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ORIGINAL ARTICLE

One-year results of a prospective, randomised clinical trial comparing four meshes in laparoscopic inguinal hernia repair (TAPP)

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Abstract
Background A low rate of chronic pain and maximum postoperative comfort are the main goals today in inguinal hernia repair. This four-arm randomised trial compares these parameters after laparoscopic hernia repair (TAPP) with a standard heavyweight mesh (HW), a pure middleweight polypropylene mesh (MW), a lightweight composite polypropylene mesh (LW), or a titanised lightweight mesh (TLW). The primary endpoint of the study was the incidence of chronic pain of any severity at the site of hernia repair at 1 year.
Methods A total of 600 patients with a laparoscopic inguinal hernia repair and a defect diameter of 3–5 cm were included in the trial. In all patients, a non-invasive mesh fixation technique was performed using fibrin glue. Patients were assessed for pain, foreign body sensation, and physical activities preoperatively, early postoperatively, at 4 weeks, at 6 months, and at 1 year by questionnaire, and were examined clinically. Postoperatively, seroma formation was measured by ultrasound.
Results At 1 year after TAPP, frequency of pain did not differ statistically between the four groups (depending on type of activity: between 6–8% with HW mesh, 2–4% with middleweight mesh, and 2–4.7% with both lightweight meshes); average intensity of pain was very low, at between VAS 0.4 ± 3.1 and 1.5 ± 7.8 (MW, LW, TLW) and between 1.9 ± 8.6 and 2.3 ± 9.1 (HW) depending on activity (n.s.). Early postoperatively between 31.3% (LW) and 21.3% (TLW) of the patients needed pain medication (n.s.); at 1 year this percentage had dropped to 0.3% (one HW, one MW). Foreign body sensation did not differ but impairment of physical activities ($P = 0.0437$) was significantly less in the MW, LW, and TLW group (6–12.7%) compared to HW (15.3%) at 4 weeks; at 1 year this percentage was between 0 and 1.3% (n.s.).
Conclusion Compared to HW mesh, the use of MW, LW, and TLW meshes for laparoscopic hernia repair did not significantly affect rate of chronic pain, but seemed to improve early postoperative convalescence. No difference was found between middleweight pure polypropylene (MW), composite lightweight (LW), or titanised lightweight polypropylene (TLW) meshes.

Keywords Inguinal hernia · Laparoscopic hernia repair · TAPP · Lightweight mesh · Fibrin glue fixation

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Introduction

The introduction of meshes for inguinal hernia repair has reduced recurrence rates significantly [1, 2], and recurrence

rate is thus no longer the most important outcome parameter after surgery. Nowadays the focus is on other undesired side effects such as acute and chronic pain and convalescence [3]. Chronic pain was first identified as an important quality factor by Cunningham et al. [4] and Poobalan [5] when reviewing the literature, where a prevalence of 0–63% was found 1 year after hernia surgery. Several patient-dependent factors, but also factors related to surgical technique, were identified as increasing the risk of development of chronic pain [6]. Recent studies have shown that the type of mesh material (lightweight vs heavyweight) may affect postoperative pain and recovery after both open [7–14] and laparoscopic [15–20] surgery, and lightweight meshes are thought to lower the incidence of acute and chronic pain [21]. However, all such studies are biased by not mentioning or using invasive mesh fixation techniques.

The aim of the present randomised controlled clinical trial was to compare outcomes after laparoscopic inguinal hernia repair (TAPP) using traditional heavyweight polypropylene mesh (HW), middleweight pure polypropylene mesh (MW), composite lightweight polypropylene (LW), or titanised lightweight polypropylene mesh (TLW). To exclude the influence of the invasive mesh fixation technique on the development of chronic pain, for the first time in this study the meshes were fixed by a non-invasive technique using fibrin glue.

The primary endpoint of the study was the incidence of chronic pain of any severity at the site of hernia repair at 1 year. Secondary endpoints were: frequency and intensity of early postoperative pain, analgesia consumption, foreign body sensation, impairment of physical activities, and seroma formation.

Materials and methods

After approval by the local ethics committee, all patients scheduled consecutively for inguinal hernia repair using the transabdominal preperitoneal patch plasty (TAPP) technique, and who met the inclusion criteria listed below, were invited to participate in this randomised controlled trial. TAPP is the standard technique in our hospital and is applied in 98% of patients. The technique was introduced in 1993 and described in detail previously [22–24]. More than 10,000 repairs had been carried out since that time before starting this trial.

The patients were given detailed information on the operation and the trial. They all signed an informed consent form for the entire research protocol including the 1-year follow-up clinical examination and separate authorisation for fibrin fixation.

Fundamentally, our technique involves a wide, arcuated opening of the peritoneum high above all possible hernia openings from the spina iliaca anterior superior to the plica umbilicalis medialis. Complete anatomic dissection of the total inguinal area (retropubic space of Retzii and Bogros) is performed, exposing all important structures. Careful, predominantly blunt, dissection in the avascular "spider's web" tissue of the visceral compartment [25] of the preperitoneal space is carried out, sparing the fascia spermatica and the nerves below located in the parietal compartment. Ablation of the peritoneum and hernial sac from the fascia spermatica is performed down to approximately the middle of the m. psoas (parietalization). Finally, 10 × 15 cm of mesh is placed in a wrinkle-free manner to overlap the hernia openings by, on average, 3 cm (vertical direction)–5.5 cm (horizontal direction).

In the control group, a standard HW polypropylene monofilamental mesh of 90 g/m^2 in weight, pore size 1.2 mm (Prolene, Ethicon, Norderstedt, Germany) was used. Patients in the three study groups received either a MW pure polypropylene mesh (55 g/m^2; pore size 0.75 mm; Premilene LP, Aesculap, Tuttlingen, Germany), or a composite LW (28 g/m^2; pore size 3–4 mm) mesh (Ultrapro, Ethicon, Norderstedt, Germany), or LW (35 g/m^2, pore size >1 mm, TLW) monofilamental polypropylene mesh coated with Titanium (TiMesh TC light, GfE, Nürnberg, Germany). All meshes were fixed with 1 ml fibrin glue (1 ml sealer protein solution + 1 ml thrombin solution Tissucol, Baxter, Unterschleißheim, Germany).

The peritoneum was closed with a running suture (monofilament, absorbable) at 12 mm Hg during dissection down to 6–8 mm of reduced intra-abdominal pressure.

All operations were carried out under general anaesthesia (sevoflurane/desflurane in combination with a 70:30% mixture of nitrous oxide and oxygen) with endotracheal intubation and controlled artificial ventilation. All patents received thromboembolic prophylaxis with a low-molecular-weight heparin and a one-shot antibiotic prophylaxis immediately before surgery. Pain was managed with paracetamol, diclophenac, or piritramid in a standardised way [visual analogue scale (VAS) ≤ 4 on the scale 1–10] and was documented. As soon as the patients were awake after anaesthesia, they were encouraged to stand up and go to the bathroom. In the evening, they received a light meal taken at the table. The next morning, they were allowed to move and eat freely, and were usually discharged on the 2nd postoperative day. The stitches were removed on the 6th postoperative day, with return to normal activities.

Patients eligible for inclusion had a reducible primary or recurrent inguinal or femoral hernia scheduled to undergo elective repair; were aged over 30 years, and had a hernia opening between 3 and 5 cm intraoperatively confirmed. The decision to study hernia of 3–5 cm in size only was made according to our standardised clinical praxis after

more than 10,000 hernias operated on laparoscopically—in small hernias with a defect diameter less than 3 cm, no mesh was fixed at all, and in large hernias with a diameter of more than 5 cm we had clinical evidence that non-invasive fixation using fibrin glue might be not safe enough to prevent dislocation under stress during the early post-operative period. Thus, in these patients, we preferred an invasive fixation technique with clips. Exclusion criteria were defect size less than 3 cm or more than 5 cm, irreducible and scrotal hernia, emergency case, trainee operation (less than 50 self-performed TAPP's), patients with inguinal neuralgia, or inability to understand the study design.

Randomisation was by computer-generated random numbers and disclosed to the surgeon by sealed envelope with block sizes to ensure balanced recruitment. The envelope was opened only after dissection of the pelvic floor was finished to allow precise measurement of the diameter of the hernia defect. Patients and the follow-up examiner were blinded to the type of mesh used. Randomisation was stratified according to primary or recurrent hernia.

The primary outcome measure was chronic pain in the groin at 1 year follow-up. The sample size of the study was designed to detect a difference lying between 18 (HW) and 5% (LW) in the rate of patients developing chronic pain. With an alpha error of 0.05 and a beta error of 0.1, the minimum sample size was calculated to be 140 patients per group. To allow for withdrawals, the recruitment target was set at 600 (150 per mesh group).

According to our usual clinical practice, the patients were admitted the day prior to surgery. Details of patient demography, medical history, and occupation were recorded. Furthermore, following a study published by Aasvang et al. [6], a special questionnaire was completed asking for occurrence, frequency and intensity of pain in the groin and the testes measured by VAS—ranging from 0 (no pain) to 100 (unbearable pain) when sitting on a chair for a longer time, when getting up out of bed, when walking (about 100 m), and when climbing stairs (two floors). Chronic pain was defined as pain persisting longer than 3 months after surgery [26]. In addition, the questionnaire asked for information on impairment of daily activities [rated by VAS–ranging from 0 (no) to 100 (unable to do anything)], foreign body sensation in the groin (VAS 0–100), numbness or other sensoric dysfunction in the region of the groin, and analgesia consumption.

Intraoperative details (hernia type, operating time, surgeon, complications), early postoperative course (complications, hospital stay, duration of work disability), and the results of clinical examination (recurrence) during hospital stay were recorded on separate sheets. On the 1st or 2nd postoperative day, an ultrasound investigation (occurrence and amount of seroma production) was performed.

Patients attended for clinical follow-up at 4 weeks, 6 months, and 1 year after surgery. At each visit a clinical and an ultrasound examination were carried out and the special questionnaire described above was completed.

Statistical analysis

All analyses were performed using SAS version 9.2. All statistical tests are two-sided, P values below 0.05 are considered statistically significant. For secondary parameters, no adjustments for multiplicity were made. All analyses and summaries are based on observed values, i.e., missing values were not imputed.

Summary statistics for quantitative variables (intensity of pain, VAS) include mean, standard deviation, minimum, median, and maximum.

Intensity of pain as well as other measures based on VAS were investigated using an analysis of variances models with repeated measures. P values are presented for the effect of time, the effect of treatment, and the interaction between time and treatment.

Qualitative data were summarised using frequency tables (frequencies and percentages), and were analysed qualitatively. Frequency distributions were compared with the Chi-square test.

Results

During the 30-month study period, a total of 2,754 inguinal and femoral hernia repairs were done. Of these, 383 patients refused to participate in the study or to use fibrin glue for mesh fixation, 228 patients had an irreducible ($n = 84$), a strangulated ($n = 18$), or a large scrotal ($n = 126$) hernia, and 286 were trainee operations. Thus, in a total of 1,857 cases, the hernias were found to be suitable for the study, and the patients consented. Intraoperatively, 1,257 hernias (67.7%) had a defect diameter of less than 3 cm or more than 5 cm, and these patients were excluded from the study. Finally, 600 hernias were randomised intraoperatively to the HW, MW, LW, or TLW group. All patients completed the questionnaire at each point of time in the follow-up, but clinical examination at 1 year was possible in only 96% of the patients with no difference between the four groups. Preoperative and intraoperative variables were similar in the two groups. Sex ratio was male 139 (92.7%) to female 11 (7.3%) in the HW group, male 147 (98%) to female 3 (2%) in the MW group, male 149 (99.3%) to female 1 (0.7%) in the LW group, and male 139 (92.7%) to female 11 (7.3%) in the TLW group; mean age: 59.1 ± 13.9 years of HW patients, 56.3 ± 12.7 years of MW patients, 56.2 ± 13.8 years in LW patients, and 59.2 ± 13.9 years of TLW patients; BMI: 25.3 ± 2.7

Table 1 Hernia characteristics (defect size 3–5 cm)

Frequencies	Prolene		Premilene		Ultrapro		TiMesh		Total	
	N	%	N	%	N	%	N	%	N	%
Type										
Primary hernia	139	92.7	145	96.7	143	95.3	146	97.3	573	95.5
Recurrent hernia	11	7.3	5	3.3	7	4.7	4	2.7	27	4.5
Nyhus										
II	41	27.3	40	26.7	49	32.7	41	27.3	171	28.5
IIIa	64	42.7	72	48.0	50	40.0	73	48.7	269	44.8
IIIb	34	22.7	33	22.0	35	23.3	29	19.3	131	21.8
IIIc	–	–	–	–	–	–	1	0.7	1	0.2
IV	11	7.3	5	3.3	6	4.0	6	4.0	28	4.7
Side										
Right	86	57.3	78	52.0	86	57.3	79	52.7	329	54.8
Left	64	42.7	72	48.0	64	42.7	71	47.3	271	45.2
Total	150	100.0	150	100.0	150	100.0	150	100.0	600	100.0

Table 2 Pain in the inguinal region when walking

Frequencies	Prolene		Premilene		Ultrapro		TiMesh		Total	
	N	%	N	%	N	%	N	%	N	%
Preoperative										
No	87	58.0	91	60.7	89	59.3	99	66.0	366	61.0
Yes	63	42.0	59	39.3	61	40.7	51	34.0	234	39.0
Early postop										
No	70	46.7	78	52.0	64	42.7	56	37.3	268	44.7
Yes	80	53.3	72	48.0	86	57.3	94	62.7	332	55.3
After 4 weeks										
No	140	93.3	143	95.3	142	94.7	139	92.7	564	94.0
Yes	10	6.7	7	4.7	8	5.3	11	7.3	36	6.0
After 6 months										
No	144	96.0	140	93.3	146	97.3	142	94.7	572	95.3
Yes	6	4.0	10	6.7	4	2.7	8	5.3	28	4.7
After 1 year										
No	138	92.0	146	97.3	146	97.3	144	96.0	574	95.7
Yes	12	8.0	4	2.7	4	2.7	6	4.0	26	4.3

(HW) vs 25 ± 2.7 (MW) vs 25.2 ± 2.8 (LW) vs 24.9 ± 3 (TLW). Hernia characteristics are shown in Table 1.

Of all the patients, 52–60.7% were operated on by the chief surgeon, 28.7–39.3% by senior residents, and 8.7–12% by residents (>50 self performed TAPPs) with nearly identical distribution in the study groups.

There were no differences in postoperative surgical complications, either early or late, between the treatment groups: HW 2.64% vs 0.66% (MW) vs 1.98% (LW) vs 3.3% (TLW). There was one haematoma (TLW-operative treatment), three trocar hernias at the umbilicus in HW patients and one in TLW patients, one lesion of the cutaneous femoral nerve in the HW group and two in the TLW group plus an additional lesion of the genital branch of the genitor-femoral nerve, and a persistent seroma in the HW group. In the TLW group, two medial recurrences (1.3%), and in the HW group one medial recurrence (0.66%) were seen 1 year after surgery (n.s.).

Fibrin sealant was well tolerated and none of the postoperative events was deemed to be related to its use.

Chronic pain

Preoperatively, depending on the type of activity, 20% (when getting up) to 39% (when walking) of patients complained of groin pain. At 1 year after TAPP, the frequency of chronic pain went down to 3.2–4.7% with no significant difference between the four study groups, but

Table 3 Impairment of physical activity

Frequencies	Prolene		Premilene		Ultrapro		TiMesh		Total	
	N	%	N	%	N	%	N	%	N	%
Preoperative										
No	77	51.3	76	50.7	63	42.0	86	57.3	302	50.3
Yes	73	48.7	74	49.3	87	58.0	64	42.7	298	49.7
Early postop										
No	34	22.7	44	29.3	38	25.3	30	20.0	146	24.3
Yes	116	77.3	106	70.7	112	74.7	120	80.0	454	75.7
After 4 weeks										
No	127	84.7	141	94.0	137	91.3	131	87.3	536	89.3
Yes	23	15.3	9	6.0	13	8.7	19	12.7	94	10.7
After 6 months										
No	150	100.0	148	98.7	148	98.7	147	98.0	593	98.8
Yes	–	0.0	2	1.3	2	1.3	3	2.0	7	1.2
After 1 year										
No	149	99.3	149	99.3	148	98.7	150	100.0	596	99.3
Yes	1	0.7	1	0.7	2	1.3	–	0.0	4	0.7

the results show a clear tendency for more pain in HW patients when walking at 1 year after TAPP (Table 2). Pain in the testes was complained of by 5.4–9.9% of patients preoperatively, and 1.7–1.9% 1 year after surgery, with no difference between the four groups during the whole study period.

Average and maximal intensity of pain in the groin and the testes assessed by VAS did not differ between the treatment groups, either preoperatively or at 1 year after operation. Average intensity of pain in the groin was low, at between VAS 3.6 ± 9.5 (getting up) and 12.4 ± 19.6 (walking) preoperatively, and went down to 0.4 ± 2.8 (getting up)–2.3 ± 9.1 (walking) at 1 year after TAPP ($P < 0.0001$). Maximal intensity of pain was between VAS 16.7 ± 14.2 (getting up) and 30.3 ± 19.9 (climbing stairs) preoperatively, and between 16.3 ± 7.5 (LW) and 45 ± 12.9 (MW) at 1 year after surgery (n.s.). At 4 weeks, maximal pain intensity (39.5 ± 27.8–47.9 ± 32.6) in the HW group was significantly higher compared to the three other groups (15.7 ± 14.6–21.9 ± 16.5) when climbing stairs ($P < 0.0384$), getting up (0.0295), or walking ($P < 0.0402$). At 6 months, significantly more pain was seen in the MW group compared to the other three groups when climbing stairs ($P < 0.0492$) or walking ($P < 0.008$). Average intensity of pain in the testis at 1 year was between 0 (walking) and 0.7 ± 4.2 (walking).

Analgesia consumption

Preoperatively, 98% of patients did not need any analgetics, with no difference between the four groups. Early postoperatively, 26% needed pain killers with no statistically significant difference between the four groups regarding analgesia type and number of tablets needed. On the 1st postoperative day, pain medication was given once in 12.8% (9.3–15.3) of patients, twice in 11.8% (8.7–16), three times in 0.8% (0–3.3), and more than three times in 0.5% (0–1.3) of patients. On the 2nd postoperative day, pain medication was given once in 9.2% (6.7–12.7) of patients, twice in 2.7% (2.0–3.3), three times in 0.3% (0.0–1.3), and more than three times in 0.0%. At 1 year after surgery, one patient in the HW group (0.7%, daily) and one patient in the MW group (0.7%, once a week) received pain medication, but none did so in either of the LW groups.

Foreign body sensation

No significant difference in this parameter was seen between the four groups either preoperatively or postoperatively. Overall, at 1 year, the frequency of foreign body sensation was 0.8%, with a low intensity of VAS 0 (MW, TLW), VAS 0.1 ± 1.2 (LW), and VAS 0.4 ± 3.5 (HW).

Impairment of physical activity

Regarding frequency of impairment of physical activity, Table 3 shows a significant improvement in all groups ($P < 0.001$), postoperatively. At 4 weeks, there is a significant advantage in favour of MW, LW, and TLW meshes ($P < 0.0437$), but no difference between the groups at 1 year. The severity of impairment of physical activities decreases significantly after TAPP ($P < 0.001$). Preoperatively, the severity of impairment was VAS 15.2 ± 23.7

(HW), 15.6 ± 23.5 (MW), 16.9 ± 22.6 (LW), and 11.9 ± 19.1(TLW), and went down to VAS 0.5 ± 5.7, 0.5 ± 6.1, 0.4 ± 4.2 and 0 postoperatively. At 4 weeks, the severity of impairment in all three treatment groups was significantly less than in the HW group (1.1–2.2 vs. 3.6; $P < 0.027$), but after 1 year there was no longer any significant difference.

Seroma formation

No significant difference in detectable seroma formation was found between the four groups, either early postoperatively (HW 16.7%, MW 26%, LW 22.7%, TLW 16%) or in the later postoperative course.

Discussion

Aasvang and Kehlet [27] analysed 35 studies of at least 100 patients and a follow-up assessment of at least 6 months and found that 12% of patients undergoing hernia repair had chronic pain. In a recently published systematic review of 29 studies including mesh repairs only (open and laparoscopic), Nienhuijs et al. [28] showed that chronic pain had an incidence of 11%, and was regarded to be mild for 74%, moderate for 17%, moderate/severe for 1%, and severe for 8% of patients. Nienhuijs found two risk factors for the development of chronic pain after inguinal hernia repair: open surgical technique and the use of HW meshes. Regarding long-term pain, the RCT presented here does not confirm Nienhuijs conclusion. Chronic pain at 1 year after surgery was complained of by 2–8% of patients depending on the kind of physical activity being carried out; however, no statistically significant difference was found between the four mesh groups. According to the pain classification published by Fujita et al. [29], most patients regarded their pain as mild (VAS < 40). This very low incidence and severity of chronic pain found in the presented study compared with most results reported in the literature could be due mainly to (1) the abundant experience at our centre in TAPP, which has been carried out with a meticulous and continuously refined technique for years [22] strictly preserving the preperitoneal fascia and so protecting the underlying nerve structures [25], as discussed below; and (2) the use of a non-invasive fixation technique for the meshes using fibrin glue.

In agreement with the review published by Nienhuijs et al. [28], a large number of studies demonstrate less pain after laparoscopic hernia repair when compared to open [21].

A meta-analysis by Schmedt et al. [30] found the incidence of chronic pain to be 7.6% after laparoscopic or totally extraperitoneal repair, and 12.5% after a Lichtenstein procedure. The aim of the present RCT was to investigate if there is still some room for improvement when using lightweight meshes. Meanwhile, one meta-analysis [31] and 16 RCTs have been published comparing heavyweight vs lightweight meshes, 10 (8 studies) in open surgery [7–14] and 6 in laparoscopic repair [15–20]. In most studies, a standard polypropylene mesh (weight 80–110 g/m^2) was compared to a lightweight composite mesh that consisted of non-absorbable polypropylene (27–30 g/m^2) and absorbable polyglactin fibres in equal parts, with the exception of one study [11] in which a lightweight titanium-coated mesh of 35 g/m^2 was employed in the study group, another [13] that used a pure lightweight polypropylene mesh of 43 g/m^2, and a third [14] using a lightweight pure polypropylene mesh of 36 g/m^2. The results were controversial and limited; in laparoscopic surgery only two studies [19, 20] had a follow-up of longer than 3 months. In the short term (up to 3 months), similar to the results of our study, there are advantages in favour of LW meshes with regard to physical fitness [17], concerning daily activities [15], general health and bodily pain [16], and in one study with regard to pain [18]. However, after 1 year, neither Chowbey et al. [20] nor Chui et al. [19] found any significant advantages regarding chronic pain, but Chui et al. [19] reported significantly less foreign body sensation in the groin with the lightweight mesh. The reasons for these rather diffuse results (a similar lack of clarity is found after open repair [7–14]) are manifold: most study groups compared are too small, and thus have limited statistical significance; additionally, in some studies, patient populations are heterogeneous and the follow-up is too short. Furthermore, in all these cited studies, insufficient or no information is given regarding mesh fixation. According to Taylor et al. [32], invasive fixation of the mesh with clips or tacks might be a significant risk factor for developing chronic pain. In the present RCT, all meshes were fixed with fibrin glue. Thus, pain caused by nerve damage or tissue compression produced by invasive fixation devices can be excluded completely. Kathkouda [33] was the first to show that non-invasive fixation with fibrin glue is effective in inguinal hernia repair. Recently published clinical RCTs [34–36] confirm Kathkouda's results and further prove that patients with glue fixation experience a lower incidence of chronic pain.

Remarkably, Chowbey et al. [20] observed a significantly higher recurrence rate in their patients with a lightweight and unfixed mesh. In our study, which included patients with hernia openings of 3–5 cm, recurrence rates were low, at between 0 (MW, LW), 0.7% (HW) and 1.4% (TLW) with no significant differences between groups, but the three recurrences we saw were located medially.

The RCT presented here highlights two important results: firstly, frequency and intensity of chronic pain were remarkably low, as discussed above, and secondly,

although there may be some advantages in favour of lightweight meshes during the early postoperative period, at 1 year after surgery no significant differences were found between the HW group and the MW, LW, and TLW groups. It is generally accepted that chronic groin pain seen postoperatively after hernia surgery with implantation of a mesh may be due to the involvement of inguinal nerves in scar tissue produced by the foreign body reaction [6]. Anatomical studies have shown that the preperitoneal space consist of a visceral (approaching the peritoneum) and a parietal (neighbouring the abdominal wall) compartment separated by a thin fascial layer (spermatic or lumbar). The nerves are located behind this fascia and thus are in some way protected against the inflammatory foreign body reaction [25] when, as in TAPP, the operation is carried out in the visceral compartment only. This may be quite different from open surgery where the nerves are not infrequently relatively unprotected and fully exposed to the mesh. This different anatomical situation might explain in part the lower pain experienced after TAPP compared to open surgery that is seen in the literature, and might explain why there is no significant difference between the heavyweight mesh and the lightweight meshes at 1 year after repair as shown in the present study.

In summary, the RCT presented here shows that, after laparoscopic hernia repair (TAPP), the intensity and frequency of chronic pain are very low, independently of the type of mesh implanted and using a non-invasive fixation technique with fibrin glue. In accordance with most reports in the literature, the study proves that implantation of material-reduced meshes may be able to improve the comfort of the patient during the early postoperative period, but the type of mesh does not play a significant role regarding frequency and intensity of long-term complaints after inguinal hernia repair. The results allow the conclusion that, regarding patient comfort during the early postoperative period, the selection of material-reduced meshes may improve recovery in patients, but in the long term no significant difference between results for the use of meshes of different weight can be found.

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