



**UNIVERSITY OF CALGARY**  
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# Surgical mesh for stress urinary incontinence, pelvic organ prolapse, and inguinal hernia:

Addendum to a health technology assessment considering  
observational studies assessing complications and safety  
outcomes beyond 3 years post-surgery

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# 1 Introduction

“Surgical mesh” refers to sheets or strips of reticulated material, usually polypropylene, that can be implanted into the body. Polypropylene surgical mesh has been used for decades to treat hernias, and more recently to treat pelvic organ prolapse (POP) and stress urinary incontinence (SUI).<sup>1</sup>

In February 2019, the Health Technology Assessment (HTA) Unit at the University of Calgary completed an HTA of surgical mesh for repair of SUI, POP and inguinal hernia. The final HTA report included an environmental scan of the current state of the use of mesh in comparator countries (USA, UK, Australia, and New Zealand), a review of relevant guidelines concerning the use of surgical mesh, a review of HTAs already published on surgical mesh, and three systematic reviews of scientific literature. The three systematic reviews focused on SUI, POP, and inguinal hernia and included only randomized controlled trials (RCTs) assessing the safety and efficacy of surgical mesh, as well as its impact on quality of life.

The environmental scan of comparator countries found that multiple health regulators had issued bans, recalls, or pauses on the use of surgical mesh for SUI and POP. The review of guidelines revealed that more recent guidelines have endorsed increased vigilance and restriction on the use of mesh. In particular, guidelines mentioned special arrangements for clinical governance, careful attention to patient consent, long-term research, and assiduous reporting of complications. The environmental scan and guideline reviews indicate that concern over the safety of mesh has led to both regulatory action and adjustments to best practice recommendations since 2015. The HTA review identified two HTAs addressing SUI, and two addressing hernia. No HTAs in POP were identified. The HTAs for SUI found that tension-free vaginal tape (TVT) for treatment of SUI is more cost-effective than tissue repair (non-mesh surgery). However, both HTAs called for more research with more consistent methods, since conclusions regarding the safety and efficacy of surgical mesh remained unknown given the heterogeneity in the literature.

The systematic reviews of the RCT literature revealed numerous gaps in current knowledge. While several RCTs were identified for each condition (n= 29 for SUI, n= 32 for POP, n= 20 for

hernia), analysis of these studies was complicated by a multiplicity of outcome definitions and follow-up times. In particular, few data were identified on the safety and efficacy of surgical mesh more than 12 months after implantation. Data on the impact of mesh on quality of life were also scarce, measured by a variety of instruments, and reported at various follow-up times. Thus, the systematic reviews of the RCTs did not provide knowledge about the long-term complications of surgical mesh for SUI, POP, and inguinal hernia, nor did they identify information about the patient experience with surgical mesh.

As a result, this systematic review of observational studies was undertaken to fill the gaps identified by the systematic reviews of RCTs. The inclusion criteria for studies in this review were designed to capture literature that reports on the safety, complications and quality of life associated with surgical mesh beyond 36 months post-operatively. Long-term observation of cohorts of patients who have undergone surgical mesh procedures may provide evidence that can be used to synthesize a more detailed picture of the impact of surgical mesh years after implantation.

## **1.1 Purpose**

The purpose of this systematic review of observational cohort studies is to complement the HTA completed by the HTA Unit at the University of Calgary in February 2019. This review of cohort studies was undertaken to assess the safety and complication rates of surgical mesh for repair of SUI, POP, and inguinal hernia three years or more after implantation, and to gather additional data on the impact of surgical mesh on patient quality of life.

## 2 Methods

### 2.1 Search strategy

A systematic review of the literature was completed. MEDLINE, EMBASE, PsycINFO, and CINAHL were searched from 2010-present. We chose to limit our search to studies published after 2010 to exclude early generation meshes of outdated design, while still capturing studies with sufficient follow-up time. The searches were performed on March 18, 2019. Terms capturing conditions of interest (e.g. “stress urinary incontinence,” “pelvic organ prolapse,” “inguinal hernia”) were searched in combination with terms capturing treatments of interest (e.g. “mesh,” “suburethral slings,” “hernia patch”). The search was limited to exclude animal studies, editorials, letters, reviews, and case reports. The full search strategies are reported in Appendix 1: Search strategies. We followed the MOOSE checklist for meta-analyses of observational studies.<sup>2</sup>

### 2.2 Study selection

Reviewers screened abstracts in duplicate to identify observational cohort studies addressing SUI, POP, or inguinal hernia. Abstracts marked for inclusion by any reviewer progressed to the next screening stage. These included abstracts were re-screened by two reviewers using more fine-grained *a priori* inclusion and exclusion criteria as listed in Table 1. Abstracts marked for inclusion by either reviewer progressed to the full-text screening stage. Studies were included if they addressed a general population of patients suffering from primary SUI, POP, or inguinal hernia treated with permanent or semi-permanent surgical mesh. Both comparative and non-comparative studies were included. RCTs were excluded as the previous HTA captured that body of literature. Studies were excluded if: 1) they did not report a general population (e.g. all patients were elderly), 2) they did not address one of the three conditions of interest (SUI, POP, inguinal hernia), or if the study population included other conditions not of interest and the results were not stratified (e.g. inguinal and ventral hernias) 3) the intervention studied was not surgical mesh, or was completely absorbable or tissue mesh (e.g. porcine dermis), or 4) the study was not an observational cohort study design (e.g. systematic review, meta-analysis, case-study, RCT).

Full-texts were retrieved and screened in duplicate by four reviewers based on the same criteria as those used in abstract review, with added criteria that the population of study exceeded 20 participants, and that the study reported safety, complications or quality of life outcomes after 36 months of follow-up. Discrepancies between reviewers were resolved through discussion and consensus. A diagram of studies included and excluded at each stage may be found in Appendix 2: PRISMA diagram.

Table 1: Inclusion and exclusion criteria

	<b>Inclusion</b>	<b>Exclusion</b>
<b>Population</b>	Adults aged 18 years and older General population Primary condition No concurrent surgeries performed during study procedure	Animal studies, pediatric population Recurrent condition Incarcerated hernia Concurrent surgeries
<b>Intervention</b>	Permanent or semi-permanent surgical mesh for inguinal hernia, SUI, or POP	Not surgical mesh, surgical mesh for other conditions
<b>Comparators</b>	No comparator required	
<b>Outcomes</b>	Any safety, complication or QoL outcomes	No safety, complication or QoL outcome
<b>Study Design</b>	Prospective observational cohort studies, both comparative and non-comparative	Systematic review, meta-analysis, letter, editorial, case studies, case series, retrospective studies, RCTs
	English or French	Not English or French
	Data after 36 months	Data prior to 36 months only
	Full-text available	No full-text, conference abstract
	Published in or after 2010	Published before 2010
	n $\geq$ 20	n<20

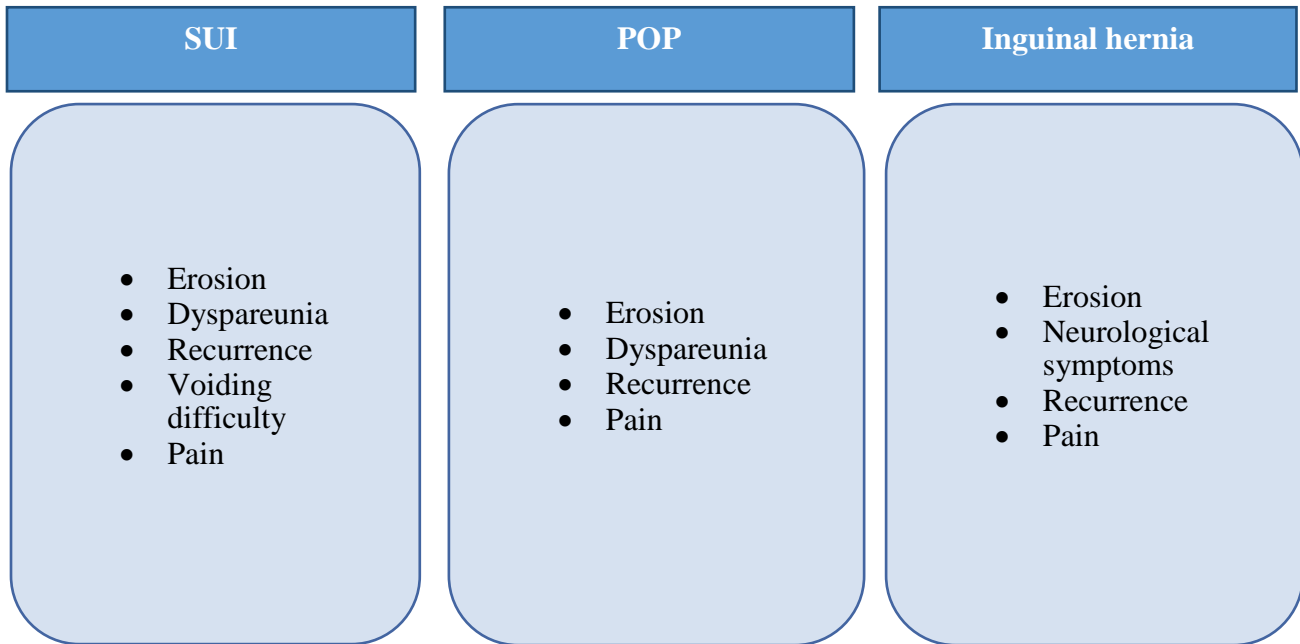
### 2.3 Data extraction and meta-analysis

Study characteristics and outcomes of interest of the included papers were extracted in duplicate by independent reviewers. Procedure type, mesh material, patient inclusion and exclusion criteria, and study population data were extracted from each study (see Appendices 3 and 4). The results of any quality of life instrument were included as relevant outcomes. Complication data were included if the complication presented after three years post-operatively. An *a priori* list of



late-presenting complications was compiled (Figure 1), but other complications were included if the study reported that they occurred after three years.

Figure 1: Selected late-presenting complications of mesh



A meta-analysis was planned for comparisons with two or more studies to synthesize the treatment effect for synthetic surgical mesh with respect to quality of life measurements and complications. However, the meta-analysis was not performed because the data were too variable and inconsistently reported within the available in the studies identified by the review.

#### 2.4 Quality assessment

Included studies were assessed for quality using the Joanna Briggs Institute checklist for cohort studies critical appraisal tool.<sup>3</sup> Quality assessment was completed in duplicate by independent reviewers, and discrepancies were resolved through discussion. Using this tool, each study was evaluated on 11 questions listed on the checklist. For each question, the study was assigned a “yes”, “no”, “unclear” or “not applicable”. The first three questions of the checklist relate to measuring exposure to conditions across groups; these questions did not apply to the studies included in this review. Two questions addressed the identification of confounding factors, and how the study dealt with them. Two further questions assessed whether participants were free

from the outcome at the start of the study, and whether the outcomes were measured in a valid and reliable fashion. Three questions assessed whether follow-up was long enough for outcomes to manifest, whether follow-up was complete or lost participants were accounted for, and whether strategies to address incomplete follow-up were used. The last question assessed whether the study's statistical methods.

## 3 Stress urinary incontinence

### 3.1 Results

Our search identified 6930 abstracts for all three conditions. After removing duplicates, 5500 records remained. We excluded 4981 of these records as irrelevant, leaving 519 studies included at full-text review stage. Of these 519, 16 were identified as relevant to the SUI review. The PRISMA flow-chart of each review stage is included in Figure A1 in Appendix 2: PRISMA diagram.

#### 3.1.1 Included studies

Sixteen studies assessing mesh for SUI were included.<sup>4-19</sup> Studies were from China,<sup>4-7</sup> Australia,<sup>8</sup> Germany,<sup>9</sup> South Korea,<sup>10</sup> Greece,<sup>11-13</sup> Italy,<sup>14,15</sup> Finland and Sweden,<sup>16</sup> Egypt,<sup>17</sup> Switzerland and Italy,<sup>19</sup> and Turkey.<sup>18</sup> Studies ranged from 48 to 204 months in duration and examined between 21 and 153 patients (Table A1 in Appendix 3: Characteristics and quality assessment for SUI studies for detailed descriptions of included studies.). All patients were female. Study inclusion criteria included presence of urodynamic SUI treated with a synthetic sling. Exclusion criteria included absence of previous SUI repair surgery and concomitant pelvic organ prolapse repair. Average patient age was between 44.21 and 69.0 years of age; average BMI was between 25.0 and 29.1; and average parity was 2. Eight studies examined the TVT procedure,<sup>4,9,10,13-16,19</sup> three examined TVT-O,<sup>5,11,12</sup> three examined TOT,<sup>6,17,18</sup> and two studies examined either mixed<sup>8</sup> or other<sup>7</sup> procedures. Most studies reported data from a single surgeon at a single center.

#### QoL

Four studies reported validated QoL outcomes that included the King's Health Questionnaire (KHQ)<sup>8</sup>, the Incontinence Impact Questionnaire (IIQ-7),<sup>4-6,16</sup> the Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire (PISQ-12),<sup>4-6</sup> the Urinary Distress Inventory Questionnaire (UDI-6),<sup>6,16</sup> the Urinary Incontinence Severity Score (UISS),<sup>16</sup> Detrusor Instability Score (DIS),<sup>16</sup> and visual analogue scale (VAS) of urinary problems;<sup>16</sup> one study reported a non-validated QoL outcome only that consisted of one question (Figure 2).<sup>17</sup> In the study that assessed VAS of urinary problems (0 represents no urinary problems, and 100 represents unbearable urinary problems), results suggest that urinary complaints decreased substantially from baseline (median=75.0, range: 35-100) to 17-years post-operation (median=9.0, range: 0-

100).<sup>16</sup> In the study that assessed QoL using the KHQ, there was significant improvement in all nine domains of the KHQ at 3 months which persisted at the 4-year follow-up: scores on the domains ranged from 57.5 to 95.3 at baseline and 0 to 3.8 at the 4-year follow-up.<sup>8</sup> IIQ-7 scores improved significantly compared to baseline in studies that assessed follow-up at 3 and 5 years,<sup>6</sup> 12 years<sup>5</sup> and 13 years.<sup>4</sup> In the study that assessed IIQ-7 at the 17-year follow-up, the median score was 0 (range: 0 to 16); however, baseline data for comparison were not reported.<sup>16</sup> Compared to baseline, PISQ-12 scores were not significantly different at the 12-year<sup>5</sup> and 13-year<sup>4</sup> follow-ups in two studies. However, in another study, compared to baseline, PISQ-12 scores improved at 3 years but were not significantly improved at the 5-year follow-up.<sup>6</sup> Lastly, improvements were seen in UDI-6 scores at 3 and 5 years,<sup>6</sup> and UDI-6 and UISS scores at 17 years<sup>16</sup>

Figure 2: Quality of life instruments reported by SUI studies

No QoL Outcome Reported	Validated QoL Outcome Reported	Non-Validated QoL Outcome Reported
<ul style="list-style-type: none"> <li>• Lee<sup>10</sup>, 2010</li> <li>• Liapis<sup>11</sup>, 2010</li> <li>• Bakas<sup>12</sup>, 2018</li> <li>• Bakas<sup>13</sup>, 2019</li> <li>• Serati<sup>14</sup>, 2012</li> <li>• Serati<sup>15</sup>, 2017</li> <li>• Kociszewski<sup>9</sup>, 2010</li> <li>• Jiang<sup>7</sup>, 2013</li> <li>• Yonguc<sup>18</sup>, 2016</li> <li>• Braga<sup>19</sup>, 2018</li> </ul>	<ul style="list-style-type: none"> <li>• Chung<sup>8</sup>, 2010 (KHQ)</li> <li>• Zhang<sup>4</sup>, 2018 (IIQ-7; PISQ-12)</li> <li>• Zhang<sup>5</sup>, 2019 (IIQ-7; PISQ-12)</li> <li>• Nilsson<sup>16</sup>, 2013 (DIS, UISS, UDI-6, IIQ-7, VAS)</li> <li>• Lo<sup>7</sup>, 2016 (UDI-6, IIQ-7; PISQ-12)</li> </ul>	<ul style="list-style-type: none"> <li>• El-Eweedy<sup>17</sup>, 2014 (McConnell 1994 questionnaire)</li> </ul>

### Voiding

Eight studies reported on voiding dysfunction: four studies reported voiding difficulty,<sup>9,14,16,17</sup> two studies reported bladder emptying difficulties,<sup>12,13</sup> two studies reported voiding dysfunction

requiring catheterization and tape removal,<sup>4,5</sup> and one study reported voiding symptoms (Table A1 in Appendix 3).<sup>5</sup> Voiding difficulty was observed in 4.9% of patients at 48 months,<sup>9</sup> 2.1% of patients at 71 months,<sup>17</sup> 3.4% of patients at 120 months,<sup>14</sup> and 1.7% of patients at 201 months.<sup>16</sup> Bladder emptying difficulties were observed in 7.1% of patients at 157.2 months<sup>12</sup> and 17.9% of patients in 204 months<sup>13</sup> (the latter study was a longer-term follow-up of the former cohort). Voiding symptoms were observed in 21.9% of patients at 144 months.<sup>5</sup> No patients experienced voiding dysfunction that required catheterization and tape removal.<sup>4,5</sup>

## **Pain**

Six studies reported pain: two studies reported dysuria,<sup>11,15</sup> two studies reported groin pain,<sup>5,6</sup> one study reported leg pain,<sup>11</sup> one study reported leg or pelvic pain,<sup>12</sup> and one study reported “pain” more generally (Table A1 in Appendix 3).<sup>4</sup> Dysuria was observed in 7.3% of patients at 48 months<sup>11</sup> and 1.8% of patients at 156 months.<sup>15</sup> Groin pain was not observed in any patients at 60 months<sup>6</sup> and 1.4% of patients at 144 months.<sup>5</sup> Leg pain was observed in 12.2% of patients at 48 months.<sup>11</sup> Rate of leg or pelvic pain was 0% at 157.2 months.<sup>12</sup> Lastly, no pain was reported at 156 months in one study that assessed “pain” more generally.<sup>4</sup>

Dyspareunia (painful sexual intercourse) was reported in five studies,<sup>4,5,12,13,15</sup> two of which were later follow-up studies of the same cohorts (Table A1 in Appendix 3).<sup>4,13</sup> Dyspareunia was observed in 6.7% of patients at 144 months,<sup>5</sup> no patients at 156 months in one study<sup>15</sup> and 6.9% of patients at 156 months in another study,<sup>4</sup> no patients at 157.2 months,<sup>12</sup> and no patients at 204 months.<sup>13</sup>

## **Recurrence**

Four studies reported recurrence.<sup>6,7,9,18</sup> The following rates of recurrence were observed: 8.9% at 36 months,<sup>6</sup> 29.3% at 48 months,<sup>9</sup> 24.2% at 66.3 months,<sup>7</sup> and 2.97% at 69.83 months.<sup>18</sup>

### **3.2 Quality assessment**

Overall, studies were of low quality (Table A2 in Appendix 3). While 13 of the 16 studies identified some confounding factors in their population, important risk factors like body mass index (BMI) were often overlooked. Three of the studies did not report any confounding factors. Strategies to deal with confounding factors were stated in some studies, but the description of these methods and the results of using these strategies were not reported.

While the outcomes in studies were mostly measured in reliable ways, the data were seldom reported clearly, with the total population at risk at various follow-up times often unreported. All studies reported sufficient follow-up time, since analysts excluded studies for which follow-up time was unclear, but the number of patients lost to follow-up, the reasons for their departures from the study, and the way their data were handled were frequently not reported. While no studies used specifically inappropriate statistical methods, descriptions of methods were often very brief and unclear.

### **3.3 Discussion**

Evidence from the studies that examined long-term complications and quality of life associated with mesh repair of SUI suggests that recurrence rates ranged considerably across studies and follow-up time-points. Notably, recurrence was observed in 8.9% of patients at 36 months,<sup>6</sup> 29.3% of patients at 48 months,<sup>9</sup> 24.2% of patients at 66.3 months,<sup>7</sup> and 2.97% of patients at 69.83 months.<sup>18</sup>

Rates of other commonly reported complications, namely voiding difficulties and pain, ranged across studies and follow-up time-points, but overall were relatively low. Ten out of the 16 studies did not report QoL data, and only five studies used validated measures. Overall, reporting of QoL and safety data was not consistent across studies and did not appear to be of very good quality. Nonetheless, except the PISQ-12 instrument, all instruments used in all studies demonstrated that quality of life for participants improved after their mesh surgery.

Importantly, many of the studies reported on a single center experience of a single surgeon, which limits the generalizability of the findings to practitioners with different skillsets that use different SUI repair techniques. Furthermore, several of these studies reported follow-up longer than 12 years after the initial surgery. It is likely that SUI repair techniques have evolved over that time period, which limits the generalizability of the repair technique that was used in the original study to the present day.

In keeping our criteria similar to the criteria used in the RCT review used in the prior HTA, we excluded many papers that included patients with mixed urinary incontinence. MUI may be caused by a different mechanism than pure SUI,<sup>20</sup> and heightened urgency symptoms are associated with higher rates of failure in anti-incontinence surgery.<sup>21</sup> We also excluded patients with recurrent SUI, and those who underwent concomitant procedures. Repeat mid-urethral sling

procedures are significantly less likely to succeed completely, and are associated with more complications than primary procedures.<sup>22</sup> Although some evidence indicates that concomitant POP procedures do not affect SUI surgery outcomes, this hypothesis has not been tested across various combinations of mid-urethral slings and POP surgery techniques.<sup>23</sup> The requirement for a study to have a population of patients with pure, primary SUI treated with one mesh procedure only eliminated many studies from this review.

Requiring that papers report study data at clearly defined follow-up times also excluded many studies from this review. Long-term evidence about the safety of surgical mesh was missing from the review of RCTs which this review was designed to supplement. The RCTs included in the prior review provided robust evidence up to 12-18 months after implantation, but long-term safety evidence was lacking. In order to supplement the RCT review, we were only interested in long-term outcomes (>3 years after mesh implantation). This requirement excluded many studies for which complications were not stratified into early- and late-presenting complications. Thus, even some studies that reported follow-up times longer than 3 years were excluded if the complications data did not indicate which complications occurred late in the follow-up period and which complications occurred closer to the operation.

Despite the inclusion of 16 papers presenting data on surgical mesh for SUI, most outcomes were reported by very few papers. All but two complications were reported by no more than three studies. Voiding issues are complications commonly associated with incontinence procedures, but the studies included in this review did not report these complications similarly to one another. For example, voiding difficulty was reported by three studies,<sup>9,14,17</sup> while voiding difficulty and urge symptoms were reported by two studies,<sup>9,16</sup> and difficulty emptying bladder was reported by two studies with the same population.<sup>12,13</sup> It was not clear how these studies defined the complications they reported, so it was possible that they measured and defined these complications differently from one another. In the absence of standardized reporting, the data presented by these studies could have referred to the same phenomenon, or not.

### **3.4 Conclusions**

While 16 studies were identified that met our inclusion criteria, few studies shared outcomes and follow-up times in common with one another. The variability in QoL instruments and complications reporting made it difficult to compare studies with one another.

Table 2: Complications reported by SUI studies

First Author, Year	Mesh						Voiding						Pain				Erosion				Dyspareunia	Recurrence		
	Sling Erosion	Sling Division	Mesh Erosion	Tape Rejection	Tape Exposure	Tape/Mesh Extrusion	Dysuria	Urge	Difficulty Emptying Bladder	Voiding Difficulty	Voiding dysfunction requiring catheterization or tape removal	Voiding difficulty and urge	Obstructive complications	Groin or suprapubic	Groin	Leg	Leg or pelvic	Erosion not specified	Vaginal	Bladder or urethral			Vaginal, bladder, or urethral	Vaginal or urethral
Chung, 2010 <sup>8</sup>	✓	✓																						
Lee, 2010 <sup>24</sup>																						✓		
Liapis, 2010 <sup>25 a</sup>							✓	✓								✓								
Bakas, 2018 <sup>12a</sup>				✓					✓								✓							✓
Bakas, 2019 <sup>13 a</sup>					✓				✓															✓
Serati, 2012 <sup>14b</sup>									✓												✓			
Serati, 2017 <sup>26b</sup>							✓												✓					✓
Zhang, 2018 <sup>27</sup>					✓					✓				✓										✓
Zhang, 2019 <sup>4</sup>					✓					✓			✓											✓
Kociszewski, 2010 <sup>9</sup>								✓	✓		✓	✓												✓
Jiang, 2013 <sup>7</sup>			✓																					✓
Nilsson, 2013 <sup>16</sup>						✓					✓													
El-Eweedy, 2014 <sup>17</sup>									✓									✓						
Lo, 2016 <sup>6</sup>						✓								✓			✓							✓
Yonguc, 2016 <sup>18</sup>																		✓						✓
Braga, 2018 <sup>19</sup>																				✓				
<b>Total</b>	1	1	1	1	3	2	2	2	2	3	2	2	1	1	2	1	1	1	2	1	2	1	5	4

Note: <sup>a</sup> Same cohort different follow up time; <sup>b</sup> Same cohort different follow up time



## 4 Pelvic organ prolapse

### 4.1 Results

Our searches identified 6930 abstracts for all three conditions. After removing duplicates, 5500 records remained. We excluded 4981 of these records as irrelevant, leaving 519 studies to review at the full-text review stage. None of these studies were included in the POP review. The PRISMA flow-chart of each review stage is included in Figure A1 in Appendix 2: PRISMA diagram.

#### 4.1.1 Included studies

Among these 519 studies, no studies meeting our criteria for evaluating surgical mesh for POP were identified.

### 4.2 Discussion

Due to our strict criteria, we did not include any studies evaluating mesh surgery for POP. We excluded studies that reported performing concomitant procedures in some or all of their participants without stratifying the results. We also excluded studies that examined recurrent prolapse and studies that did not address a general population (e.g., studies that examined elderly patients only). This review is positioned to shore up the shortcomings of the RCT review, so keeping most of the previous parameters for inclusion of studies was considered to be important. If we had included studies whose population differed in some relevant way from the populations we included in the RCT review, then we would have been unable to compare the results of this review to the results of the RCT review.

Concurrent surgeries performed was the most common reason for exclusion of POP studies. Fifty-five percent of women with stage 2 prolapse also suffer from SUI, and occult SUI (which manifests only when the prolapse is reduced) may be present in up to 68%.<sup>28</sup> Concomitant surgery to address SUI in POP patients is common and affects some urinary outcomes and complication rates. It is unclear whether concomitant SUI surgery for POP affects rates of recurrence. Hysterectomies are also commonly performed as part of POP repair surgeries and are shown to impact short-term complication rates, although long-term data are scarce.<sup>29</sup> Concomitant hysterectomy has also been shown to decrease rates of re-operation for POP.<sup>30</sup> Thus, because concomitant surgeries may affect the rates of complications and recurrence,

including these studies in our review would have made the results of this review incongruent with the results of the RCT review.

Recurrent POP accounts for approximately 30% of POP repair surgeries. The anatomy of recurrent prolapse differs from that of primary prolapse.<sup>31</sup> While these differences may not affect the choice of treatment course, they may affect outcomes, given that prior pelvic surgery is a major risk factor for recurrent or subsequent prolapse.<sup>32</sup> Thus, including patients with recurrent prolapse may have impacted the results of this review, and rendered the review less useful in filling the gaps of the RCT review.

Requiring studies to report complications after 36 months also diminished the pool of studies that met our criteria. Numerous papers reported complications as a single block, combining perioperative, immediate post-operative, short-term, and long-term complications. For these papers, it was not possible to determine whether any given complication, for example a case of mesh erosion, occurred within months of implantation or years thereafter. The systematic review of RCTs performed as part of the HTA included a meta-analysis of complications data, but only up to 1-2 years after surgery. Since the RCT review provided robust short-term complication data, we aimed to include long-term complications only in this review. Without the ability to determine when a complication occurred, including all data from short- and long-term observations would have skewed the results of this review. For example, reporting an overall erosion rate of over several years of follow-up would not provide information about long-term complications specifically, since it is possible that all the cases of erosion occurred in the first few months after surgery. Thus including this data would not have provided information about long-term complications.

Since the purpose of this review is to supplement the RCT review, our criteria mandated the inclusion of observational studies that assessed similar populations as RCTs. Specifically, in order to evaluate the complications and impact of surgical mesh for POP repair, our RCT review required that included studies assessed populations without complicating factors. However, actual clinical practice is more complex. Concurrent surgeries and recurrent cases of prolapse are both common, so studies designed to assess the way POP surgeries are performed in real-world practice include patients subject to these complicating factors. Both these factors have the potential to significantly impact outcomes, as they are relevantly different from pure and primary

POP surgeries. Therefore including these papers would have resulted in a review that was not well-positioned to supplement the RCT review.

### **4.3 Conclusions**

No studies of surgical mesh for POP repair met the criteria we established for this review, which were designed to position this review of observational studies as a supplement to the RCT review performed as part of the HTA published in February 2019.

## 5 Inguinal hernia

### 5.1 Results

Our searches identified 6930 abstracts for all three conditions. After removing duplicates, 5500 records remained. We excluded 4981 of these records as irrelevant, leaving 519 studies to review at the full-text review stage. Two of these studies were included in the hernia review. The PRISMA flow-chart of each review stage is included in Figure A1 in Appendix 2: PRISMA diagram.

#### 5.1.1 Included studies

Two studies assessing mesh for inguinal hernia were included.<sup>33,34</sup> One study took place in the UK in 2010<sup>33</sup> and the other in Japan in 2014.<sup>34</sup> The 2010 study used a modified version of the plug-and-patch technique for mesh implantation,<sup>33</sup> while the other study used either a mesh plug technique, or the Prolene Hernia System (PHS).<sup>34</sup> In the 2010 study, a cohort of 47 male patients was followed up by questionnaire after 7 years, and a cohort of 78 male patients was followed up at 5 years.<sup>33</sup> In the 2014 study, 716 patients (n=611 for PHS, n=105 for mesh plug) were followed for a mean of  $43 \pm 42$  months, with recurrence rates reported by time period (Table A3 in Appendix 4: Characteristics and quality assessment for inguinal hernia studies ).<sup>34</sup>

#### 5.1.2 Findings

Table 3 presents the outcomes reported by each study, and whether they were collected by validated methods. Bhattacharjee et al assessed groin symptoms, including pain, discomfort, and restriction. In the 5 year-follow up cohort, 4/78 patients experienced groin discomfort, 5/78 experienced pain, and 2/78 experienced restriction. In the cohort followed up after 7 years, 3/47 patients experienced discomfort, 2/47 experienced pain, and 2/47 experienced restriction. When asked if they would have the same procedure performed again, 105/106 patients replied “yes.”<sup>33</sup>

Hayashi et al addressed both chronic pain and recurrence, but did not report pain specifically after 3 year of follow-up; they reported pain at 2 years, and did not differentiate between male and female patients for pain outcomes. Thus, we were not able to use their data on chronic pain. This study reported a rate of hernia recurrence at 5 year follow-up, and stratified this outcome by male and female participants. Among 1020 male patients, 14 (1.4%) experienced recurrence at 5 years.<sup>34</sup>

Table 3: Outcomes reported across included inguinal hernia studies

Author, country, year	Pain		Recurrence		Patient perspective	
	Reported?	Valid?	Reported?	Assessed in person?	Reported?	Valid?
Bhattacharjee, UK, 2010 <sup>33</sup>	✓	✗	✗	N/A	✓	✗
Hayashi, Japan, 2014 <sup>34</sup>	✗	N/A	✓	✗	✗	N/A

## 5.2 Quality assessment

Overall, the two studies assessing hernia were found to be of low to moderate quality (Table A4 in Appendix 4: Characteristics and quality assessment for inguinal hernia studies). Confounding factors that may affect the outcomes of the study, and strategies to deal with these factors were identified for one study,<sup>34</sup> while the other study failed to identify confounding factors.<sup>33</sup>

Bhattacharjee et al assessed groin symptoms in hernia patients after surgery, so in this study the participants were not free from the outcome of interest at the beginning of the study.<sup>33</sup> Although follow up time was reported for both studies, follow up was missing for several participants in Bhattacharjee et al’s study, with no strategies to address the incomplete follow up.<sup>33</sup> It was also unclear if this study used appropriate statistical analysis. Hayashi’s study used appropriate statistical analysis.<sup>34</sup>

## 5.3 Discussion

Both studies used non-validated questionnaires to gather their results. While this method of data collection allows for many patients to be contacted without requiring the patients to appear in person, non-validated questionnaires may not provide reliable data. In particular, patient satisfaction and pain levels are prone to subjectivity. For example, asking patients to describe their pain as mild, moderate, or severe (as Hayashi et al did)<sup>34</sup> may be interpreted differently than asking patients to describe their pain as bad, very bad, awful, or incapacitating (as Bhattacharjee did).<sup>33</sup> As such, assessment of these outcomes using non-validated measures should be treated with caution.

Our ability to draw conclusions from these studies is limited by the number of studies included and the outcomes they report. Strict criteria excluded many studies from this review. In particular, many studies included some female participants but did not stratify their outcomes by sex. In our review of RCTs performed as part of the prior HTA, we excluded studies with female participants. There are significant anatomical differences between inguinal hernias in men and women, and observed recurrence of inguinal hernia in women may actually be the manifestation of previously undiagnosed femoral hernia.<sup>35</sup> Many cohort studies included some female patients, and were thus excluded from our analysis.

Requiring studies to report complications after 3 years postoperatively also excluded many papers that reported perioperative, immediate postoperative, short-term, and long-term complications as a block. Since the review of RCTs in the original HTA provided a strong analysis of short-term complications, we aimed only to report late complications. When all complications were reported simultaneously without distinguishing between early- and late-presenting complications, we were unable to determine whether the data presented met our criteria for occurring after 3 years post-operatively. Thus, we excluded papers which did not present complication data by time period.

The two studies did not overlap in terms of their reported outcomes. Bhattacharjee et al reported groin symptoms, including pain, and patient satisfaction.<sup>33</sup> Based on their reporting of results, recurrence was the only outcome that we could extract from the Hayashi et al study.<sup>34</sup>

Since only two studies were identified that met our criteria and they did not report the same outcomes, meta-analysis was not feasible.

#### **5.4 Conclusions**

Two studies assessing surgical mesh for inguinal hernia repair were included. These studies addressed different outcomes, with one focusing on groin symptoms and patient satisfaction, while the other study addressed recurrence. Bhattacharjee et al found low rates of chronic pain and discomfort (<7%), and Hayashi et al reported a low recurrence rate (1.4%).

## 6 Discussion

The current review aims to supplement the evidence obtained from the three systematic reviews of the RCT literature that were included in a previously completed HTA. The RCT literature did not include many data on the long-term complication rates associated with mesh surgeries, nor the impact of these procedures on quality of life, due to insufficient data. This review of cohort studies was meant to fill the gaps in the RCT literature by evaluating the safety and patient experience of surgical mesh 36 or more months after implantation. This review did not examine efficacy outcomes, such as cure rates, since these outcomes are most reliably addressed by studies with a randomized design.

While the paucity of literature meeting our criteria precluded meta-analysis, the general trend in the SUI literature indicated that implantation of mesh for SUI repair resulted in better quality of life for patients. Instruments used to measure quality of life varied significantly between studies, but in general the parameters reported by these instruments demonstrated significant improvement from baseline measurements to follow-up. Recurrence rates for SUI ranged between approximately 3% to approximately 30%. Rates of dyspareunia were reported by five studies, but two of these studies were later follow-ups of other studies reporting dyspareunia, so only three individual cohorts could be identified. Rates of other complications varied as well, but each complication was reported by no more than three studies.

Two studies examining mesh for inguinal hernia repair met our inclusion criteria. These studies reported no outcomes in common with one another, limiting our ability to draw conclusions from these data.

The criteria used for including studies in this review were designed to isolate studies that addressed the dearth of long-term safety and quality of life data in the RCT literature. These criteria imposed limitations on the scope of our analysis. We only included papers that clearly indicated that the complications reported by the study occurred 36 months or more after implantation of surgical mesh. This criterion excluded papers that did not indicate the timelines of when complications occurred, even if their overall follow-up time exceeded 36 months.

Other than the follow-up time restriction of 36 months or more, we kept our criteria as similar as possible to the criteria used in the reviews of RCTs performed as part of the HTA on surgical

mesh. Thus, we excluded studies that addressed recurrent SUI, POP, and inguinal hernia. We also excluded studies with heterogeneous populations, for example studies that included both patients with SUI and patients with mixed urinary incontinence (MUI), or studies that included both male and female inguinal hernia patients. We excluded studies in which all or some patients underwent concurrent procedures, for example implantation of surgical mesh for POP with a concomitant procedure to address incontinence, and studies that addressed particular populations, for example obese or elderly patients. These criteria ensured that studies included in this review were comparable to the RCT literature in terms of variables other than follow-up time that may impact rates of complications and quality of life.

The stringent requirements for clearly reported follow-up time and patient selection limited our inclusions to a small pool of studies. In particular, studies examining mesh for POP frequently included patients undergoing concomitant procedures for SUI or hysterectomy. While concurrent surgeries, such as hysterectomy performed during POP surgery, are common in clinical practice, they may affect outcomes.<sup>29</sup> Including these papers would have impacted the results of this review, making the results less commensurate with those of the systematic review of RCTs and diminishing the usefulness of this review in shoring up the gaps in the RCT literature. Similarly, papers examining mesh for inguinal hernia were excluded for including some female patients, and studies examining mesh for SUI were excluded for including some patients with MUI.



## 7 **Conclusions**

While 16 studies assessed mesh for SUI, these studies were non-standard in their reporting and aside from dyspareunia and recurrence, no complication was reported by more than three studies. Quality of life tools were similarly variable. For inguinal hernia, the two studies identified shared no outcomes in common. Studies were also generally of low quality. No studies assessing mesh for POP repair met our criteria for inclusion. Due to these limitations, conclusions about the long-term safety of surgical mesh cannot be drawn from this evidence.

## 8 References

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## Appendix 1: Search strategies

### MEDLINE

1. Hernia, Inguinal/
2. (inguinal\* adj5 hernia\*).tw,kf.
3. (groin adj5 hernia\*).tw,kf.
4. 1 or 2 or 3
5. Surgical Mesh/
6. (mesh or polypropylene mesh\* or surgical mesh\* or synthetic mesh\*).tw,kf.
7. (hernia patch or Kugel patch or Lichtenstein patch or (plug and patch) or (plug and dart)).tw,kf.
8. 5 or 6 or 7
9. 4 and 8
10. exp Pelvic Organ Prolapse/
11. Pelvic Floor/
12. Prolapse/
13. 11 and 12
14. ((pelvic or pelvis or uterus or uterine or vagina\*) adj3 (prolapse\* or reconstructive surger\* or repair\*)).tw,kf.
15. 10 or 13 or 14
16. 5 or 6
17. 15 and 16
18. Urinary Incontinence, Stress/
19. (stress adj1 incontinence).tw,kf.
20. (stress incontinence or ((urine incontinence or urinary incontinence) adj3 stress)).tw,kf.
21. sui.tw,kf.
22. 18 or 19 or 20 or 21
23. Suburethral Slings/
24. (tape or mid-urethral sling or single-incision sling or mini-sling or TVT or TOT or TVT-O or MUS or SIMS or TVT Secur).tw,kf.
25. 5 or 6 or 23 or 24
26. 22 and 25
27. 9 or 17 or 26
28. limit 27 to (english or french)
29. animals/ not humans/
30. 28 not 29
31. limit 30 to (case reports or clinical trial, all or editorial or letter)
32. 30 not 31
33. limit 32 to "review articles"
34. 32 not 33

### EMBASE

1. inguinal hernia/
2. (inguinal\* adj5 hernia\*).tw,kw.
3. (groin adj5 hernia\*).tw,kw.
4. 1 or 2 or 3

5. exp surgical mesh/
6. (mesh or polypropylene mesh\* or surgical mesh\* or synthetic mesh\*).tw,kw.
7. 5 or 6
8. (hernia patch or Kugel patch or Lichtenstein patch or (plug and patch) or (plug and dart)).tw,kw.
9. 7 or 8
10. 4 and 9
11. exp pelvic organ prolapse/
12. pelvis floor/
13. ((pelvic or pelvis or uterus or uterine or vagina\*) adj3 (prolapse\* or reconstructive surger\* or repair\*)).tw,kw.
14. 11 or 12 or 13
15. 14 and 7
16. stress incontinence/
17. (stress incontinence or ((urine incontinence or urinary incontinence) adj3 stress)).tw,kw.
18. (stress adj1 incontinence).tw,kw.
19. 16 or 17 or 18
20. (tape or mid-urethral sling or single-incision sling or mini-sling or TVT or TOT or TVT-O or MUS or SIMS or TVT Secur).tw,kw.
21. 7 or 20
22. 19 and 21
23. 10 or 15 or 22
24. limit 23 to (english or french)
25. limit 24 to animal studies
26. limit 24 to human
27. 25 not 26
28. 24 not 27
29. limit 28 to conference abstract
30. 28 not 29
31. limit 30 to (editorial or letter or "review")
32. 30 not 31
33. limit 32 to (clinical trial or randomized controlled trial or phase 1 clinical trial or phase 2 clinical trial or phase 3 clinical trial or phase 4 clinical trial)
34. 32 not 33
35. case study/
36. 34 not 35

*PsyncINFO*

1. (inguinal\* adj5 hernia\*).tw.
2. (groin adj5 hernia\*).tw.
3. 1 or 2
4. (mesh or polypropylene mesh\* or surgical mesh\* or synthetic mesh\*).tw.
5. (hernia patch or Kugel patch or Lichtenstein patch or (plug and patch) or (plug and dart)).tw.

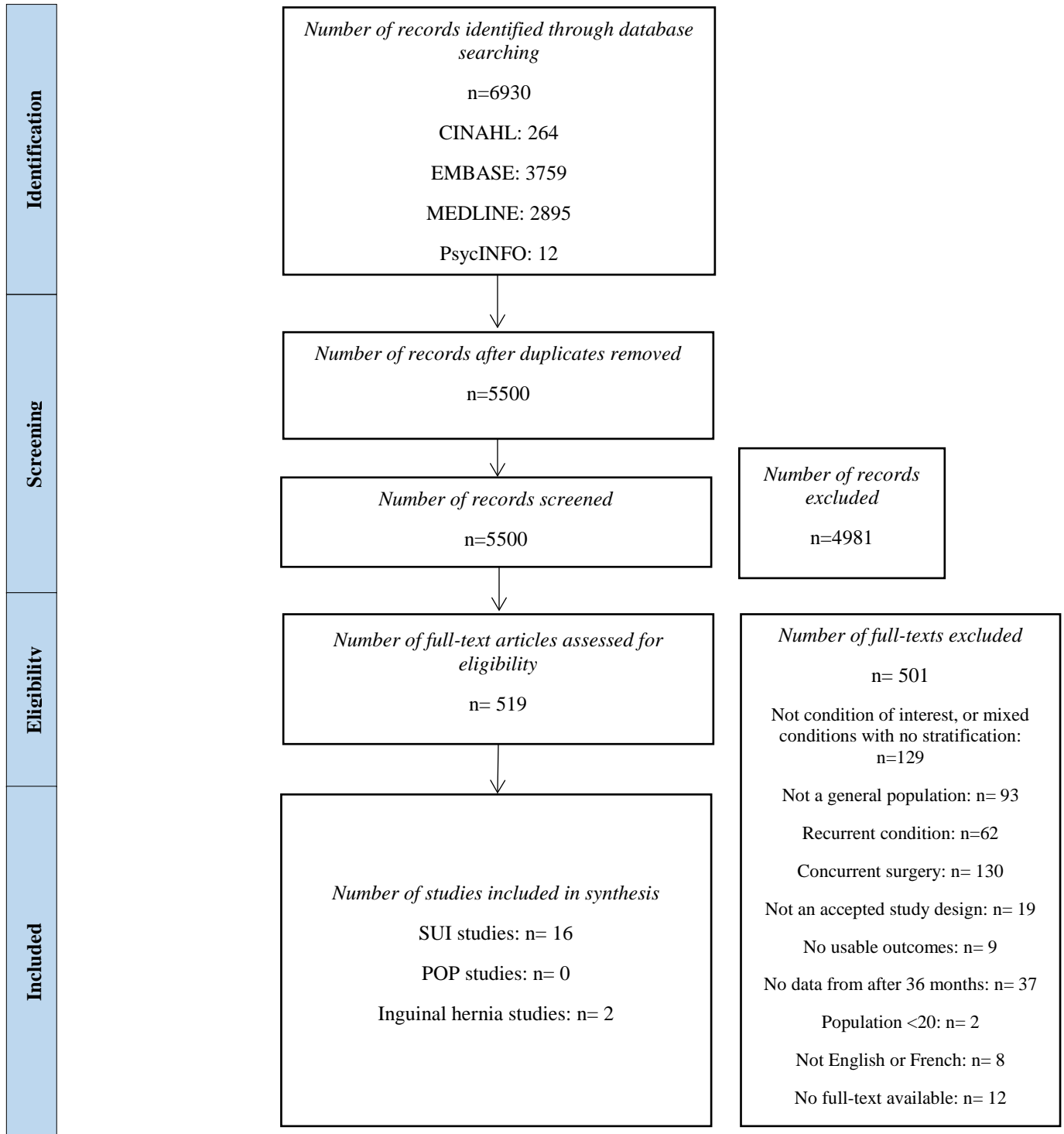
6. 4 or 5
7. 3 and 6
8. ((pelvic or pelvis or uterus or uterine or vagina\*) adj3 (prolapse\* or reconstructive surger\* or repair\*)).tw.
9. 4 and 8
10. urinary incontinence/
11. (stress adj1 incontinence).tw.
12. (stress incontinence or ((urine incontinence or urinary incontinence) adj3 stress)).tw.
13. sui.tw.
14. 10 or 11 or 12 or 13
15. (tape or mid-urethral sling or single-incision sling or mini-sling or TVT or TOT or TVT-O or MUS or SIMS or TVT Secur).tw.
16. 4 or 15
17. 14 and 16

### CINAHL

1. (MH "Hernia, Inguinal") OR TI (inguinal\* N5 hernia\*) OR AB (inguinal\* N5 hernia\*) OR TI (groin N5 hernia\*) OR AB (groin N5 hernia\*)
2. ((MH "Surgical Mesh") OR TI ( (mesh or polypropylene mesh\* or surgical mesh\* or synthetic mesh\* ) OR AB ( (mesh or polypropylene mesh\* or surgical mesh\* or synthetic mesh\* ) )
3. TI ( hernia patch or Kugel patch or Lichtenstein patch or (plug and patch) or (plug and dart)) ) OR AB ( hernia patch or Kugel patch or Lichtenstein patch or (plug and patch) or (plug and dart)) )
4. 2 or 3
5. 1 and 4
6. ( (MH "Pelvic Organ Prolapse+") OR (MH "Pelvic Floor Muscles") OR (MH "Pelvic Floor Disorders") ) OR TI ( ((pelvic or pelvis or uterus or uterine or vagina\*) adj3 (prolapse\* or reconstructive surger\* or repair\*)) ) OR AB ( ((pelvic or pelvis or uterus or uterine or vagina\*) adj3 (prolapse\* or reconstructive surger\* or repair\*)) )
7. 6 and 2
8. MH "Stress Incontinence") OR TI stress N1 incontinence OR AB stress N1 incontinence OR TI ( ((urine incontinence or urinary incontinence) N3 stress)) ) OR AB ( ((urine incontinence or urinary incontinence) N3 stress)) ) OR TI sui OR AB sui
9. (MH "Suburethral Slings") OR TI ( (tape or mid-urethral sling or single-incision sling or mini-sling or TVT or TOT or TVT-O or MUS or SIMS or TVT Secur) ) OR AB ( (tape or mid-urethral sling or single-incision sling or mini-sling or TVT or TOT or TVT-O or MUS or SIMS or TVT Secur)
10. 2 or 9
11. 8 and 10
12. 5 or 7 or 10
13. Limit 12 to English and French
14. Limit 13 to scholarly peer-reviewed journals
15. Limit 14 to Exclude MEDLINE records

## Appendix 2: PRISMA diagram

Figure A1: PRISMA flow-chart





### Appendix 3: Characteristics and quality assessment for SUI studies

Table A1: Studies assessing mesh for SUI

Author, country, year	Procedure and dates	Inclusion criteria	Exclusion criteria	Procedure; Mesh Material	Population characteristics (mean $\pm$ SD, unless stated otherwise)	Follow-up time; Number of patients (n)	Results
Chung, Australia, 2010 <sup>8</sup>	Two surgeons at one centre; September 2001 to September 2004	Synthetic MUS for urodynamic SUI	Concomitant pelvic floor reconstructive surgery for POP	Mixed; NR	age: 67.6 (range 41.0 to 81.0) parity: NR BMI: NR	48 months n=21	<u>QoL:</u> KHQ Domains Improvement mean (SD) General Perception 3.1 (29.9) Incontinence Impact 3.1 (29.9) Role Limitations 3.8 (29.2) Physical Limitations 0 Social Limitations 3.1 (29.9) Personal Relationships 3.1 (29.9) Emotions 0 Sleep/Energy 3.5 (29.5) Severity Measures 2.1 (17.9) <u>Complications:</u> Sling erosion n=0 Sling division for obstructive voiding n=0
Kociszewski, Germany, 2010 <sup>9</sup>	Two surgeons at one centre; April 2000 to June 2002	Urodynamic SUI and TVT insertion	None reported	TVT; NR	age: 58.8 (range 38.0 to 82.0) parity: NR BMI: median 26.2	48 months n=41	<u>Complications:</u> Recurrence n=12 Voiding difficulty n=2 Urge n=3 Voiding difficulty and urge n=4 Obstructive complication n=8
Lee, J.H. South	Two surgeons at one centre;	SUI	UTI, urogynecological malignancy, concomitant surgery or urogynecological	TVT; NR	age: 55.8 $\pm$ 9.3 parity: 2.8 $\pm$ 0.9 BMI: 26.3 $\pm$ 1.8	85.5 months n=141	<u>Complications:</u> Vaginal/urethral erosion n=0

Korea, 2010 <sup>10</sup>	March 1999 to May 2003		surgery during post-op f/u, and f/u less than 6 years				
Liapis, A. Greece, 2010 <sup>11</sup>  *cohort overlaps with Bakas 2018 <sup>12</sup> and Bakas 2019 <sup>13</sup>	One surgeon at one centre; January 2008 to May 2009	SUI and BMI less than 30	Urodynamic findings of detrusor overactivity, previous operation on the vaginal wall, or maximum urethral closure pressure less than 20cm H2O	TVT-O; NR	age: 56.2 ± 10.3 parity: 2.0 ± 1.0 BMI: 26.3 ± 1.6	48 months n=74	<u>Complications:</u> Urgency 10.8% Dysuria 7.3% Leg pain n=9
Serati, Italy, 2012 <sup>14</sup>  *cohort overlaps with Serati 2017 <sup>15</sup>	One surgeon at one centre; January 2000 to June 2001	Urodynamic SUI	Previous history of anti-incontinence or radical pelvic surgery, psychiatric and neurologic disorders, concomitant vaginal prolapse higher than stage 1 by POP-Q, OAB symptoms, uroynamically proven detrusor overactivity, and PVR >100mL	TVT; NR	age: median 58.0 (range 48.0 to 69.0) parity: NR BMI: NR	120 months n=58	<u>Complications:</u> Vaginal, bladder, or urethral erosion n=0 Voiding difficulties n=2
Jiang, China, 2013 <sup>7</sup>	One surgeon at one centre; 1998 to 2010	SUI and pubovaginal sling procedure with polypropylene suburethral sling and regular post-op f/u for 6 months at a single medical centre	Preoperatively proven urodynamic detrusor overactivity, detrusor underactivity, neurogenic bladder dysfunction, high-grade cystocele requiring concomitant colporrhaphy, and pelvic floor reconstruction	Other; Polypropylene Mesh	age: 60.7 ± 10.6 parity: 3.8 ± 1.8 BMI: 25.5 ± 3.8	66.3 months n=153	<u>Complications:</u> Recurrence n=37 Mesh erosion n=0
Nilsson, Finland +	Three centres;	No prior incontinence surgery, positive stress	None reported	TVT; NR	age: 69.0 (range 51.0 to 89.0)	201 months	<u>QoL:</u>

Sweden, 2013 <sup>16</sup>	January 1995 to August 1996	test and urodynamic SUI, no detrusor over-activity, and a urethral maximal closure pressure >20cm H2O			parity: NR BMI: NR	n=58	DIS (0-20) median 4.0 (range 0.0 to 14.0); n=56 UISS (0-100) median 5.0 (range 0.0 to 75.0); n=56 UDI-6 (0-18) median 3.0 (range 0.0 to 15.0); n=55 IIQ-7 (0-21) median 0.0 (range (0.0 to 16.0); n=55 VAS (0-100) median 9.0 (range (0.0 to 100.0); n=55 <u>Complications:</u> Voiding difficulty n=1 Tape extrusion n=1
El-Eweedy, Egypt, 2014 <sup>17</sup>	Surgeons and centres not reported; December 2005 to February 2008	SUI, undergoing TOT procedure	Concomitant anterior or apical pelvic organ prolapse repair	TOT; NR	age: 44.21 (range 30.0 to 58.0) parity: NR BMI: NR	71 months n=48	<u>QoL:</u> McConnell 1994 <sup>36</sup> QoL (0-6) 1.3 ± 0.4 *0=delighted, 6=terrible <u>Complications:</u> Vaginal erosion n=0 Voiding difficulty n=1
Lo, China, 2016 <sup>6</sup>	One surgeon at one centre; February 2006 to March 2009	Confirmed SUI, treated with TOT procedure without other concurrent surgical procedures	Previous continence surgery, neurological bladder dysfunction, psychiatric conditions, previous radical pelvic surgery, stage >1 pelvic organ prolapse based on ICS grading, overactive bladder symptoms, urodynamically proven detrusor activity, and PVR > 100mL	TOT; NR	age: 52.9 ± 14.1 parity: median 2.0 BMI: 25.4 ± 3.6	60 months n=56	<u>QoL:</u> UDI-6 post 3rd year 4.4 ± 3.5 UDI-6 post 5th year 5.7 ± 3.4 IIQ-7 post 3rd year 4.9 ± 4.1 IIQ-7 post 5th year 5.7 ± 3.7 PISQ-12 post 3 <sup>rd</sup> year 28.9 ± 6.1 PISQ-12 post 5 <sup>th</sup> year 26.7 ± 5.2 <u>Complications:</u> Recurrence at 3 years n=5 Groin pain at 5 years n=0 Erosion n=0 Mesh extrusion n=0

Yonguc, Turkey, 2016 <sup>18</sup>	Two surgeons at two centres; March 2005 to March 2009	SUI, at least 21 years old	Neurological disorder history, previous urethral reconstruction, morbid obesity and pelvic organ prolapse greater than stage 1	TOT; Macroporous monofilament polypropylene	age: 52.9 ± 8.3 parity: median 2.0 (range 0.0 to 5.0) BMI: 29.1 ± 2.7	69.83 months n=101	<u>Complications:</u> Recurrence n=3 Vaginal erosion n=1
Serati, M. Italy, 2017 <sup>15</sup>  *cohort overlaps with Serati 2012 <sup>14</sup>	Single surgeon at one centre; January 2000 to June 2001	Urodynamic SUI	Mixed incontinence, detrusor overactivity and/or any other associated surgical procedure	TVT; NR	age: NR parity: NR BMI: NR	156 months n=55	<u>Complications:</u> Dysuria n=1 Bladder or urethral erosion n=0 Dyspareunia n=0
Bakas, Greece, 2018 <sup>12</sup>  *cohort overlaps with Liapis 2010 <sup>11</sup> and Bakas 2019 <sup>13</sup>	One surgeon at one centre; f/u appointment between April 3 and December 20, 2017	Presence of urodynamic stress urinary incontinence, BMI less than 30, residual urine volume less than 100mL	History of previous surgery in the anterior compartment for prolapse or SUI, mixed incontinence, maximum urethral closure pressure less than 20cm H2O, and urodynamic findings of detrusor overactivity	TVT-O; NR	age: 68.5 ± 10.3 parity: median 2.0 (range 0.0 to 4.0) BMI: 27.2 ± 1.8	157.2 months n=70	<u>Complications:</u> Difficulty emptying bladder n=5 Dyspareunia n=0 Leg or pelvic pain n=0 Tape rejection n=1 (this occurs at 37 months, and was not reported in Liapis et al., 2010 <sup>11</sup> )
Braga, Switzerland + Italy, 2018 <sup>19</sup>	Two centres; January 1998 to January 2000	Complaints of pure SUI symptoms with urodynamic SUI	History of radical pelvic surgery, psychiatric and neurological disorders, concomitant vaginal prolapse greater than stage 1 (POP-Q), OAB symptoms, urodynamically proven detrusor overactivity, PVS > 100 mL	TVT; NR	age: median 60.0 (IQR: 51.0 to 72.0) parity: median 2.0 (IQR: 1.0 to 4.0) BMI: median 25.9 (IQR: 25.0-28.0)	204 months n=46	<u>Complications:</u> Bladder, vaginal, or urethral erosion n=0

<p>Zhang, Y. China, 2018<sup>5</sup></p> <p>*cohort overlaps with Zhang 2019<sup>4</sup></p>	<p>Single surgeon at one centre; August 2004 to August 2006</p>	<p>Involuntary leakage when abdominal pressure is increased, urodynamic SUI, and failure of conservative treatment</p>	<p>UII or MUI, overactive bladder symptoms, PVR &gt; 100mL, detrusor underactivity, POP requiring surgery, or history of POP or SUI surgery</p>	<p>TVT-O; NR</p>	<p>age: 53.0 ± 12.0 parity: median 1.0 (IQR 1.2) BMI: 25.0 ± 4.0</p>	<p>144 months n=73</p>	<p><u>QoL:</u> IIQ7 total score median 0 (IQR 0 to 1) PISQ-12, median 33 (IQR 29 to 36) in 30 sexually active patients <u>Complications:</u> Voiding dysfunction requiring catheterization, tape removal, or both n=0 Voiding symptoms n=16 Groin pain n=1 Dyspareunia n=2 of 30 sexually active patients Tape exposure n=4</p>
<p>Bakas, Greece, 2019<sup>13</sup></p> <p>*cohort overlaps with Liapis 2010<sup>11</sup> and Bakas 2018<sup>12</sup></p>	<p>One surgeon at one centre; see Liapis et al., 2010<sup>11</sup></p>	<p>Pure urodynamic SUI with stage 1 prolapse or less of the anterior compartment (POP-Q)</p>	<p>Urodynamic findings of detrusor overactivity, previous operation in the genital tract or maximum urethral closure pressure of less than 20cm H<sub>2</sub>O, prolapse of the middle or posterior compartment requiring management</p>	<p>TVT; NR</p>	<p>age: NR parity: NR BMI: NR</p>	<p>204 months n=56</p>	<p><u>Complications:</u> Difficulty emptying bladder n=10 Tape exposure n=1 Dyspareunia n=0</p>
<p>Zhang, China, 2019<sup>4</sup></p> <p>*cohort overlaps with Zhang 2018<sup>5</sup></p>	<p>One surgeon at one centre; January 2004 to December 2005</p>	<p>Complaints of involuntary leakage when abdominal pressure is increased, urodynamic SUI, failure of conservative treatment</p>	<p>Urgency or mixed urinary incontinence, intrinsic sphincter dysfunction defined as a Valsalva leak-point pressure &lt; 60cm H<sub>2</sub>O; PVR &gt; 100mL; and pelvic organ prolapse requiring surgery.</p>	<p>TVT; Polypropylene</p>	<p>age: 52.0 ± 11.0 parity: median 2.0 (IQR: 1.0 to 3.0) BMI: 25.0 ± 3.0</p>	<p>156 months n=70</p>	<p><u>QoL:</u> IIQ-7 at 5 years median 0.0 (IQR 0.0 to 0.0) IIQ-7 at 10 years median 0.0 (IQR 0.0 to 0.5) IIQ-7 at 13 years median 0.0 (IQR 0.0 to 0.8) PISQ-12 (n=29 sexually active patients) PISQ-12 at 5 years, median 36 (IQR 33 to 38) PISQ-12 at 10 years, median 34 (IQR 31 to 37)</p>

							PISQ-12 at 13 years, median 33 (IQR 29 to 35) <u>Complications:</u> Voiding dysfunction requiring catheterization or tape removal n=0 Pain n=0 Dyspareunia n=2 of 29 Tape exposure n=2
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Table A2: Quality assessment of SUI studies

Author Country Year	1. Groups similar and recruited from the same population?	2. Exposures measured similarly to assign to groups?	3. Exposure measured in a valid and reliable way?	4. Confounding factors identified?	5. Strategies to deal with confounding factors stated?	6. Participants free of outcome at start of study?	7. Outcomes measured in valid and reliable way?	8. Follow up time reported and sufficient?	9. Follow-up complete, or reasons why not reported?	10. Strategies to address incomplete follow up utilized?	11. Appropriate statistical analysis used?
Chung, Australia, 2010 <sup>8</sup>	N/A	N/A	N/A	No	No	No	Yes	Yes	Yes	N/A	Yes
Kociszewski, Germany, 2010 <sup>9</sup>	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Lee, J.H. South Korea, 2010 <sup>10</sup>	N/A	N/A	N/A	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Liapis, A. Greece, 2010 <sup>11</sup>  *cohort overlaps with Bakas 2018 <sup>12</sup> and Bakas 2019 <sup>13</sup>	N/A	N/A	N/A	Yes	No	Yes	Yes	Yes	Yes	N/A	Yes
Serati, Italy, 2012 <sup>14</sup>  *cohort overlaps with Serati 2017 <sup>15</sup>	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Jiang, China, 2013 <sup>7</sup>	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nilsson, Finland + Sweden, 2013 <sup>16</sup>	N/A	N/A	N/A	No	N/A	No	Yes	Yes	Unclear	No	No

El-Eweedy, Egypt, 2014 <sup>17</sup>	N/A	N/A	N/A	No	N/A	Yes	Yes	Yes	Yes	N/A	No
Lo, China, 2016 <sup>6</sup>	N/A	N/A	N/A	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Yonguc, Turkey, 2016 <sup>18</sup>	N/A	N/A	N/A	Yes	No	Yes	Yes	Yes	N/A	N/A	Yes
Serati, M. Italy, 2017 <sup>15</sup> *cohort overlaps with Serati 2012 <sup>14</sup>	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Bakas, Greece, 2018 <sup>12</sup> *cohort overlaps with Liapis 2010 <sup>11</sup> and Bakas 2019 <sup>13</sup>	N/A	N/A	N/A	Yes	No	Yes	Yes	Yes	Yes	No	Unclear
Braga, Switzerland + Italy, 2018 <sup>19</sup>	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zhang, Y. China, 2018 <sup>5</sup> *cohort overlaps with Zhang 2019 <sup>4</sup>	N/A	N/A	N/A	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Bakas, Greece, 2019 <sup>13</sup> *cohort overlaps with Liapis	N/A	N/A	N/A	Yes	N/A	Yes	Yes	Yes	Yes	No	Yes



2010 <sup>11</sup> and Bakas 2018 <sup>12</sup>											
Zhang, China, 2019 <sup>4</sup>  *cohort overlaps with Zhang 2018 <sup>5</sup>	N/A	N/A	N/A	Yes	No	Yes	Yes	Yes	Unclear	No	Yes

## Appendix 4: Characteristics and quality assessment for inguinal hernia studies

Table A3: Studies included assessing mesh for hernia

Author, country, year	Procedure and dates	Inclusion criteria	Exclusion criteria	Procedure; Mesh Material	Population characteristics (mean ± SD, unless stated otherwise)	Follow-up time; Number of patients (n)	Results
Bhattacharjee, United Kingdom, 2010 <sup>33</sup>	One surgeon at one centre; 2002 and 2004	200 unselected men	None reported	Plug and patch; NR	age: 64.0 (range 23.0 to 97.0) BMI: NR	84 months n=47	<u>Complications:</u> Groin discomfort after 5 years 4 of 78 Groin discomfort after 7 years 3 of 47 Groin pain after 5 years 5 of 78 Groin pain after 7 years 2 of 47 Groin “restricting” after 5 years 2 of 78 Groin “restricting” after 7 years 2 of 47
Hayashi, Japan, 2014 <sup>34</sup>	One centre; January 199 to December 2008	Adult patients that have undergone primary inguinal hernia repair with the Prolene hernia system and the mesh plug	Concurrent operations or bilateral repair	Mixed; Mixed	age: 63.1 (range 16.0 to 95.0) BMI: NR	60 months n=1,020	<u>Complications:</u> Recurrence n=14 (results extracted for men only)

Table A4: Quality assessment of hernia studies

Author Country Year	1. Groups similar and recruited from the same population?	2. Exposures measured similarly to assign to groups?	3. Exposure measured in a valid and reliable way?	4. Confounding factors identified?	5. Strategies to deal with confounding factors stated?	6. Participants free of outcome at start of study?	7. Outcomes measured in valid and reliable way?	8. Follow up time reported and sufficient?	9. Follow-up complete, or reasons why not reported?	10. Strategies to address incomplete follow up utilized?	11. Appropriate statistical analysis used?
Bhattacharjee, UK, 2010 <sup>33</sup>	N/A	N/A	N/A	No	N/A	No	No	Yes	No	No	Unclear
Hayashi, Japan, 2014 <sup>34</sup>	N/A	N/A	N/A	Yes	Yes	No	Unclear	Yes	Yes	Yes	Yes