred that there is no association between hernia and the alteration of arterial blood flow. Conversely, some authors conclude that testicular blood flow is altered by hernia [20]. In comparing the RI of a group of patients receiving herniorraphy with the RI of a control group, Lima Neto et al. found the RI in the herniorraphy group to be higher than in the control group, although not at the level of statistical significance [21]. Aydede et al. found elevated RI during the early postoperative period after hernia surgery, but no difference at the 6-month postoperative check [7]. In our study, the RI levels were based on the assessment of testicular blood flow, and were evaluated statistically. We found that the RI levels were significantly elevated postoperatively in both the LG and the MPG ($P = 0.027$, $P = 0.012$, respectively). However, this elevation does not affect the testicular volume and spermiogram negatively. Our results were in contradiction with the study of Pinggera et al. [15]. They found that patients with oligoasthenozoospermia had increased RI and stated that RI can be used as an indicator of spermatogenesis. Although the RI values were higher postoperatively, we did not observe any pathological findings in the semen analyses. It is possible to give an explanation to clarify this counter-view. Initially, the patients were operated for unilateral inguinal hernia, and we did not undergo a surgical procedure for the other site and the vas deferens in the opposite inguinal region was intact. Secondly, we may speculate that our study population was younger and the lumens of testicular

arteries, which were the target organs of androgens, were not narrow by virtue of age. Therefore, we think that the RI cannot be used as a marker of spermatogenesis.

Uzzo et al. showed that there was no difference in terms of spermiograms in their study [14]. In our study, two parameters were examined in the result of the spermiogram: sperm concentration and the rate of progressive motility. We found no statistically significant difference in LG and MPG.

Despite the common use and some advantages of mesh, reports of complications are increasing. Mesh is composed of inert materials, yet, over time, mesh contracts, and this contraction may cause congestion in the plexus pampiniformis. Moreover, the sharp edges of the mesh can erode the spermatic cord [22]. A study by Uzzo et al. comparing the Lichtenstein and Shouldice techniques found thickening in the muscular layer of the vasa deferentia secondary to mesh reaction. There was no difference in testicular volume, blood flow, and vasogram [14]. Mesh adhesions were seen without cord damage in Fitzgibbons' onlay mesh operation [23]. Mesh placed deep in the inguinal ring comes into wider contact with cord structures and affects the severity of complications. Various studies have shown that mesh itself [24], mesh localization [7], and perimesh fibrosis [25] do not affect the testicular blood flow.

Testicular volume is an important outcome measure in patients with repaired inguinal hernia [26]. Among patients who underwent inguinal hernia surgery with mesh, Lima Neto et al. observed no alteration in testicular volume or arterial flow over a 6-month postoperative period [21]. Homonnai et al. found that 14.4% of 131 infertile men who had undergone hernia repair experienced changes in testicular size on the operated side [27]. Taylor et al. showed that mesh contraction following inguinal hernioplasty does not adversely affect the testes or femoral vessels, concluding that mesh can be used safely [24]. There was no statistically significant difference in terms of testicular volume in our study.

Conclusion

In order to assess infertility after inguinal hernia surgery, the study should be performed in young adults who are of the highest degree in their fertility. The uniqueness of our study is its focus on young adults. The preservation of fertility is an important consideration when deciding upon a hernia repair technique for particular patients who desire children. This study indicates that open mesh repair in unilateral inguinal hernia repair increases the resistive index (RI) level significantly 3 months postoperatively, but has no statistically significant effect on the sperm concentration and rate of progressive motility, although the sperm concentration was reduced. Further investigations with longer follow up periods are necessary in order to determine the risk for infertility in using meshes for inguinal hernia repair.

Acknowledgment The authors thank Marilyn Carlson for her editorial assistance.

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