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Review

Ventral hernia and pregnancy: A systematic review

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ABSTRACT

Background: Consensus lacks concerning management of ventral hernia in women who are, or might become pregnant. The aim of this systematic review was to examine the risk of recurrence following pre-pregnancy ventral hernia repair, and secondly the prevalence of ventral hernia during pregnancy and the risk of surgical repair pre- and post-partum.

Data sources: PubMed, Embase, CINAHL, Cochrane Library and Web of Science were systematically searched for randomized controlled trials, case-control, cohort studies and larger case-series on ventral (umbilical, epigastric or incisional) hernia repair in relation to pregnancy.

Conclusions: If possible, elective ventral repair should be postponed until after last pregnancy. A non-mesh repair seems appropriate for smaller primary ventral hernia in women who plan future pregnancies. Umbilical hernia during pregnancy seems very rare and seldom requires repair pre- and post-partum. Routine practice of umbilical hernia repair in combination with cesarean section cannot be recommended. PROSPERO: CRD42017073736.

Introduction

Ventral hernia repair is commonly performed in women of childbearing age. In Denmark, women aged 15–45 years old constituted 15.4, 24.6 and 10.9% of patients undergoing umbilical, epigastric and incisional hernia repair, respectively.[1,2] Recent studies suggest that ventral hernia repair should be performed with mesh reinforcement, even for hernia defects less than 2 cm.[3,4] However, these studies do not consider pregnancy as a subsequent exposure, and consensus lacks concerning the management of ventral hernia in women of childbearing age.

Pre-pregnancy hernia repair may be complicated by pregnancy-induced physiological changes, and increase the risk of recurrence or abdominal wall pain. In 2015, a systematic review on abdominal wall hernia and pregnancy was published, identifying 31 papers, all of which were either case-reports or smaller case-series.[5] The study concluded that the literature was sparse, and no definite treatment recommendations could be made. Since then, several studies have emerged focusing on different aspects of ventral hernia in relation to pregnancy.

The objective of this systematic review was to examine the risk of recurrence following pre-pregnancy ventral hernia repair, and secondly to evaluate the prevalence of ventral hernia during pregnancy and the risk of surgical repair before and after childbirth, in an attempt to propose a treatment algorithm for this patient group.

Material and methods

A study protocol was conducted before initiation of the review and registered on PROSPERO on August 28, 2017 (https://www.crd.york.ac.uk/PROSPERO/, ID: CRD42017073736). This study is reported in accordance with the MOOSE guidelines for reporting of meta-analysis of observational studies in epidemiology.[6]

Search strategy

PubMed, Embase, The Cochrane CENTRAL, CINAHL and Web of Science were systematically searched from the date of initiation of the databases through March 5, 2018. The following search strategy was used for PubMed without any language restrictions: ((“hernia, ventral” [MeSH Terms] OR (“hernia” [All Fields] AND “ventral” [All Fields]) OR “ventral hernia” [All Fields] OR (“ventral” [All Fields]

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AND "hernia" [All Fields])) OR ("hernia, umbilical" [MeSH Terms] OR ("hernia" [All Fields] AND "umbilical" [All Fields]) OR "umbilical hernia" [All Fields] OR ("umbilical" [All Fields] AND "hernia" [All Fields])) OR (epigastric [All Fields] AND ("hernia" [MeSH Terms] OR "hernia" [All Fields])) OR ("incisional hernia" [MeSH Terms] OR ("incisional" [All Fields] AND "hernia" [All Fields]) OR "incisional hernia" [All Fields]) OR ("hernia" [MeSH Terms] OR "hernia" [All Fields])) AND ("pregnancy" [MeSH Terms] OR "pregnancy" [All Fields]). The search strategy was subsequently translated into the other databases. The identified records were uploaded and screened by title and abstract through an online platform (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org). The references of the included studies were scrutinized manually for any additional material. The named authors developed the search strategy collaboratively.

Selection criteria

Ventral hernia was defined as primary ventral (umbilical and epigastric) or incisional hernia in the present study. We chose to exclude all other types of ventral hernia, such as parastomal, lumbar, traumatic and Spigelian, as these hernias combined only constitute 4% of ventral hernia repairs performed.[7] All studies published in English reporting on ventral hernia in relation to pregnancy were eligible for inclusion. In an effort to make sound conclusions, it was decided to exclude studies generally considered low-grade evidence, such as case-reports and small case-series (defined as 100 cases or less). Hence, only randomized controlled trials (RCTs), analytical observational studies (cohort or case-control) or large case-series were eligible for inclusion. Authors of identified published congress abstracts were contacted in an attempt to retrieve any available study data.

EO screened all identified records on title and abstract. EO and KKJ independently examined full-text articles for inclusion. Discrepancies were solved through discussion and consultation with NAH until consensus was reached. An algorithm developed by The National Institute for Health and Care Excellence was used for classifying the study design of identified studies.[8]

Study outcomes and methodological quality assessment

The aim of the study was to examine the risk of recurrence after pre-pregnancy ventral hernia repair. Further, we examined the prevalence of ventral hernia during pregnancy and the risk of pre- and post-partum repair. Primary ventral and incisional hernia are distinct in several aspects, including etiology and recurrence rates,[9] and thus it was chosen to subdivide presentation of data on primary ventral and incisional hernia whenever suitable.

Cohort and case-control studies were critically appraised using the Newcastle-Ottawa scales.[10] These scales rate studies with a star system from 0-9 (nine being best) on three key study perspectives: (1) selection of participants, (2) comparability, and (3) ascertainment of outcome or exposure of interest for cohort and case-control studies, respectively. In meta-analyses of observational studies, it has been considered that studies scoring less than 6 stars should be excluded due to high risk of bias.[11] The Institute of Health Economics' quality appraisal checklist was used to assess case-series.[12] The checklist covers 20 criteria on eight different aspects of a case-series study. The checklist was developed through a modified Delphi process,[13] and underwent a subsequent validation process including a random sample of 105 case-series, most of which reported on the effectiveness of surgical procedures. *Levels of Evidence* developed by the Oxford Centre for Evidence-based Medicine was used to grade the evidence of included studies.[14]

Results

In total, 5189 unique articles were identified, of which 31 were assessed for full-text eligibility (Fig. 1). Twenty-two studies were excluded after full-text read (reasons for exclusion are listed in Fig. 1). In total, nine studies were included, consisting of four cohort studies, four case-control and one case-series (Table 1).

Pregnancy following ventral hernia repair

One cohort study (level 2b evidence) evaluated pregnancy following ventral hernia repair as a potential risk factor for hernia recurrence.[15] The study included all women of childbearing age undergoing ventral (umbilical, epigastric or incisional) hernia repair registered in the Danish Hernia Database. The study included 3578 patients, of whom 267 (7.5%) became pregnant. In a multivariable analysis, it was found that subsequent pregnancy was independently associated with a 1.6-fold increased risk of hernia recurrence. The model adjusted for hernia type, defect size, mesh use and approach. There was no difference on recurrence rate when comparing mesh or suture repair. Recurrence was defined as diagnosis of clinical recurrence or reoperation for recurrence, based on the Danish National Patient Registry, and thus assumedly underestimated the risk of recurrence as no structured clinical follow-up was performed.

Lappen et al.[16] (level 2b evidence) similarly examined the association between subsequent pregnancy and reoperation for recurrence after incisional hernia repair. The study was based on records in the database *EPM:Explore* which stores data on patients from hospitals across the Unites States. The authors identified 11 020 women of childbearing age, of whom 840 (7.6%) were pregnant following incisional hernia repair. In a multivariable analysis, adjusted for wound complication, diabetes, obesity and tobacco use, the study found that pregnancy was independently associated with 73% increased risk of reoperation for recurrence. The use of mesh was unavailable and thus not included in the analyses.

Finally, a Danish register-based cohort study (level 2b evidence) examined if mesh repair was protective against recurrence compared to suture repair in patients who became pregnant after primary umbilical or epigastric hernia repair.[17] The study included 49 (21.9%) and 175 patients who underwent pre-pregnancy mesh and suture repair, respectively. The primary outcome was clinical recurrence or reoperation for recurrence based on the Danish National Patient Registry, thus likely underestimating the true recurrence rate, as no structured clinical follow-up was performed. The study found no difference in risk of recurrence comparing mesh and suture repair after a median follow-up of 3.8 years, in a model adjusted for body mass index and defect size.

Umbilical hernia during pregnancy

A case-series (level 4 evidence) examined patients undergoing umbilical hernia repair during pregnancy based on the *ACS-NSQIP* database.[18] The authors identified 126 cases of which 73 (58%) were registered with incarceration or strangulation. Six (5%) and 120 (95%) patients underwent laparoscopic and open umbilical hernia repair, respectively. Three (3%) of the patients undergoing open repair had mesh reinforcement. Twenty (16%) patients underwent umbilical hernia repair concomitant to another non-obstetric procedure and 16 (80%) of them had an asymptomatic umbilical hernia. None underwent umbilical hernia repair concomitant to cesarean section. The surgical procedures were associated with minimal 30-day morbidity and no deaths. The study did not report on gestational age, fetal morbidity and

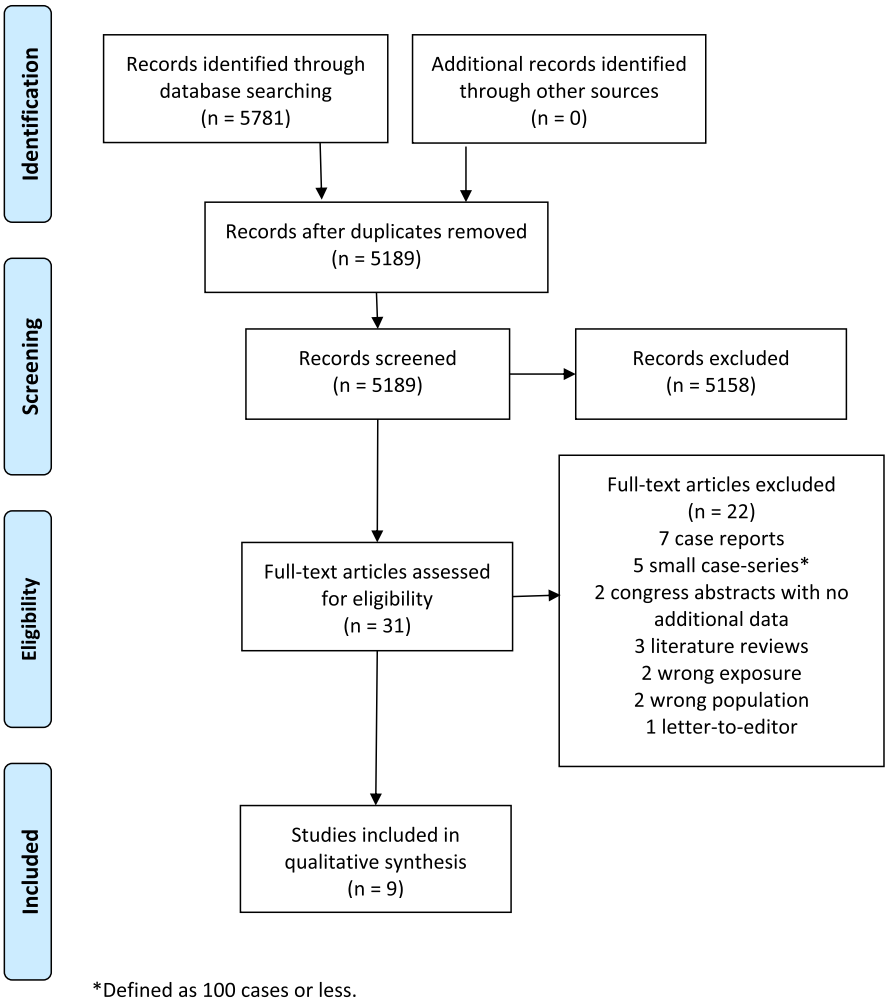

Fig. 1. PRISMA flow diagram of the review process.

mortality or long-term hernia recurrence.

A single-center cohort study (level 4 evidence) including 20 714 pregnant women examined the prevalence of primary ventral and inguinal hernia during pregnancy and the risk of pre- and postpartum repair.[19] The study identified 17 (0.08%) patients registered with an umbilical hernia, of which none required repair before delivery. No epigastric hernias were found. The study retrospectively identified pregnant patients with a primary ventral hernia through screening of medical records, and thus likely underestimated the true prevalence. The study did not report on specific hernia-related symptom load. All patients had uncomplicated childbirth. During a postpartum follow up of median 4 years, five (29%) patients underwent elective umbilical hernia repair.

Umbilical hernia repair concomitant to elective cesarean section

Four case-control studies reported on hernia repair in combination with cesarean section compared to controls undergoing cesarean section alone. In total, 74 umbilical hernia repairs concomitant to elective cesarean section were compared to 645 elective cesarean sections.

Steinemann et al.[20] (level 3b evidence) reported on 14 patients who underwent combined sutured umbilical hernia repair and cesarean section compared with a matched control group of 140 patients undergoing cesarean section only. A Pfannenstiel incision was used for the cesarean section, and subsequently seven patients underwent an internal repair where the anterior abdominal wall was lifted upwards to expose the umbilical region. Seven patients underwent closure of the Pfannenstiel with a subsequent external repair through a paraumbilical incision. The combined procedure was 27 min longer than cesarean section alone, but not associated with an increased risk of postoperative complications. In total, four (28%) patients had hernia recurrence after clinical follow-up including ultrasonography after median 10 and 55 months for the internal and external hernia repair groups, respectively.

Gabriele et al.[21] (level 4 evidence) likewise reported nine cases of concomitant cesarean section and umbilical hernia repair with mesh compared to 100 controls. The cesarean delivery was performed with a Pfannenstiel skin incision and a transverse incision of the rectus sheath, and a paraumbilical incision was made for the following hernia repair. The authors found no difference in the risk of complications comparing the two groups. No hernia recurrences were reported based on physical examination up to one year postoperatively. Any loss of follow-up was not described.

Ghnnam et al.[22] (level 4 evidence) prospectively evaluated 48 patients undergoing cesarean section and umbilical hernia repair compared to 100 low-risk patients undergoing cesarean section only. The cesarean delivery was performed through a Pfannenstiel skin incision, with a subsequent internal hernia repair through the same incision. Thirty-six (75%) patients had simple suture repair,

Table 1
Characteristics of included studies.

Authors	Year	Study Design	Quality Assessment*	Study population	N	Exposure/Outcome	Result	Conclusion
Pre-pregnancy ventral hernia repair								
Oma et al.[15]	2017	RC	********	Women operated on for umb, epi or incisional hernia	3578	Subsequent pregnancy (n = 267)	HR 1.56 (95% CI 1.09–2.25)	Pregnancy associated with increased risk of recurrence
Lappen et al.[16]	2016	RC	******	Women operated on for incisional hernia	11 020	Subsequent pregnancy (n = 840)	OR 1.73 (95% CI 1.40–2.14)	Pregnancy associated with increased risk of recurrence
Oma et al.[17]	2016	RC	*******	Women operated on for umb or epi hernia with subsequent pregnancy	224	Mesh (n = 49) vs. suture (n = 175)	Mesh HR 2.77 (95% CI 0.98–7.85)	Mesh repair not superior to suture repair
Umb hernia/umb hernia repair during pregnancy								
Haskins et al.[18]	2017	RCS	Good quality	Pregnant patients undergoing umb hernia repair	126	NA	Minimal 30-day morbidity to mother	Umb hernia repair in pregnancy is safe
Oma et al.[19]	2017	RC	******	Pregnant patients	20 714	17 (0.08%) patients with umb hernia	No repairs in pregnancy	Umb hernia in pregnancy is rare and harmless
Umb hernia repair in combination with cesarean section								
Steinemann et al.[20]	2013	RCC	*********	Women undergoing CS	14 vs. 140	CS and umb hernia repair vs. CS	4 recurrences	High recurrence rate, but safe
Gabriele et al.[21]	2010	RCC	***	Women undergoing CS	9 vs. 100	CS and umb hernia repair vs. CS	0 recurrence	Combined procedure safe
Ghnnam et al.[22]	2009	PCC	*****	Women undergoing CS	48 vs. 100	CS and umb hernia repair vs. CS	1 recurrence	Combined procedure safe
Ochsenbein-Kölble et al.[23]	2004	RCC	******	Women undergoing CS	3 vs. 305	CS and umb hernia repair vs. CS	0 recurrence	Combined procedure safe

*Newcastle-Ottawa scales for cohort and case-control studies[8] and The Institute of Health Economics' quality appraisal checklist for case-series.[10] NA, not applicable; Umb, umbilical; CS, cesarean section; HR, hazard ratio; OR, odds ratio; CI, confidence interval; Epi, epigastric; RCS, retrospective case-series; RC, retrospective cohort; RCC, retrospective case-control; PCC, prospective case-control.

while 12 (25%) underwent repair with mesh reinforcement. The combined procedure was significantly longer, and the patients needed more analgesic during the first postoperative week compared to cesarean section only. After mean 22 months of follow-up, one patient experienced recurrence after a suture hernia repair. The method of follow up was not clearly described.

Ochsenbein-Kölble et al.[23] (level 3b evidence) reported on three patients undergoing umbilical hernia repair and cesarean section with no difference in length of surgery or postoperative complications compared with 305 control patients. The incision used for the cesarean section and the umbilical hernia repair technique were not described. None of the patients experienced hernia recurrence, based on structured telephone questionnaire after mean 4.7 years.

Discussion

A tailored approach for the management of ventral hernia in women of childbearing age seems warranted as the abdominal wall may be exposed to pregnancy-induced stretch and tension leading to increased recurrence rate. Apart from the four case-control studies on combined cesarean section and umbilical hernia repair, all studies have been published in 2016 or later, and were thus not included in the latest published systematic review on hernia and pregnancy.[5]

Pregnancy following ventral hernia repair was associated with an increased risk of recurrence as reported by two cohort studies.[15,16] The risk of recurrence was presumably underestimated, as definition of recurrence was based on administrative registry data.[24] However, the magnitude of underestimation was likely equal among patients with and without subsequent pregnancy. We found no studies comparing a pre-pregnancy repair to the natural course of a conservatively treated ventral hernia subsequently exposed to pregnancy. Therefore, whether the rapid abdominal wall alterations during pregnancy increase the risk of defect enlargement, pain or complications remains unknown. However, none of the patients registered with an umbilical hernia during pregnancy underwent pre-partum repair in the Danish single-center cohort study.[19] If an umbilical hernia requires emergency repair during pregnancy, Haskins et al.[18] found that repair was associated with minimal 30-day morbidity to the mother. Furthermore, a recent large-scale study reported that adverse birth outcomes were generally low following non-obstetric surgery during pregnancy, but no estimates considering hernia repair specifically were described.[25] Furthermore, watchful waiting has been proven safe in the general adult population for both primary ventral and incisional hernia.[26]

Whether or not to use mesh reinforcement in primary ventral hernia repair in women of childbearing age remains debatable. In the general adult population, there is emerging evidence to support repair with mesh for all types and sizes of ventral hernia.[3,4] Interestingly, these findings could not be reproduced in the study on umbilical or epigastric hernia repair in women who subsequently became pregnant.[17] Most mesh materials have lower elastic capabilities compared with the abdominal wall,[27] and the rapid physiologic alterations during pregnancy could theoretically explain the diverging results. We found no studies that compared mesh and suture technique for a pre-pregnancy incisional hernia repair. However, suture repair of incisional hernia in the general adult population is discouraged, as recurrence rates as high as 63% has been reported.[28]

The four case-control studies on cesarean section and umbilical hernia repair found no major complications related to the combined procedure compared to cesarean section alone, justifying the procedure in terms of short-term morbidity. Three of the studies

reported low recurrence rates, but the length or method of follow-up was not satisfyingly described. In contrast, the most recent case-control study, which included an adequate follow-up protocol found a recurrence rate of 28%. Despite the high recurrence rate, the authors concluded that the combined procedure should be offered if requested, and the latest systematic review on the topic concluded that the combined procedure seemed safe and feasible.[5,20] However, the recent cohort study included in this systematic review, which examined the prevalence of primary ventral hernia during pregnancy found that relatively few required repair post-partum,[19] as only five (29%) underwent surgery out of 17 patients registered with an umbilical hernia conservatively treated during pregnancy.

The abdominal wall is gradually strained as the pregnancy progress. According to LaPlace's law, the tension of the abdominal wall is intensified by an increase in both intraabdominal pressure and volume. A study that followed 300 first-time pregnant women throughout pregnancy reported that 33, 60 and 33% had abdominal rectus diastasis at 21 weeks of gestation, 6 weeks and 12 months post-partum, respectively.[29] Hypothetically, this widening and thinning of the linea alba predispose to hernia formation. Although it is suggested that symptomatic primary ventral hernias are very rare during pregnancy, the prevalence of asymptomatic hernias is possibly much higher. Köhler et al.[30] found that concomitant diastasis was a significant risk factor for recurrence for sutured repair of small primary ventral hernias, but concomitant diastasis was not reported in any of the included studies of this review, and its impact remains unknown in this patient population.

There seems to be an emerging interest on this topic, as previously published reviews identified only case-series and individual case reports and hence were not able to give any definite treatment recommandations.[5,31] In an effort to minimize the risk of bias, we chose to include only RCTs, analytic observational studies, as well as larger case-series. However, we identified no RCTs, and a limitation of the study is the risk of selection bias due to the nature of observational studies and that the included studies predominantly analyzed retrospective data from administrative databases. The majority of studies were quality-graded acceptable or better, but some studies included substantial methodological flaws such as insufficient follow-up. It has been suggested that 10 years of follow-up is warranted to identify the actual recurrence rate following ventral hernia repair.[32] It is important to emphasize that incisional and primary ventral hernia have distinct etiological and prognostic dissimilarities, including different recurrence rates. This systematic review included both primary ventral and incisional hernia, as it was considered appropriate for the identified volume of literature. However, future studies on ventral hernia and pregnancy should be conducted on non-pooled data of either primary ventral or incisional hernia.[9] Based on the above limitations, the conclusions of the current study should be interpreted with caution, however since controlled studies including pregnancy are hard to conduct, database studies may offer the best possible evidence.

Conclusions

Based on the current data, candidates for elective primary ventral or incisional hernia repair of childbearing age should be counselled on the increased risk of recurrence associated with subsequent pregnancy, and if possible, the procedure should be postponed until after last planned pregnancy. If a pre-pregnancy repair is performed for an umbilical or epigastric hernia, a non-mesh repair seems appropriate for smaller defects. If the hernia recurs, a mesh repair might be performed after last pregnancy. The prevalence of clinically relevant primary ventral hernias is very low during pregnancy and it seems safe to recommend watchful waiting until after delivery. Repair during pregnancy should be reserved for emergency cases, and carries a seemingly low risk to the mother. Umbilical hernia repair in combination with cesarean section has been reported as a safe and convenient procedure, but recent data suggest that an umbilical hernia left untreated might not need repair post-partum, and thus, routine practice of the combined procedure cannot be recommended. More studies are needed before a comprehensive treatment algorithm can be made.

Summary

Consensus lacks concerning management of ventral hernia in women of childbearing age. This systematic review summarizes the literature and proposes novel treatment strategies in selected settings.

Disclosure of potential conflict of interest

All authors declare no conflict of interest.

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