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Laparoscopic repair is superior to open techniques when treating primary groin hernias in women: a nationwide register-based cohort study

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Abstract

Background Few studies have described recurrence rates after groin hernia repair in women. Our aim was to investigate if laparoscopic repair of primary groin hernias in women results in a lower reoperation rate for recurrence compared with open repairs. Furthermore, we wished to compare hernia subtypes at primary repair and reoperation.

Methods This nationwide cohort study was reported according to the RECORD statement. We used prospectively collected data from the Danish Hernia Database to generate a cohort of females operated for a primary groin hernia from 1998 to 2017. Our primary outcome was reoperation for recurrence. The secondary outcome was subtype of hernia at primary repair and reoperation. All females had at least 6-month follow-up.

Results We included 13,945 primary groin hernia operations in women, of whom 649 had undergone a reoperation for recurrence. Median follow-up time was 8.8 years. The cumulative reoperation rates were lower after laparoscopic repair compared with the open techniques, for both inguinal hernias (1.8 vs. 6.3%, $p < 0.001$) and femoral hernias (2.2 vs. 5.5%, $p = 0.005$). After laparoscopic repair, 25% of inguinal hernias recurred as femoral, compared with 47% after Lichtenstein ($p < 0.001$). Direct inguinal hernias and femoral hernias had higher risk of reoperation for recurrence after open repair compared with indirect inguinal hernias. For laparoscopic procedures, hernia subtypes at the primary groin hernia repair had similar reoperation rates.

Conclusion Laparoscopic repair of primary groin hernia in women had lower reoperation rates and fewer femoral recurrences than open repair techniques.

Keywords Inguinal · Femoral · Hernia · Female · Surgery · Database

Women account for 8–16% of all groin hernias [1–3], resulting in approximately 2–3 million repairs yearly worldwide [4]. For many years, surgeons have considered recurrence as the main outcome when measuring the quality of groin hernia repair. Recurrence rates have been reported up to 6.3% after open repairs [5] and up to 6.5% after laparoscopic repairs [6] in populations including both sexes. The rarity of female patients with groin hernias, combined with recurrence as a relatively rare outcome, makes it difficult to study the effect of surgical technique on recurrence rates in women in randomized controlled trials. Thus, no such trial has been performed. For this reason, prospectively registered, nationwide databases are useful when assessing this subject.

Recurrence rates differ between men and women. Large-population studies from Denmark and Sweden have reported that recurrence rates in women are lower after laparoscopic repair compared with open repair [7–10], which seems to be the opposite in men [8, 9]. Studies have also reported that after primary inguinal hernia repairs in women, 22–67% of the recurrent hernias were femoral [7–12]. In men, the same studies found this percentage to be only 5–7% [9–11]. However, the majority of these studies were published before 2007 without reporting nationwide data on both inguinal and femoral hernias in women.

Our aim was to investigate if laparoscopic repair of primary groin hernias in women results in a lower reoperation rate for recurrence compared with open repairs. Our

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secondary aim was to compare hernia subtypes at primary and recurrent operation.

Methods

This nationwide cohort study has been reported according to the RECORD statement [13]. The study is based on data from the Danish Hernia Database, which has been described in detail elsewhere [14]. In short, the database contains prospectively registered data from groin hernia repairs throughout Denmark since 1998. The database covers more than 98% of all groin hernia repairs in Denmark, and each year approximately 10,000 groin hernia operations are registered. Immediately after repair, the surgeon registers perioperative data including patient characteristics, hernia type, method of repair, anesthesia, and admission status. Furthermore, each patient is registered through a unique personal identification number [15], which makes it possible to follow reoperations from all public and private hospitals throughout Denmark, even if a reoperation is performed at another department.

From the hernia database, we extracted data of all women with groin hernia repairs from January 1, 1998 to December 1, 2017. The inclusion criteria were women ≥ 18 years of age undergoing surgical repair of a primary groin hernia. Therefore, we excluded all men and patients < 18 years of age. We also excluded surgical procedures with less than 15 operations, e.g., Onstep and robot-assisted laparoscopy, as well as reoperations where the primary operation had not been registered in the database. We excluded all primary repairs performed after June 1, 2017, ensuring that all patients had at least 6 months of follow-up. A bilateral groin hernia, i.e., surgery in both groins, was considered as two separate repairs. The selection of participants is presented in Fig. 1.

Our primary outcome was reoperation for recurrence. The secondary outcome was type and subtype of hernia at both primary and reoperation. Reoperation was considered as a subsequent groin hernia repair in the same groin as the primary operation, regardless of hernia type. If no hernia was found at reoperation, it was not considered a recurrence. We registered type (inguinal, femoral, or combined inguinal/femoral) and subtype of inguinal hernia (indirect, direct, or pantaloon). We also registered type of inguinal hernia repair (laparoscopic, Lichtenstein, other open mesh, or open non-mesh) as well as type of femoral hernia repair (laparoscopic, infraligamental, or combined supra-/infraligamental). All cases with unclear registration of method of repair were excluded. When analyzing crude reoperation rates and multivariate regression models, we categorized a combined femoral/inguinal hernia as an inguinal hernia because type of repair for combined hernias was registered as inguinal procedures. When comparing hernia subtypes at primary and reoperation, we considered any hernia with a femoral component as a femoral hernia, ensuring that the percentage of femoral recurrences after a primary inguinal hernia repair was not overestimated. Data from groin hernias found at a third or later operation were not included in the analyses. Follow-up time was defined as time from primary operation until December 1, 2017.

Statistical methods

Analyses were performed using SPSS version 22 (SPSS Inc., Chicago, USA). We used Kaplan–Meier curves to illustrate

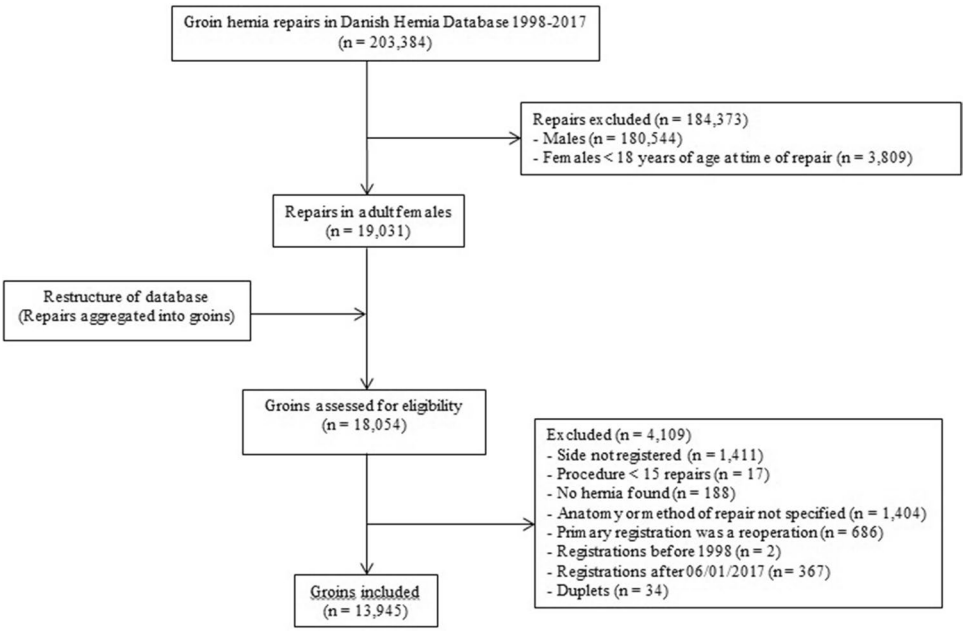

Fig. 1 Flowchart illustrating selection of participants

cumulative reoperation rates, and log-rank was used to determine statistical significance. We used Pearson's χ^2 test to compare crude reoperation rates (reoperations/total repairs) as well as differences between groups. We used Cox regression for multivariate analyses to further evaluate the risk of reoperation. The multivariate analyses were fitted with covariates that may have influenced the risk of reoperation, using backwards step approach, only including variables with $p < 0.2$. We considered statistical significance when $p \leq 0.05$.

The authors had full access to all relevant data in the Danish Hernia Database. We used SPSS to sort data, and we did not link our data with other databases. This study was approved by the Danish Data Protection Agency (Journal No. 2012-58-0004). According to Danish Law, no approval from The Ethics Committee was required.

Results

We included 13,945 primary groin hernia repairs. The selection process is presented in Fig. 1, and patient characteristics are presented in Table 1. An indirect inguinal hernia was the most common hernia type (49%), followed by direct hernias (25%) and femoral hernias (23%). Laparoscopic procedure has been the most common technique in women in the past 7 years. Figure 2 shows the distribution of open and laparoscopic techniques for all groin hernias in Denmark from 1998 to 2017. In this period, surgeons used mesh in 84% of the open inguinal hernia repairs. The majority of operations were performed in general anesthesia, and Fig. 3 shows the development of anesthesia methods in groin hernia repair in women from 1998 to 2017. The majority of the reoperations were elective (86%). The median follow-up was 106 months (range 6–238).

Reoperation rates

Of 13,945 primary groin hernia repairs, 649 had a registered reoperation for recurrence. Crude reoperation rates are presented in Table 2. For inguinal and combined hernias, the crude reoperation rate was lowest after laparoscopic repair, 1.8%, compared with 6.8% after Lichtenstein ($p < 0.001$). There were no significant differences in crude reoperation rates between the open mesh and non-mesh techniques ($p = 0.659$). For femoral hernia repairs, laparoscopic approach had the lowest crude reoperation rate, 2.4%, compared with 6.5% after combined supra-/infraligamental approach ($p < 0.001$). As for the inguinal hernias, there were no significant differences between the open techniques for femoral hernias ($p = 0.165$). The cumulated reoperation rates are presented as Kaplan–Meier curves in Fig. 4A, B. The cumulated reoperation rate was 1.8% after laparoscopic inguinal hernia repair, compared with 6.2% after open repairs ($p < 0.001$). For femoral hernias, the cumulated reoperation rate was 2.2% after laparoscopic

Table 1 Patient and hernia characteristics

	Primary operation ($n = 13,945$)	Reoperation ($n = 649$)
Patient, median (range)		
Age, years	63 (18–105)	61 (20–95)
Follow-up, months	106 (6–238)	142 (8–238)
Time to recurrence, months		16 (0–227)
Admission, *n* (%)		
Elective	12,047 (86%)	534 (82%)
Acute	1898 (14%)	71 (11%)
Not registered	0 (0%)	44 (7%)
Hernia type, *n* (%)		
Inguinal	10,355 (74%)	333 (51%)
Femoral	3136 (23%)	241 (37%)
Combined[a]	454 (3%)	31 (5%)
Not registered	0 (0%)	44 (7%)
Subtypes[b], *n* (%)		
Indirect	6810 (63%)	144 (40%)
Direct	3518 (32%)	189 (52%)
Pantaloon	279 (3%)	12 (3%)
Not specified	202 (2%)	19 (5%)
Method of repair, *n* (%)		
Inguinal		
Laparoscopic[c]	4340 (40%)	202 (55%)
Lichtenstein	4792 (44%)	100 (28%)
Other open mesh[d]	663 (6%)	34 (9%)
Open non-mesh[e]	1014 (10%)	21 (6%)
Not registered	0 (0%)	7 (2%)
Femoral		
Laparoscopic[c]	1247 (40%)	105 (44%)
Infrainguinal[f]	1058 (34%)	72 (30%)
Supra-/infrainguinal[g]	831 (26%)	42 (17%)
Not registered	0 (0%)	22 (9%)
Anesthesia, *n* (%)		
Local	1421 (10%)	21 (3%)
Regional	607 (4%)	18 (3%)
General	11,917 (86%)	556 (87%)
Not registered	0 (0%)	44 (7%)

[a]Combined inguinal and femoral hernia

[b]Subtypes of inguinal and combined hernias

[c]99% transabdominal preperitoneal (TAPP), 1% totally extraperitoneal (TEP)

[d]22% plug, 38% plug and patch

[e]58% annuloraphy, 19% Bassini, 10% McVay, 9% Shouldice

[f]91% plug repair

[g]53% McVay with mesh, 34% McVay without mesh

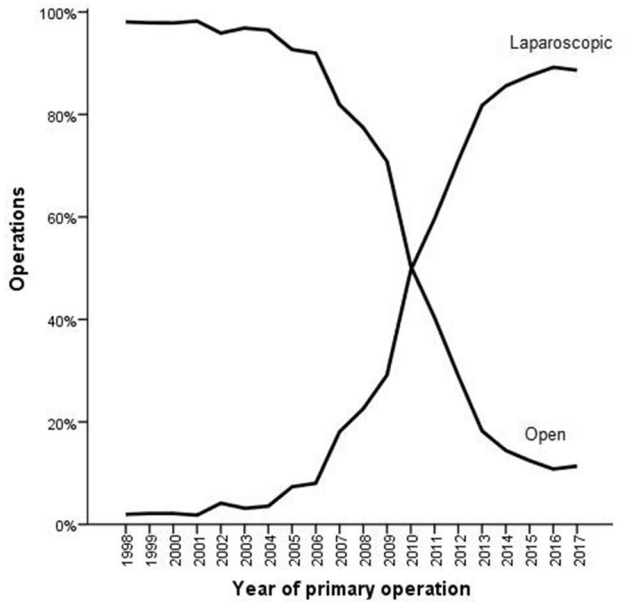

Fig. 2 Prevalence of laparoscopic and open groin hernia repairs in Denmark 1998–2017

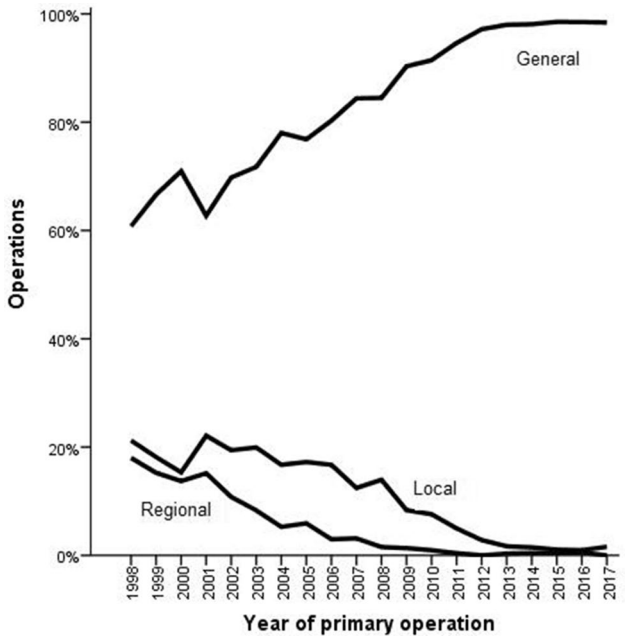

Fig. 3 Prevalence of type of anesthesia for groin hernia repairs in Denmark 1998–2017

repair, compared with 5.5% after open repairs ($p = 0.005$). There were no differences in cumulated reoperation rates between open repair methods for neither inguinal nor femoral hernias, $p = 0.372$ and $p = 0.170$.

Table 2 Crude reoperation rates after different types of repair

Type of repair	Operations, *n*	Reoperations, *n*	Reoperation rate, % (95% CI)
Inguinal and combined[a]			
Laparoscopic repair	4340	77	1.8 (1.4–2.2)
Lichtenstein	4792	327	3.8 (6.1–7.5)
Other open mesh	663	39	5.9 (4.1–7.7)
Open non-mesh	1014	69	6.8 (5.3–8.4)
Total	10,809	512	4.7 (4.3–5.1)
Femoral			
Laparoscopic	1247	30	2.4 (1.6–3.3)
Supra-/infrainguinal	831	54	6.5 (4.8–8.2)
Infrainguinal	1058	53	5.0 (3.7–6.3)
Total	3136	137	4.4 (3.7–5.1)

CI 95% confidence interval

[a]Combined inguinal and femoral hernia

Hernia types at primary and reoperation

Types and subtypes of primary and recurrent hernias are presented in Table 3. Types and subtypes of hernia were registered at both primary and recurrent operation in 89% (578/649) of groins. A total of 44% of the groin hernias recurred as another hernia type. After primary inguinal hernia repair, the laparoscopic approach had the lowest percentage of femoral recurrences, 25% (14/55), compared with Lichtenstein that had the highest percentage, 47% (141/298) ($p = 0.003$). Among the recurrences after primary femoral hernia repairs, 44% (57/131) recurred as inguinal hernias. For these inguinal recurrences, there were no differences between methods of repair ($p = 0.513$). The majority of inguinal recurrences after primary femoral hernia repair were direct, 65% (37/57).

Risk factors associated with reoperation for recurrence in women

Table 4 presents risk factors associated with reoperation for recurrence after all types of groin hernia repair, while Table 5 only presents risk factors associated with open repairs. The multivariate models are adjusted for age, side, and hernia subtype. Furthermore, the model used in Table 4 is adjusted for method of repair (open vs. laparoscopic). Neither year of operation nor elective versus acute admission were significant covariates in any of the models. Overall, open techniques had significantly higher risk of reoperation for recurrence compared with laparoscopic technique, hazard ratio (HR) = 2.47 ($p < 0.001$). In both models, there was an increased HR after direct

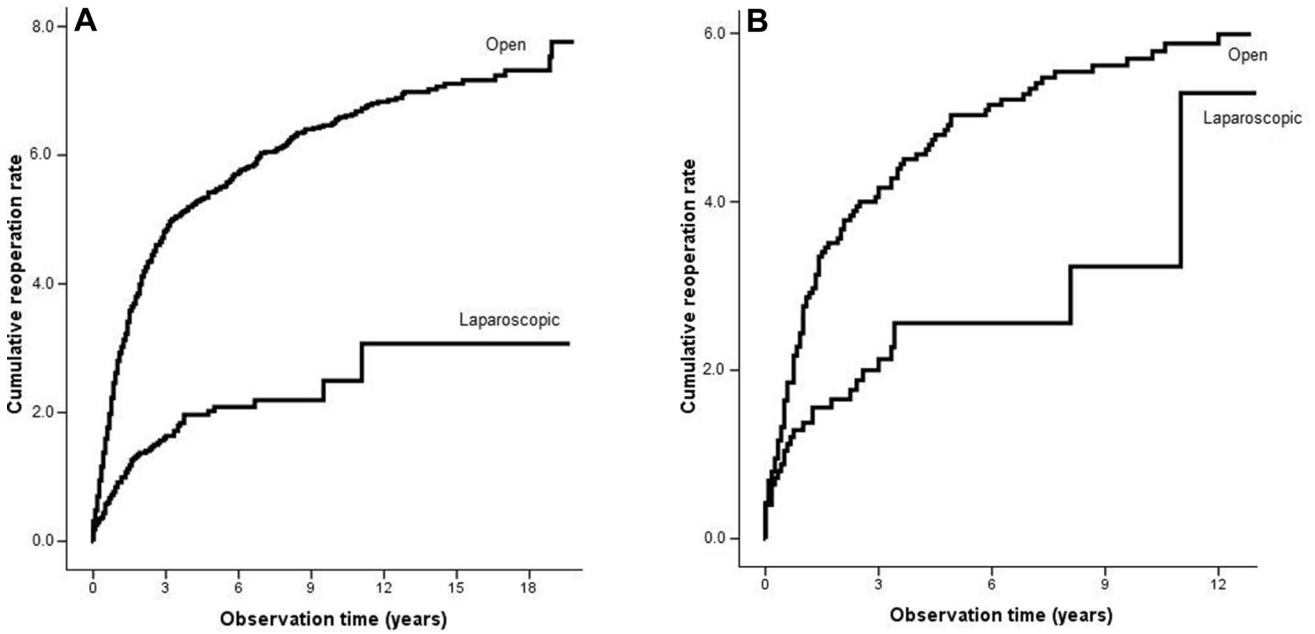

Fig. 4 **A** Kaplan–Meier plot showing cumulative reoperation rate after inguinal hernia repair in females, subdivided on laparoscopic- and open repairs. Laparoscopic repair had a significantly lower cumulative reoperation rate ($p < 0.001$). There were no significant difference in cumulative reoperation rate between open mesh repairs and open non-mesh repairs. **B** Kaplan–Meier plot showing cumulative reoperation rate after femoral hernia repair in females, subdivided on laparoscopic and open repairs. Laparoscopic repair had a significantly lower cumulative reoperation rate ($p = 0.005$). There were no significant differences in cumulative reoperation rate between open mesh repairs and open non-mesh repairs

Table 3 Hernia subtypes during primary repair and reoperation registered in the Danish Hernia Database

Primary operation (*n*)	Reoperation (*n*)				
	Indirect	Direct	Femoral	Pantaloon	Total
Indirect	56	46	96	5	203
Direct	56	84	98	2	240
Pantaloon	0	3	1	0	4
Femoral	17	37	74	3	131
Total	129	170	269	10	578

Any hernia with a femoral component was classified as a femoral hernia

Table 4 Cox multivariate analysis of risks of reoperation for recurrence after primary groin hernia repair in females

	Hazard ratio (95% CI)	*p* value
Age	0.99 (0.98–0.99)	< 0.001
Method of repair		
Laparoscopic	1 (ref)	
Open	2.47 (1.99–3.04)	< 0.001
Hernia subtype		
Indirect	1 (ref)	
Direct	2.20 (1.84–2.63)	< 0.001
Pantaloon	0.63 (0.26–1.52)	0.300
Femoral	1.33 (1.07–1.64)	0.009
Side		
Right	1 (ref)	
Left	0.88 (0.75–1.03)	0.103

The model is adjusted for age, groin side, hernia type, and method of repair (open versus laparoscopic). Year of primary operation and emergent versus elective repair did not contribute significantly to the model ($p > 0.20$) and were removed using a backward stepwise approach

inguinal and femoral hernia repair compared with indirect hernia repair. In a Cox regression multivariate analysis only including laparoscopic procedures, there were no significant differences in HRs between hernia types and subtypes. In fact, none of the covariates adjusted for in the other models were significant for the laparoscopic technique.

Overall, we found a slightly lower risk of reoperation with increasing age, HR = 0.99 ($p < 0.001$). In the multivariate model including all open procedures, regional anesthesia had a lower risk for reoperation compared with general anesthesia, HR = 0.50 ($p = 0.002$). There were no significant

Table 5 Cox multivariate analysis of risks of reoperation for recurrence after primary open groin hernia repair in females

	Hazard ratio (95% CI)	*p* value
Age	0.99 (0.98–0.99)	< 0.001
Hernia subtype		
Indirect	1 (ref)	
Direct	2.35 (1.93–2.85)	< 0.001
Pantaloon	0.47 (0.15–1.49)	0.200
Femoral	1.26 (0.99–1.61)	0.059
Side		
Right	1 (ref)	
Left	0.88 (0.74–1.04)	0.141
Anesthesia		
General	1 (ref)	0.005
Local	0.88 (0.70–1.11)	0.273
Regional	0.50 (0.32–0.77)	0.002

The model is adjusted for age, groin side, hernia type, and method of anesthesia. Year of primary operation, emergent versus elective repair, and method of open repair did not contribute significantly to the model ($p > 0.20$) and were removed using a backward stepwise approach

differences between local anesthesia and general anesthesia ($p = 0.273$).

Discussion

We found that reoperation rates were lower after laparoscopic repair compared with open repairs for women undergoing groin hernia repair. Furthermore, we found that after primary repair for an inguinal hernia, the percentage of femoral recurrences were lower after laparoscopic repair compared with open repair methods. For open procedures, risk factors associated with reoperation for recurrence were direct inguinal hernias, femoral hernias, general anesthesia, and a lower age. For laparoscopic procedures, there were no significant differences in risks of reoperation between hernia subtypes at primary operation. In a multivariate model, open repair methods had a significantly increased risk of reoperation for recurrence compared with laparoscopic procedures.

Our finding that laparoscopic repairs had a lower risk of reoperation compared with open procedures is in line with previous studies from the Swedish Hernia Database [8, 9]. This finding supports the recommendations from the European Hernia Society [16] and the HerniaSurge Group [17] that primary groin hernias in female patients should be treated laparoscopically. Since no randomized clinical trial has addressed recurrences after groin hernia repair in women, reoperation rates in large database studies like this present study are useful to compare reoperation rates among different methods of repair.

We found that 44% of hernias that were registered as inguinal at the primary operation recurred as femoral. This percentage was lower after laparoscopic repair compared with both the Lichtenstein repair and other open repair methods. Previous studies have reported that 22–67% of hernia recurrences after open inguinal hernia repairs actually were femoral recurrences [7–12]. A small amount of studies have discussed whether previous open inguinal hernia repair may facilitate the formation of a femoral hernia, where one study reported postsurgical anatomical changes in the groin after open repair (in the areas of Hesselbach's and Hessert's triangles, as well as the hernia orifices) [18]. However, a more likely explanation is probably that mesh placement in laparoscopic repair covers all three orifices in the groin, thereby treating all types of groin hernias. A number of studies support this explanation, where one study reported that a synchronous femoral hernia was found in 37% of females during laparoscopic repair for an inguinal hernia [19]. Another study found unsuspected femoral hernias in 38% of women after recurrent inguinal hernia repair compared with only 7% in men [20]. A previous study from the Danish Hernia Database found a 15-fold higher incidence of femoral hernia repair in patients with a previous open inguinal hernia repair, compared with the rate of femoral hernia repair in the general population [21]. Furthermore, the femoral hernia recurrences occurred earlier than the inguinal hernia recurrences, indicating that a femoral hernia might have been overlooked at the primary operation. Another study from the Danish Hernia Database, found that all 116 femoral recurrences after primary inguinal hernia repair happened after open techniques, and found no femoral recurrences after laparoscopic approach [7]. In our updated data, we found 14 femoral recurrences after 55 laparoscopic recurrent inguinal hernia repairs. The laparoscopic technique is newer than the open methods, and the shorter follow-up time in previous studies may have been too short to detect recurrences after laparoscopic repair. A Swedish study showed similar reoperation rates after the use of Lichtenstein and open preperitoneal repair, where the latter should detect a femoral hernia if present [9]. One should notice that in the Swedish study, the open preperitoneal method had more acute procedures than the Lichtenstein repair, which theoretically could explain the similar reoperation rates. However, a systematic review did not find differences in recurrence rates between acute and elective admissions [22]. Even so, the most likely explanation to the lower number of femoral recurrences after laparoscopic repair compared with open repairs is the simultaneous coverage of both the inguinal and the femoral orifices with a mesh.

The main strength of our study is the large number of females with primary groin hernia repair. The Danish Hernia Database consists of prospectively registered data, registered immediately after the hernia repair by the surgeon

with an almost complete nationwide registration, ensuring a high quality of data with low risk of recall bias and non-respondent bias. Another strength is the long follow-up time and the possibility to follow patients reoperated at another department. One study found that 26% of patients with a previous groin hernia were reoperated for their recurrence at a different healthcare facility [23] but this had no influence on our data because of the nationwide study design. Using national data over a 20-year period should minimize the potential local institution and surgeon bias. Thereby, the study has a very high external validity. There are some limitations to consider. Laparoscopic procedures have a shorter follow-up time, because this technique is newer. However, the median follow-up time for laparoscopic procedures in this study was 46 (6–236) months, and previous studies have shown that the majority of recurrences after laparoscopic repair are likely to occur within the first year [24, 25]. Another limitation to consider is the possible influence of the surgeons' experience, which may influence the recurrence rate, especially if there is an imbalance between the techniques. In one study, the cumulative risk of recurrence was lowered from 3.5 to 2.4% when excluding one surgeon responsible for a large number of recurrences after laparoscopic repair [24]. In the Danish Hernia Database, it is not possible to link the individual surgeon to a procedure, and thereby analyzing each surgeon's contribution (or the experience level) to recurrence rates. However, this feature has been implemented in 2016, making it possible in the future. In this study, we used reoperation as an estimate for recurrence, which is an underestimation since the actual recurrence rate is up to 40% higher [26]. However, we have no reason to believe that this should differ between laparoscopic and open surgery and between different hernia subtypes.

In conclusion, we found that laparoscopic technique was superior to open procedures, based on reoperation for recurrence after primary groin hernia repair in women. We found a larger percentage of femoral recurrences after primary open inguinal hernia repairs compared with the laparoscopic approach. Based on reoperation rates, laparoscopic procedure is the optimal type of repair for primary groin hernias in women.

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Compliance with ethical standards

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