Risk factors for perioperative complications in inguinal hernia repair – a systematic review

Dirk Weyhe, Navid Tabriz, Bianca Sahlmann and Verena-Nicole Uslar*

Abstract: The current literature suggests that perioperative complications occur in 8%–10% of all inguinal hernia repairs. However, the clinical relevance of these complications is currently unknown. In our review, based on 571,445 hernia repairs reported in 39 publications, we identified the following potential risk factors: patient age, ASA score, diabetes, smoking, mode of admission (emergency vs. elective surgery), surgery in low resource settings, type of anesthesia, and (in men) bilateral and sliding hernias. The most commonly reported complications are bleeding (0.9%), wound infection (0.5%), and pulmonary and cardiovascular complications (0.2%). In 3.9% of the included publications, a reliable grading of the reported complications according to Clavien-Dindo classification was possible. Using this classification retrospectively, we could show that, in patients with complications, these are clinically relevant for about 22% of these patients (Clavien-Dindo grade ≥ IIIa). About 78% of all patients suffered from complications needing only minor (meaning mostly medical) intervention (Clavien-Dindo grade < III). Especially with regard to the low incidence of complications in inguinal hernia repair, future studies should use the Clavien-Dindo classification to achieve better comparability between studies, thus enabling better correlation with potential risk factors.

Keywords: Clavien-Dindo classification; inguinal hernia surgery.

Introduction

For men, there is a lifelong risk of contracting an inguinal or femoral hernia of 27%–43%. For women, there is a risk of 3%–6% [1]. Throughout the world, about 20 million inguinal hernia repairs are performed every year. Thus, inguinal hernia repair is one of the most frequently performed surgeries worldwide. Although three professional societies have developed guidelines for the treatment of inguinal hernia [2–4], no consensus has been reached with regard to a standardized therapy. Since the introduction of mesh augmentation in hernia repair, a multitude of techniques have developed, each with respective inherent risk factors. In this context, complications are defined as an uncommon course of disease accompanied by particular symptoms. Complications may develop due to an underlying illness and/or due to the treatment of the disease. The severity of the complications may be classified using the seven-point Clavien-Dindo classification scale [5]. The scale is patient-oriented and uses the most important clinical consequences impacting the course of treatment. Most of the studies in this review do not use the classification.

An overview of complications occurring perioperatively in inguinal hernia repair might best be achieved using registry data. The Swedish Hernia Registry, for instance, reports an overall complication rate of about 8% [6]. This is in line with Polak and Nyhus [7]. However, there is still some ambiguity with regard to the actual incidences of specific complications. For instance, a newly published review reports incidence rates for wound infection after hernia surgery of 2.4%, which is about twice as high as the incidence rate published in the Swedish registry and almost 10 times higher than the reports of the German Herniamed Registry [6, 8, 9].

Light or severe complications are often not clearly defined. For instance, seromas are mostly regarded as low-grade, common complications, whereas intraoperative or postoperative bleeding of anticoagulated patients may lead to major complications, including death [10].
Therefore, the aim of this systematic review is to offer an overview on potential risk factors with regard to the Clavien-Dindo classification.

Materials and methods

Laparoendoscopic hernia surgery was established in the early 1990s. Case reports and studies dating back to this time were not included in this review due to the general learning curve for those techniques. Only actual evidence on complication potential was considered here. We conducted a literature search as described in Figure 1. All publications reporting perioperative outcome in relation to the specified risk factors in elective and emergency inguinal hernia repair were included. All reports concerning only chronic groin pain, which is often classified as a postoperative complication, were excluded.

Overall, 39 reports were found to be relevant to the research question. Of these, 3 were randomized controlled trials [11–13], 5 were prospective studies [14–18], 4 were case reports [10, 19–21], 25 were retrospective (registry) studies [22–46], and 2 were meta-analyses [47, 48].

Risk factors were identified. In addition, incidence rates were analyzed for various types of complications in 17 of the studies [11, 13, 15, 16, 18–20, 22, 24, 26, 29, 32, 36–38, 44]; if possible, the complications reported in the included studies were graded with regard to the Clavien-Dindo classification. Not all complications summarized here were reported in all of the studies. In addition, the amount of complications ranged from 1 to more than 4000 in the respective studies. For better comparison between studies, a weighting had to be implemented. Therefore, to normalize all data, the number of each respective complication reported was divided by the number of all complications reported in the respective study. The thusly calculated ratios were summed up over for each respective complication for all studies the respective complication was reported in. For example, Hellspong et al. [32] reported 2657 bleedings and 4744 complications overall, giving a ratio of 0.56. Mayer et al. [37] reported 203 bleedings and 934 complications overall, giving a ratio of 0.22. The sum of both ratios is 0.78. This method was used for all complications mentioned in all 18 studies.

Results

Analysis of risk factors and overall complication rate

In 39 studies, data of 571,445 hernia repairs were evaluated. The following risk factors for perioperative complications in inguinal hernia were identified: patient age [37, 41], ASA score [37], diabetes [32], smoking [35, 36], mode of admission (emergency vs. elective surgery) [39, 45], surgery in low resource settings [48], type of anesthesia [25, 39], and (in men) bilateral hernia [33, 39] and sliding hernia [30, 39].

Overall, 16,482 (2.9%) perioperative complications were reported. Of these, 23 were deaths corresponding to Clavien-Dindo grade V (0.004%). In low resource settings, the risk of death increases to 0.49%, thus being about 100 times higher than in developed countries. In sub-Saharan Africa, the risk of death even reaches 2.5% [48].

Analysis of specific complications

For further analysis, only one publication each concerning data from the Swedish registry and Herniamed was used. Thus, using the same patient collective, more than once was avoided.
More specific information on the actual type of complication was given only in 17 of 39 studies with 345,746 of 571,445 hernia repairs. Overall incidence rates for other complications range between 0.0003% (bowel obstruction) and 0.86% (bleeding). The most commonly reported complications were bleeding, wound infection, and pulmonary and cardiovascular complications (see Figure 2).

**Grading according to Clavien-Dindo classification**

Of the 16,482 complications, 651 (3.9%) were reliably classifiable according to Clavien-Dindo (see Figure 3). Clinically relevant complications include only grades IIIa to IV. Therefore, grades I and II were analyzed collectively. Grade V was already analyzed as mentioned above. Most reported incidences could be classified as Clavien-Dindo grades I and II (75%), indicating the need for only minor (mostly medical) intervention. Grade III, defined as requiring surgical, endoscopic, or radiological intervention, was needed in 21.5% of all cases. Only 0.2% of all reported complications were classified as life-threatening complications (grade IV).

**Discussion**

The risk of death as the most severe complication in inguinal hernia repair has an incidence of 0.004%, which is very low in developed countries. However, it may be up to 100 times higher in undeveloped countries. Incidence rates for specific perioperative complications are very low in our review (2.9% in this review and about 8% in the Swedish Hernia registry). We only regarded perioperative complications in this review. Therefore, we did not include chronic groin pain in our analysis, which is a commonly reported complication after inguinal hernia repair, explaining our relatively low overall complication rate. However, the aim of this review was not to evaluate the overall complication rate, as the focus was more on evaluating typical perioperative complications, calculating the potential impact of those complications on the patients’ treatment, and identifying risk factors associated with the respective complications.

Our literature review shows that overall complication rates in inguinal hernia repair are low. However,
we could identify risk factors for perioperative complications. For example, according to Nilsson et al. [39], the most relevant risk factors for 30-day morbidity after hernia repair are localization of the hernia (femoral vs. inguinal), patient age, ASA score, mode of admission (emergency vs. elective surgery), and type of anesthesia. In the Swedish registry, emergency surgery was more frequent in women compared to men (17 vs. 5%). For women, femoral hernia had occurred in 23% (2670 of 11,623) of all cases, whereas femoral hernia occurred only in 1% (1324 of 128,944) of all surgeries in men. For men, bilateral and sliding hernias pose an increased risk for complications.

Patients > 60 years old with emergency surgery show a significantly higher risk for cardiovascular complications within the first 30 days after surgery. Incidence rates of cardiovascular complications in our review (0.21% of all complications) are in line with the data from the Swedish registry (0.3–2.3%). Our data suggest that pulmonary and cardiovascular complications are among the five most frequent perioperative complications.

Wound infection rate in low-risk environments are reported to be less than 5%. For patients with high comorbidity, the risk may rise to 8.7%. The most important risk factor for wound infection is bilateral surgery. Overall, there is some ambiguity in the data to that regard. For example, in the Swedish registry, 96% of all inguinal hernia repairs conducted in Sweden are documented. The registry data show that the postoperative infection rate is 1.2% in men and 1.5% in women. In the German Herniamed Registry, infections occur in 0.2% of all laparoscopic cases and in 0.6% of all open repairs. However, in Sweden, only 5.6% of the patients receive antibiotic prophylaxis, whereas in Germany 70% of all patients scheduled for inguinal hernia repair receive antibiotics [49]. In our review, 0.5% of all reported complications concern wound infection, which is in line with the German Herniamed Registry.

In the literature, complications after transabdominal preperitoneal (TAPP) repair range between 1.2% and 49% (median 11.4%). For totally extraperitoneal (TEP), the results are similar (1.3–50.3%; median 12.5%). Registry studies report lower complication rates for TAPP and TEP. The overall complication rate in the Herniamed registry is higher for TAPP (5.4%) than for TEP (2.9%) contrary to the Swiss Hernia Registry (TAPP 1.7% vs. TEP 4.2%) [28]. The incidence rate for visceral complications (e.g. puncture of the bladder or bowel) after TEP or TAPP is very low (0.2% and 0.6%, respectively). Bladder or bowel injury occurred in 0.3% (29 of 10,887) of all cases after TAPP and in 0.1% (7 of 6700) after TEP [9]. Irrespective of the surgery technique, we observed an incidence rate for visceral injury in 0.1% of all cases.

Bleeding occurred more often in TEP than in TAPP (0.41% vs. 0.28) [50]. Including open repair, we detected a higher risk for bleeding of 0.9%. This observation is in line with published registry data [51].

Like every review, this review is limited due to incomplete reports in the publications and by missing definitions. For instance, we completely disregarded chronic groin pain in this review, because definition as well as the type of pain measurement are very heterogeneous. A newly published study evaluating pain measurement procedures after inguinal hernia repair [52] shows that 22 different definitions of pain were used in 48 studies. For the measurement of pain, 53 studies used 33 different procedures. Thus, developing reliable recommendations for preventive measures against chronic groin pain is very difficult.

By graduating the complications according to the Clavien-Dindo classification, we could quantify the amount of clinically relevant complications. Overall, the risk for complications in inguinal hernia repair is low (2.9–8%). If complications occur, then in 78% of all cases they are manageable by conservative means (Clavien-Dindo grades I and II). Conversely, postoperative intervention was needed in 22% of all classifiable cases (Clavien-Dindo grade ≥ III). To our knowledge, routine documentation of complications based on the Clavien-Dindo classification is not performed outside of study settings. Especially with regard to the low incidence of complications in inguinal hernia repair, future studies should use the Clavien-Dindo classification to achieve better comparability between studies, thus enabling better correlation with potential risk factors.

Author Statement
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Author Contributions
Dirk Weyhe: Conception of review study; analysis of literature; writing of the manuscript; revision of the manuscript; approval of the manuscript. Navid Tabriz: Analysis of literature; data retrieval; approval of classified data. Bianca Sahlmann: Analysis of literature; data retrieval; classification of collected data. Verena Uslar: Analysis of literature; data retrieval; data analysis; statistical analysis; writing of the manuscript; revision of the manuscript.
References

[1] Kingsnorth A, Ginge-llLittlejohn M, Nienhuijs S, et al. Randomized controlled multicenter international clinical trial of self-gripping Parie-tex™ ProGrip™ polyester mesh versus lightweight polypropylene mesh in open inguinal hernia repair: interim results at 3 months. Hernia 2012;16: 287–294.

[2] Simons M, Aufenacker T, Bay-Nielsen M, et al. European Hernia Society guidelines on the treatment of inguinal hernia in adult patients. Hernia 2009;13: 343–403.

[3] Bittner R, Arregui M, Bisgaard T, et al. Guidelines for laparoscopic (TAPP) and endoscopic (TEP) treatment of inguinal hernias [International Endohernia Society (IEHS)]. Surg Endosc 2011;25: 2773–2843.

[4] Poelman M, Van den Heuvel B, Deelder J, et al. EAES Consensus Development Conference on endoscopic repair of groin hernias. Hernia 2013;17: 3505–3519.

[5] Dindo D, Demartines N, Clavien P-A. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240: 205–213.

[6] Lundstrom KJ, Sandblom G, Smedberg S, Nordin P. Risk factors for complications following Lichtenstein repair of inguinal hernia. Gomal J Med Sci 2015;13: 9–11.

[7] Pollak R, Nyhus LM. Complications of groin hernia repair. Surg Clin North Am 1983;63: 1363–1371.

[8] Woelber E, Schrick EJ, Gessner BD, Evans HL. Proportion of chronic pain after tension-free inguinal hernia repair using polypropylene mesh: a prospective randomized comparative study. Hernia 2013;17: 3570–3576.

[9] Ginelliova A, Farkas D, Farkasova Iannaccone S, Vyhnalkova V. Unexpected fatal outcome of laparoscopic inguinal hernia repair. Forensic Sci Med Pathol 2016;12: 178–180.

[10] Chatzimavroudis G, Papaziogas B, Koutelidakis I, et al. Lichtenstein technique for inguinal hernia repair using polypropylene mesh fixed with sutures vs. self-fixating polypropylene mesh: a prospective randomized comparative study. Hernia 2014;18: 193–198.

[11] Jeroukhimov I, Wiser I, Karasic E, et al. Reduced postoperative chronic pain after tension-free inguinal hernia repair using absorbable sutures: a single-blind randomized clinical trial. J Am Coll Surg 2014;218: 102–107.

[12] Pokorny H, Klingler A, Schmidt T, et al. Recurrence and complications after laparoscopic versus open inguinal hernia repair: results of a prospective randomized multicenter trial. Hernia 2008;12: 385–389.

[13] Broadbent E, Petrie KJ, Alley PG, Booth RJ. Psychological stress impairs early wound repair following surgery. Psychosom Med 2003;65: 865–869.

[14] Falah SQ, Jamil M, Munir A, Khan MI. Frequency of complications following Lichtenstein repair of inguinal hernia. Gomal J Med Sci 2015;13: 9–11.

[15] Ujiki MB, Gitelis ME, Carbray J, et al. Patient-centered outcomes following laparoscopic inguinal hernia repair. Surg Endosc 2015;29: 2512–2519.

[16] Zanella S, Vassiliadis A, Buccellotti F, et al. Laparoscopic totally extraperitoneal inguinal hernia repair in the elderly: a prospective control study. In Vivo 2015;29: 493–496.

[17] Zierer J, Zieren HU, Wenger F, Muller JM. Repair of inguinal hernia in the elderly. Results of the plug-and-patch repair with special reference to quality of life. Chirurg 2000;71: 564–567.

[18] Koijima S, Sakamoto T, Honda M, Nishiguchi R, Ogawa F. Rare complication after totally extraperitoneal endoscopic inguinal hernia repair: small bowel perforation without peritoneal disruption. Asian J Endosc Surg 2016;9: 311–313.

[19] Nunes QM, Gemmill EH, Eastwood JR, Lobo DN. Carbon dioxide narcosis and grand mal seizure complicating laparoscopic herniorrhaphy. Surg Laparosc Endosc Percutaneous Techn 2007;17: 52–53.

[20] Stocche RM, Garcia LV, Reis MP, Klamt JG, Evora PR. Methylene blue to treat anaphylaxis during anesthesia: case report. Rev Bras Anestesiol 2004;54: 809–814.

[21] Acklin M, Ergul Z, Kaya O, Kulah B, Kulacoglu H. Predictors for duration of hospital stay after abdominal wall hernia repairs. Chirurgia (Bucur) 2012;107: 47–51.

[22] Ates M, Kinaci E, Kose E, et al. Corona mortis: in vivo anatomical knowledge and the risk of injury in totally extraperitoneal inguinal hernia repair. Hernia 2016;20: 659–665.

[23] Bombuy E, Mans E, Hugue A, et al. Elective inguinal hernioplasty in patients on chronic anticoagulation therapy. Management and outcome. Cir Esp 2009;86: 38–42.

[24] Chen T, Zhang Y, Wang H, et al. Emergency inguinal hernia repair under local anesthesia: a 5-year experience in a teaching hospital. BMC Anesthesiol 2016;16:17.

[25] Chu EW, Telem DA, Chemoguz A, Divino CM. Assessing the risk of clopidogrel-related bleeding complications in patients undergoing inguinal herniorrhaphy. Hernia 2011;15: 31–35.

[26] Do M, Liatsikos E, Beatty J, et al. Laparoendoscopic single-site extraperitoneal inguinal hernia repair: initial experience in 10 patients. J Endouriol 2011;25: 963–968.

[27] Gass M, Banz VM, Rosella L, et al. TAPP or TEP? Population-based analysis of prospective data on 4,552 patients undergoing endoscopic inguinal hernia repair. World J Surg 2012;36: 2782–2786.

[28] Gianetta E, de Cian F, Cuneo S, et al. Hernia repair in elderly patients. Br J Surg 1997;84: 983–985.

[29] Hallén M, Sevonius D, Holmberg H, Sandblom G. Low complication rate and an increasing incidence of surgical repair of primary indirect sliding inguinal hernia. Langenbecks Arch Surg 2016;401: 215–222.

[30] Hauer-Jensen M, Fort C, Mehta JL, Fink LM. Influence of statins on postoperative wound complications after inguinal or ventral herniorrhaphy. Hernia 2006;10: 48–52.

[31] Hellspong G, Gunnarsson U, Dahlstrand U, Sandblom G. Diabetes as a risk factor in patients undergoing groin hernia surgery. Langenbecks Arch Surg 2016. Doi: 10.1007/s00423-016-1519-8.

[32] Hudak KE, Frellich MJ, Rettenmaier CR, et al. Surgery duration as a risk factor in patients undergoing groin hernia surgery. Langenbecks Arch Surg 2016. Doi: 10.1007/s00423-016-1519-8.

[33] Huerta S, Patel PM, Mokdad AA, Chang J. Predictors of inguinodynia, recurrence, and metachronous hernias after inguinal herniorrhaphy in veteran patients. Am J Surg 2016;212: 391–398.

[34] Landin M, Kubasiak JC, Schimpke S, et al. The effect of tobacco use on outcomes of laparoscopic and open inguinal hernia repairs: a review of the NSQIP dataset. Surg Endosc 2016;31: 917–921.
[36] Lindström D, Sadr Azodi O, Bellocco R, et al. The effect of tobacco consumption and body mass index on complications and hospital stay after inguinal hernia surgery. Hernia 2007;11:117–123.

[37] Mayer F, Lechner M, Adolf D, et al. Is the age of >65 years a risk factor for endoscopic treatment of primary inguinal hernia? Analysis of 24,571 patients from the Herniamed registry. Surg Endosc 2016;30:296–306.

[38] McLemore EC, Harold KL, Cha SS, Johnson DJ, Fowl RJ. The safety of open inguinal herniorrhaphy in patients on chronic warfarin therapy. Am J Surg 2006;192:860–864.

[39] Nilsson H, Angeras U, Sandblom G, Nordin P. Serious adverse events within 30 days of groin hernia surgery. Hernia 2016;20:377–385.

[40] Ong W, Shen T, Tan WB, Lomanto D. Is preoperative withdrawal of aspirin necessary in patients undergoing elective inguinal hernia repair? Surg Endosc 2016;30:5542–5549.

[41] Patel JA, Kaufman AS, Howard RS, Rodriguez CJ, Jessie EM. Risk factors for urinary retention after laparoscopic inguinal hernia repairs. Surg Endosc 2015;29:3140–3145.

[42] Sivasankaran MV, Pham T, Divino CM. Incidence and risk factors for urinary retention following laparoscopic inguinal hernia repair. Am J Surg 2014;207:288–292.

[43] Smoot RL, Oderich GS, Taner CB, et al. Postoperative hematoma following inguinal herniorrhaphy: patient characteristics leading to increased risk. Hernia 2008;12:261–265.

[44] Tokumura H, Nomura R, Saijo F, et al. Tumescent TAPP: laparoscopic inguinal hernia repair after the preperitoneal tumescent injection of diluted lidocaine and epinephrine saline solution and carbon dioxide gas. Surg Today 2017;47:52–57.

[45] Vaid S, Bell T, Grimm R, Ahuja V. Predicting risk of death in general surgery patients on the basis of preoperative variables using American College of Surgeons National Surgical Quality Improvement Program data. Perm J 2012;16:10–17.

[46] Zeb MH, Pandian T, El Khatib MM, et al. Risk factors for postoperative hematoma after inguinal hernia repair: an update. J Surg Res 2016;205:33–37.

[47] O’Reilly EA, Burke JP, O’Connell PR. A meta-analysis of surgical morbidity and recurrence after laparoscopic and open repair of primary unilateral inguinal hernia. Ann Surg 2012;255:846–853.

[48] Uribe-Leitz T, Jaramillo J, Maurer L, et al. Variability in mortality following caesarean delivery, appendectomy, and groin hernia repair in low-income and middle-income countries: a systematic review and analysis of published data. Lancet 2016;4:e165–e174.

[49] Kockerling F, Bittner R, Jacob D, et al. Do we need antibiotic prophylaxis in endoscopic inguinal hernia repair? Results of the Herniamed registry. Surg Endosc 2015;29:3741–3749.

[50] McCormack K, Wake B, Perez J, et al. Laparoscopic surgery for inguinal hernia repair: systematic review of effectiveness and economic evaluation. Health Technol Assess 2005;9:1–203, iii–iv.

[51] Köckerling F, Roessing C, Adolf D, Schug-Pass C, Jacob D. Has endoscopic (TEP, TAPP) or open inguinal hernia repair a higher risk of bleeding in patients with coagulopathy or antithrombotic therapy? Data from the Herniamed registry. Surg Endosc 2016;30:2073–2081.

[52] Molegraaf M, Lange J, Wijsmuller A. Uniformity of chronic pain assessment after inguinal hernia repair: a critical review of the literature. Eur Surg Res 2016;58:1–19.

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Reviewers’ Comments to Original Submission

Reviewer 1: anonymous
Jan 31, 2017

Reviewer Recommendation Term: Accept
Overall Reviewer Manuscript Rating: 70

Custom Review Questions Response
Is the subject area appropriate for you? 5 - High/Yes
Does the title clearly reflect the paper’s content? 4
Does the abstract clearly reflect the paper’s content? 4
Do the keywords clearly reflect the paper’s content? 2
Does the introduction present the problem clearly? 4
Are the results/conclusions justified? 4
How comprehensive and up-to-date is the subject matter presented? 4
How adequate is the data presentation? 4
Are units and terminology used correctly? 4
Is the number of cases adequate? 5 - High/Yes
Are the experimental methods/clinical studies adequate? 3
Is the length appropriate in relation to the content? 4
Does the reader get new insights from the article? 3
Please rate the practical significance. 5 - High/Yes
Please rate the accuracy of methods. 3
Please rate the statistical evaluation and quality control. 3
Please rate the appropriateness of the figures and tables. 4
Please rate the appropriateness of the references. 5 - High/Yes
Please evaluate the writing style and use of language. 5 - High/Yes
Please judge the overall scientific quality of the manuscript. 3
Are you willing to review the revision of this manuscript? Yes
Comments to Authors:
This is a well presented topic of significant clinical relevance. As the authors state - hernia repairs are one of the most frequent operations worldwide. It is of utmost significance to know the risk factors for perioperative complications in particular due to the fact that many inguinal/femoral hernia repairs are performed on an outpatient Basis. Evaluating a vast amount of studies the authors could finally identify 39 publications which were further evaluated. Well-known risk factors were identified and may help in the future to improve the perioperative data for inguinal hernia repair.

The study definitely has some limitations, which are not addressed in this review because the authors clearly state these limitations in the discussion of the data. The figures in the manuscript substantially improve the paper and are essential for the understanding. It seems justified to argue for a greater acceptance of the Clavien-Dindo classification to report perioperative complications in order to better compare different studies.

The key words should be ranked as follows and extended by: inguinal hernia surgery - perioperative complications - risk factors - Clavien-Dindo classification

That can the done by the publisher and does not require a revision by the authors.

Reviewer 2: Timm Franzke

Feb 09, 2017

Reviewer Recommendation Term: Accept
Overall Reviewer Manuscript Rating: N/A

Custom Review Questions
Is the subject area appropriate for you? 5 - High/Yes
Does the title clearly reflect the paper’s content? 3
Does the abstract clearly reflect the paper’s content? 3
Do the keywords clearly reflect the paper’s content? 2
Does the introduction present the problem clearly? 4
Are the results/conclusions justified? 3
How comprehensive and up-to-date is the subject matter presented? 4
How adequate is the data presentation? 3
Are units and terminology used correctly? 4
Is the number of cases adequate? 4
Are the experimental methods/clinical studies adequate? 3
Is the length appropriate in relation to the content? 4
Does the reader get new insights from the article? 2
Please rate the practical significance. 4
Please rate the accuracy of methods. 3
Please rate the statistical evaluation and quality control. 2
Please rate the appropriateness of the figures and tables. 3
Please rate the appropriateness of the references. 4
Please evaluate the writing style and use of language. 4
Please judge the overall scientific quality of the manuscript. 3
Are you willing to review the revision of this manuscript? Yes

Comments to Authors:
The work gives a good overview of the perioperative complications after operative interventions in inguinal hernias. The known risk factors have been confirmed. The authors found that the generally accepted Clavien-Dindo classification was only rarely used and thus a comparison is difficult. The authors advocate a consistent application of this classification in the future. Unfortunately, 2 major complications are not discussed in the area of hernia surgery, recurrence, and chronic pain. The authors justify this by the difficult identification of these complications. Unfortunately, it is not fully comprehensible how the authors come to their final statements. Furthermore, the differences between surgical procedures are not clearly discussed.