

Review Article

Reorganising groin hernia surgery and training in the era of minimally invasive dominance

Jacob Rosenberg^{1, 2, 3}, Nadia A. Henriksen^{2, 3, 4}, Kristoffer Andresen^{1, 3}, Mette W. Christoffersen^{2, 3, 5}, Martin S. Kobborg^{3, 6}, Marie Kirk^{3, 7}, Marianne Krogsgaard^{3, 5, 8}, Lene Pejtersen^{3, 9}, Thorbjørn Sommer^{3, 10}, Nina Wensel^{3, 11}, Nellie B. Zinther^{3, 12} & Frederik Helgstrand^{2, 3, 5}

1) Department of Surgery, Copenhagen University Hospital – Herlev Hospital, 2) Department of Clinical Medicine, University of Copenhagen, 3) Danish Hernia Database, 4) Digestive Disease Center, Copenhagen University Hospital – Bispebjerg Hospital, 5) Department of Surgery, Zealand University Hospital, Koege, 6) Department of Surgery, Odense University Hospital, 7) Department of Surgery, Regional Hospital Viborg, 8) Department of People and Technology, Roskilde University, 9) Private Surgical Clinic, Surgical Clinic Svendborg, 10) Department of Surgery, Moelholm Private Hospital, Vejle, 11) Department of Gastrointestinal Surgery, North Denmark Regional Hospital, Hjoerring, 12) Department of Surgery, Regional Hospital Horsens, Denmark

Dan Med J 2026;73(9):A03260230. doi: 10.61409/A03260230

ABSTRACT

Groin hernia surgery has shifted from a common training procedure to a minimally invasive subspecialty dominated by laparoscopic approaches. In Denmark, open repair has declined sharply. The resulting volume and competence paradox, together with reduced training exposure, creates a mismatch between contemporary practice and the traditional expectation of universal competence in open groin hernia repair. We argue that this expectation is no longer realistic and propose centralisation, subspecialisation and revision of training models to ensure quality and patient safety.

KEY POINTS

- Groin hernia surgery is now predominantly laparoscopic, and open repair is rare in elective practice.
- Training exposure to open repair is declining, threatening future emergency competence.
- Universal proficiency in open repair is no longer realistic.
- Procedural volume per surgeon has fallen below recognised maintenance-of-competence thresholds for a substantial proportion of surgeons.
- Centralisation and subspecialisation are needed to maintain quality and safety, but the disadvantages and trade-offs of this transition must be addressed.

Groin hernia repair has long been regarded as a foundational operation and a core component of surgical training. This reflects an era of open repair dominance, with high case volumes per surgeon. Over the past three decades, the field has changed. Minimally invasive techniques - particularly totally extraperitoneal and transabdominal preperitoneal repair (TAPP) - now dominate elective practice in many high-income countries, consistent with international guidelines [1]. Denmark is among the most advanced examples of this transition, with 86% of elective groin hernia repairs now being performed laparoscopically as TAPP or TAPP-robot

procedures (**Figure 1** and **Table 1**). Open procedures (Lichtenstein repairs) are largely confined to selected complex cases and a limited number of emergency repairs, often performed by surgeons with limited recent experience in elective hernia surgery.

FIGURE 1 National trends in proportions of elective groin hernia repair procedures in Denmark, 2001-2026, stratified by surgical approach (Lichtenstein open repair, transabdominal preperitoneal (TAPP) repair, TAPP-robot repair). Source: Danish Hernia Database. The total annual volume has increased from approximately 7,000 procedures in 2001 to more than 11,600 in 2025. In the same period, the absolute number of elective open Lichtenstein repairs has fallen from approximately 6,500 to approximately 2,100, whereas laparoscopic procedures (TAPP- and TAPP-robot repair combined) have grown to account for the dominant share of activity. The figure demonstrates the proportional scale of the change, with major implications for surgical training and maintenance of competence in open techniques.

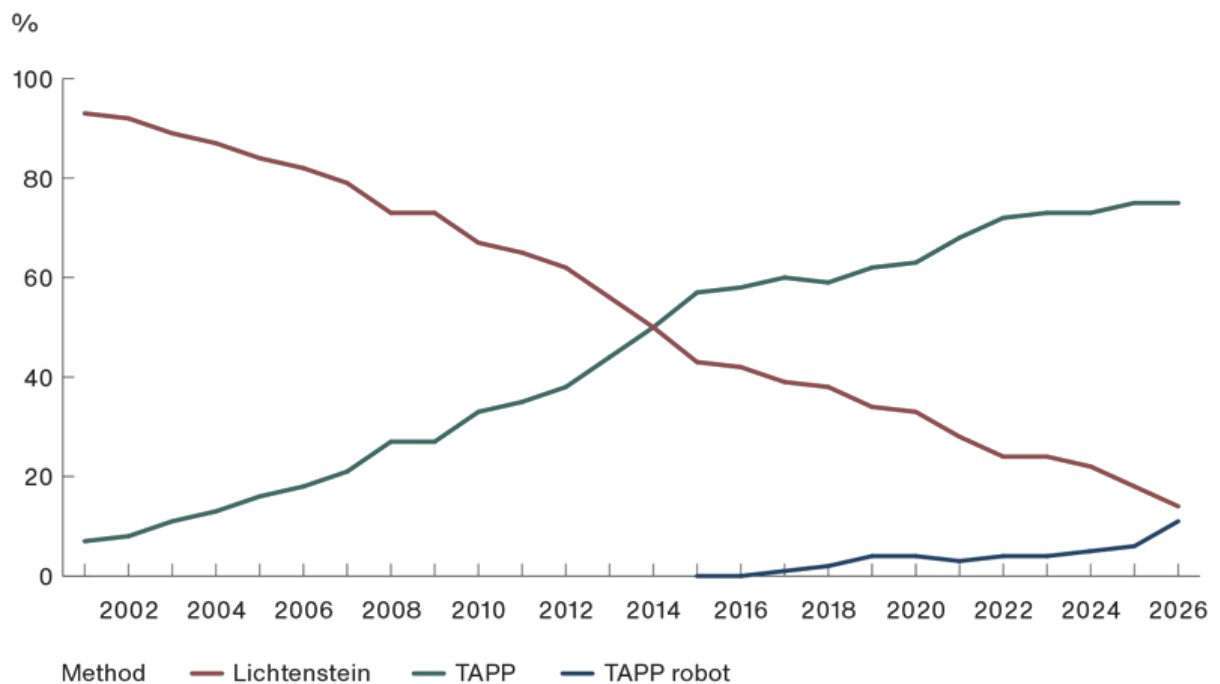


TABLE 1 Number of operative procedures per year for groin hernia using the open Lichtenstein technique and the two minimally invasive options: laparoscopic transabdominal preperitoneal (TAPP)- and robot-assisted TAPP repair.

	Lichtenstein	TAPP	TAPP-robot
2001	6,532	526	0
2002	7,179	611	0
2003	7,675	940	0
2004	6,908	1,073	0
2005	6,940	1,354	0
2006	6,825	1,461	0
2007	6,709	1,768	0
2008	5,444	2,005	0
2009	5,859	2,167	0
2010	5,737	2,841	0
2011	5,573	3,040	0
2012	5,238	3,174	0
2013	4,837	3,817	0
2014	4,348	4,373	0
2015	3,895	5,171	1
2016	3,774	5,268	0
2017	3,586	5,502	74
2018	3,260	5,025	189
2019	2,864	5,212	320
2020	2,807	5,303	324
2021	2,342	5,646	282
2022	2,358	6,979	347
2023	2,684	8,319	404
2024	2,400	8,121	532
2025	2,125	8,770	729

Many trainees complete their education with minimal exposure to open groin hernia repair and some even to laparoscopic repair. Moreover, some departments already struggle to ensure adequate expertise in open groin hernia during emergency duty hours. Furthermore, many surgeons may fall below recognised thresholds for maintaining competence [2]. We consider this volume-outcome relationship the primary rationale for reorganisation, whereas declining training exposure is a secondary concern.

This paper examines the implications of the shift toward minimally invasive groin hernia repair for surgical training and service organisation, and proposes considerations for a new national strategy.

Learning curves, maintenance of competence, and procedural volume

Laparoscopic groin hernia repair has a well-documented learning curve [2, 3]. Achieving proficiency requires structured training, supervision and sufficient case volume. A landmark study found that > 250 procedures may be required to stabilise recurrence rates [4]. Recent Danish data emphasised that > 100 procedures per surgeon per year were required to lower recurrence reoperation rates in both Lichtenstein and laparoscopic procedures [5]. This maintenance threshold is therefore the key measure when assessing whether an organisational structure is sustainable.

In the present discussion, reconsideration of groin hernia training applies primarily to open repair, where the decline in case volume is most pronounced. Laparoscopic repair remains relevant in general surgical training, but only for trainees with realistic access to a sufficient volume of supervised cases, as discussed further below in relation to core surgical competencies.

Organisational implications

In many healthcare systems, the current model of groin hernia surgery involves distributed activity across numerous hospitals and surgeons. While this model might be appropriate in an era of high open-repair volumes, it may be less suitable in the current context of minimally invasive dominance. We previously recommended that the hernia surgeon in the elective setting can perform a minimally invasive TAPP repair, Lichtenstein repair, Marcy repair or modified Lichtenstein repair for occasional open femoral hernia repairs [6], but this is obviously no longer the case for all surgeons.

A simple volume-based calculation illustrates the maintenance-of-competence problem. In 2025, approximately 2,125 elective open Lichtenstein repairs were performed in Denmark by 488 surgeons. At a maintenance threshold of 100 procedures per surgeon annually [5], this volume can sustain competence in only about 20 surgeons. The same applies to laparoscopic groin hernia repair: approximately 9,500 annual TAPP procedures performed by 530 surgeons in 2025 would sustain competence in only about 95 surgeons at the same threshold [5].

Several alternative organisational models can be considered. Centralising elective hernia surgery in high-volume units could ensure adequate procedural volume for both surgeons and trainees (by rotation). Emergency open repairs could be managed through regional specialist coverage or structured transfer pathways. Formal subspecialisation within hernia surgery [7] could support maintenance of competence and improve outcomes.

Based on existing literature and Danish procedural volumes, we propose defining a high-volume elective groin hernia centre as one performing at least 1,000 procedures annually. With around 11,600 elective procedures in Denmark, this corresponds to approximately 8-12 regional centres nationwide. This exceeds the five centres used for giant and parastomal hernia repair [8], reflecting the substantially higher volume of groin hernia surgery and the feasibility of multiple rather than a few regional centres. Denmark's relatively small population and coordinated healthcare system may facilitate the implementation of such models. Furthermore, our highly developed digital infrastructure and the Danish Hernia Database [9] enable close, comprehensive follow-up to monitor the quality of care nationwide.

Discussion

A speciality that outgrew its training model

Groin hernia surgery has evolved more rapidly than almost any other area of general surgery [10]. Over a single generation, it has transitioned from a training procedure to a technically demanding, largely minimally invasive

subspeciality in which outcomes are strongly linked to surgeon experience and procedural volume. The European Union of Medical Specialists has recognised abdominal wall surgery as a surgical speciality since 2021 [11]. Yet the training structures and organisational models governing this field still largely reflect an earlier era when open repair was common.

This mismatch is no longer sustainable. In Denmark, laparoscopic repair now accounts for the vast majority of elective groin hernia procedures [12]. This evolution follows international guidelines, which recommend minimally invasive repair as the first choice because it results in less post-operative pain. Open repair has not disappeared, but has become concentrated in emergency settings, recurrent cases and selected complex cases. As a result, many surgical trainees complete their education with limited exposure to open repair, and many departments already struggle to ensure that surgeons with sufficient open expertise are available during emergency duty hours.

Attempting to maintain universal competence in open groin hernia repair despite declining case volumes risks creating a system in which many surgeons perform too few procedures to maintain proficiency. The historical assumption that open groin hernia repair should remain a core procedure for all general surgeons [13, 14] must therefore be reconsidered. Continuing to uphold this expectation without providing the necessary caseload may pose a risk to patient safety.

The competence paradox

The central paradox of modern groin hernia surgery is that quality has improved, while maintaining competence has become more difficult. Minimally invasive techniques, standardised mesh repairs and registry-driven quality improvement have reduced recurrence rates and improved patient-reported outcomes [10]. At the same time, the number of open repairs performed in routine elective practice has declined to the point where maintaining competence across a broad surgical workforce has become unrealistic.

Evidence from hernia surgery and other surgical disciplines consistently shows that procedural volume is associated with outcomes [5, 15-18]. Surgeons and institutions performing higher volumes tend to achieve lower recurrence rates, fewer complications and better patient-reported outcomes. Together with the volume-based calculations above, this evidence suggests that many currently active surgeons must fall below recognised maintenance thresholds. We consider this the strongest argument for organisational change. The current distributed model, where many surgeons perform very few open repairs, may therefore be the least safe configuration. A more rational approach would be to concentrate expertise among surgeons who regularly perform these procedures and maintain high proficiency.

Redefining core surgical competencies

Training curricula must reflect contemporary clinical practice. In many healthcare systems, including Denmark, trainees may gain adequate experience in laparoscopic groin hernia repair but have very limited exposure to open techniques. Specifically, we argue that open groin hernia repair should no longer be regarded as a universal competency for all general surgical trainees, whereas laparoscopic repair should remain part of training only for trainees with realistic access to a sufficient volume of supervised cases.

Requiring all trainees to achieve competence in open repair may no longer be feasible or meaningful. Instead, a distinction should be made between competencies required of all general surgeons and those that should be reserved for surgeons with a dedicated hernia focus.

Such a shift would align surgical training with developments in other fields, where increasing complexity has led to subspecialisation and centralisation. It would also allow training programmes to focus resources on ensuring meaningful competence rather than superficial exposure. Importantly, redefining core competencies does not

imply lowering standards; rather, it recognises that maintaining high standards requires sufficient procedural volume and structured training environments.

Organisational implications: towards a new model

If open groin hernia repair is no longer a realistic universal competency, the organisation of care must change accordingly (Table 2). A model based on subspecialisation and centralisation offers several potential advantages.

TABLE 2 Recommendations for reorganisation and subspecialisation. Based on available evidence and the Danish context, several recommendations can be proposed for reorganisation and subspecialisation within hernia surgery.

<i>Reconsider training requirements</i> Open groin hernia repair should no longer be considered a mandatory competency for all surgical trainees Training in open repair should be concentrated among surgeons pursuing a dedicated hernia focus
<i>Establish formal hernia subspecialisation pathways</i> Structured pathways should be developed for surgeons specialising in hernia surgery, including defined case-volume requirements and ongoing maintenance of competence
<i>Centralise elective groin hernia surgery</i> Elective procedures should be concentrated in high-volume centres capable of supporting training, expertise and research Recommendations for case volume per surgeon should cover public as well as private hospitals
<i>Develop emergency coverage models</i> Emergency open repairs should be performed by surgeons with appropriate expertise through transfer pathways, or mobile specialist teams
<i>Use registry data to guide implementation</i> National registry data should be used to monitor outcomes, training exposure and workforce distribution during and after organisational changes are implemented
<i>Engage stakeholders</i> Successful implementation will require collaboration among surgical societies, hospital leadership and policymakers

Centralising elective groin hernia surgery at high-volume centres could ensure an adequate case volume for both surgeons and trainees on rotation. These centres could provide structured training environments and maintain

expertise in both minimally invasive and open techniques. Emergency open repairs could be managed through structured transfer pathways or mobile specialist teams. While these approaches would require organisational change, they would align service provision with a focus on patient safety and the realities of contemporary surgical practice.

A less radical alternative is to treat groin hernia surgery as a specialist domain within existing surgical departments rather than centralising activity into a few regional centres. Departments would maintain hernia activity only if defined surgeon volume thresholds were met, whereas a formal specialist on-call system would ensure that emergency open repairs were managed by experienced surgeons through cross-departmental coverage. We present this as a possible intermediate solution that may avoid some disadvantages of full centralisation while still addressing the maintenance-of-competence problem.

Denmark is positioned to lead such a transition. The Danish Hernia Database provides high-quality national data [9], and Danish hernia research has influenced international guidelines for decades. The relatively small size of the Danish healthcare system facilitates coordinated national strategies and their impact evaluation. A carefully planned reorganisation of groin hernia surgery in Denmark could therefore serve as a model for other countries facing similar challenges, as well as for other selected surgical procedures.

Disadvantages and trade-offs of centralisation

Proposals to centralise groin hernia repair must acknowledge important trade-offs. Denmark performs more than 11,600 elective groin hernia repairs annually, far exceeding the volume of giant and parastomal hernias managed at five regional centres [8]. Centralising open repair would also, in practice, centralise laparoscopic repair because open-conversion competence must remain immediately available. Concentrating surgery in fewer centres may further weaken hernia and abdominal wall competence in non-centralised departments, necessitating mitigation strategies such as rotation programmes and specialist on-call systems.

Although centralisation conflicts with the current Danish political focus on local healthcare access, some consolidation may still be justified by patient safety and outcome data. For a procedure most patients undergo only once, increased travel distance may be acceptable if quality improves through centralisation. The alternative – maintaining a distributed system with declining procedural volumes and eroding competence – may pose a greater risk.

International relevance

Although this review focuses on Denmark, the issues described are not unique to any single country. Many healthcare systems are experiencing similar shifts towards minimally invasive surgery and away from open techniques [19]. The questions raised here about training, competence and organisation of care are therefore of broad international relevance. Denmark's comprehensive registry infrastructure and coordinated healthcare system offer an opportunity to generate evidence that can inform global discussions.

Conclusions

The decrease in open groin hernia surgery has challenged longstanding assumptions about surgical training and organisation. Treatment of groin hernias has moved from a widely distributed “basic” operation to a largely minimally invasive subspecialty in which outcome depends on experience and volume. Continuing to use training models developed for a different era creates a mismatch between expectations and reality.

A shift toward subspecialisation, centralisation and realistic training goals may better ensure high-quality care and sustain surgical education, while the disadvantages and trade-offs of such a transition must be addressed

transparently. Denmark, with its robust registry infrastructure and tradition of data-driven quality improvement, is positioned to lead this transition. The time has come to recognise that groin hernia surgery is no longer a universal training operation and to reorganise care accordingly.

Correspondence *Jacob Rosenberg*. E-mail: jacob.rosenberg@regionh.dk

Accepted 18 June 2026

Published 7 August 2026

Conflicts of interest NH and FH report financial support from or interest in Intuitive and Medtronic. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. These are available together with the article at ugeskriftet.dk/dmj

References can be found with the article at ugeskriftet.dk/dmj

Cite this as Dan Med J 2026;73(9):A03260230

doi 10.61409/A03260230

Open Access under Creative Commons License [CC BY-NC-ND 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/)

REFERENCES

1. Stabilini C, van Veenendaal N, Aasvang E, et al. Update of the international HerniaSurge guidelines for groin hernia management. *BJs Open*. 2023;7(5):zrad080. <https://doi.org/10.1093/bjsopen/zrad080>
2. Andresen K, Friis-Andersen H, Rosenberg J. Laparoscopic repair of primary inguinal hernia performed in public hospitals or low-volume centers have increased risk of reoperation for recurrence. *Surg Innov*. 2016;23(2):142-147. <https://doi.org/10.1177/1553350615596636>
3. Sivakumar J, Chen Q, Hii MW, et al. Learning curve of laparoscopic inguinal hernia repair: systematic review, meta-analysis, and meta-regression. *Surg Endosc*. 2023;37(4):2453-2475. <https://doi.org/10.1007/s00464-022-09760-3>
4. Neumayer L, Giobbie-Hurder A, Jonasson O, et al. Open mesh versus laparoscopic mesh repair of inguinal hernia. *N Engl J Med*. 2004;350(18):1819-1827. <https://doi.org/10.1056/NEJMoa040093>
5. Christophersen C, Baker JJ, Fonnes S, et al. Lower reoperation rates after open and laparoscopic groin hernia repair when performed by high-volume surgeons: a nationwide register-based study. *Hernia*. 2021;25:1189-1197. <https://doi.org/10.1007/s10029-021-02400-0>
6. Kirk M, Henriksen NA, Christoffersen MW, et al. Management of adult groin hernia in Denmark: a national updated consensus. *J Abdom Wall Surg*. 2025;4:14904. <https://doi.org/10.3389/jaws.2025.14904>
7. Köckerling F, Morales-Conde S, Simons M, et al. Certified fellowship in abdominal wall surgery: a collaboration between the UEMS and the European Hernia Society. *J Abdom Wall Surg*. 2024;3:12945. <https://doi.org/10.3389/jaws.2024.12945>
8. Helgstrand F, Henriksen NA. Outcomes of parastomal hernia repair after national centralization. *Br J Surg*. 2023;110(1):60-66. <https://doi.org/10.1093/bjs/znac320>
9. Friis-Andersen H, Bisgaard T. The Danish Inguinal Hernia Database. *Clin Epidemiol*. 2016;8:521-524. <https://doi.org/10.2147/CLEP.S99512>
10. Rosenberg J. Growing focus on hernia surgery. *Laparosc Surg*. 2020;4:35. <https://doi.org/10.21037/ljs-2020-HS-02>
11. UEMS Section of Surgery. Surgical specialties. <https://uemssurg.org/surgicalspecialties/> (1 Mar 2026)
12. Andresen K, Rosenberg J. Decreasing use of open procedures in elective inguinal hernia surgery. *Laparosc Surg*. 2021;5:17. <https://doi.org/10.21037/ljs-20-126>
13. Öberg S, Rosenberg J. Contemporary inguinal hernia management. *Br J Surg*. 2022;109:244-246. <https://doi.org/10.1093/bjs/znab394>
14. Rosenberg J. Common techniques in elective groin hernia repair: a guide for the trainee. *ARC J Surg*. 2024;10(1):23-31. <https://doi.org/10.20431/2455-572X.1001003>

15. Vemulapalli S, Carroll JD, Mack MJ, et al. Procedural volume and outcomes for transcatheter aortic-valve replacement. *N Engl J Med*. 2019;380(26):2541-2550. <https://doi.org/10.1056/NEJMsa1901109>
16. Nazir S, Ahuja KR, Kolte D, et al. Association of hospital procedural volume with outcomes of percutaneous left atrial appendage occlusion. *JACC Cardiovasc Interv*. 2021;14(5):554-561. <https://doi.org/10.1016/j.jcin.2020.11.029>
17. Chunawala Z, Qamar A, Kennedy K, et al. Procedural volume and outcomes in lower-extremity peripheral vascular interventions: insights from the NCDR Peripheral Vascular Intervention Registry. *J Am Heart Assoc*. 2025;14(21):e037165. <https://doi.org/10.1161/JAHA.124.037165>
18. van den Berg R, den Hartog FPJ, Menon AG, et al. Is surgeon annual case volume related with intra- and postoperative complications after ventral hernia repair? Uni- and multivariate analysis of prospective registry-based data. *Hernia*. 2024;28(5):1935-1944. <https://doi.org/10.1007/s10029-024-03129-2>
19. Sanders DL, Kingsnorth AN, Windsor AC. Is there a role for hernia subspecialists? Or is this a step too far? *Hernia*. 2016;20(5):637-640. <https://doi.org/10.1007/s10029-016-1511-9>