Urinary complications after penile inversion vaginoplasty in transgender women: Systematic review and meta-analysis

Christina Ding[1], Adree Khondker[1], Mitchell G. Goldenberg[2], Jethro C.C. Kwong[2], Katherine Lajkosz[2], Emery Potter[3], Alexandra Millman[3,4], Yonah Krakowsky[3,4*], Nathan Perlis[2*]
[1]Temerty Faculty of Medicine, University of Toronto, Toronto, ON, Canada; [2]Division of Urology, Department of Surgery, University of Toronto, Toronto, ON, Canada; [3]Transition-Related Surgery Program, Women's College Hospital, University of Toronto, Toronto, ON, Canada; [4]Department of Surgery, Division of Urology, Women's College Hospital, University of Toronto, Toronto, ON, Canada
**Co-senior authors*

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Corresponding author: Dr. Yonah Krakowsky, Murray Koffler Urologic Centre, Toronto ON, Canada; yonah.krakowsky@sinaihealth.ca

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ABSTRACT

Introduction: Penile inversion vaginoplasty (PIV) remains the gold standard technique for vaginoplasty, a gender-affirming feminizing surgery, but has been associated with urinary complications; however, there is little literature synthesizing urinary complications after PIV surgery, and there is a need to compile these complications to counsel patients pre- and postoperatively on managing surgical expectations. In this systematic review, we summarize the prevalence of urinary complications following PIV.
Methods: We searched the MEDLINE, EMBASE, CINAHL, and Scopus databases in July 2020. The primary outcome was the prevalence of urinary and surgical complications in patients after penile inversion vaginoplasty. Pooled prevalence was determined from extrapolated data. ROBINS-I tool was used to assess study quality. The study was prospectively registered on PROSPERO (CRD42020204139).
Results: Of 843 unique records, 27 articles were pooled for synthesis, with 3388 patients in total. Overall patient satisfaction ranged from 80–100%. The most common urological complications included poor/splayed stream (11.7%, 95% confidence interval [CI] 5.7–19.3), meatal stenosis (6.9%, 95% CI 2.7–12.7), and irritative symptoms (frequency, urgency, nocturia) (11.5%, 95%

CI 2.6–25.1). Other urinary complications included retention requiring catheterization (5.1%, 95% CI 0.3–13.8), incontinence (8.7%, 95% CI 3.4–15.6), urethral stricture (4.6%, 95% CI 1.2–9.8), and urinary tract infection (5.6%, 95% CI 2.7–9.4). Most pooled studies had moderate risk of bias.

Conclusions: The available evidence suggests that there is a low prevalence of urinary complications following PIV. Overall, there is a need for standardization of data in transgender surgical care to better understand surgical outcomes and improve postoperative management.

INTRODUCTION

Penile inversion vaginoplasty (PIV) is the gold standard and most common approach used among a spectrum of transition-related genital feminizing surgeries [1,2]. In penile inversion vaginoplasty, the penis is disassembled and the corporal bodies are resected. A neo-clitoris is created from a portion of the glans and preserved neurovascular bundle, a vulva is created from penile and perineal skin, and the neovagina is created by dissecting into the perineal space which is then lined with penile and scrotal skin. The native urethra is shortened, spatulated and fixed to an anatomic position at the base of the vestibule between the clitoris and the vaginal introitus [3]. A urethral catheter is typically left in place for 3-7 days until the vaginal packing is removed; a suprapubic catheter may also be placed. Studies have demonstrated high satisfaction rates following penile inversion vaginoplasty [4,5].

The prevalence of urological post-operative complications in penile inversion vaginoplasties are low [6,7]. Short-term urinary complications include urinary retention and urinary tract infections (UTI) [7,8]. Patients may also experience complications such as meatal stenosis, urinary stream spraying, and recurrent urinary tract infections. There are several reasons why the rates of urinary complications are largely unknown. Patients often travel great distances to specialty centers for surgery and are therefore unreachable for follow up care [9]. Furthermore, some patients do not seek help for fear of experiencing transphobia when accessing care, and it is believed that many patients live with complications without seeking help [10,11]. As transition-related surgeries become increasingly common, it is of timely importance for the general urologic community to recognize and be aware of the common urological complications so that they can manage them appropriately. While previous reviews have examined outcomes following vaginoplasty, large-scale meta-analyses focusing on urinary complications are lacking [7]. Current systematic reviews often excluded clinically relevant outcomes such as retention, splayed stream, incontinence, need for revision surgery, and patient satisfaction [12–14]. Herein, we present the largest systematic review and meta-analysis to-date focusing on the prevalence of urinary complications after penile inversion vaginoplasty.

METHODS

Search strategy

The following databases were searched from database inception through July 2020: MEDLINE, EMBASE, CINAHL, and Scopus. Search strategy included MESH terms and keywords such as "sex reassignment surgery", "vaginoplasty", "gender affirming surgery", and "urinary complications", as detailed in Table 1. The references of published studies and grey literature were manually searched to ensure articles were not missed. This systematic review and meta-analysis was reported in accordance with the Preferred Reporting items for Systematic Reviews and Meta-Analyses (PRISMA) [15].

Eligibility criteria and data collection

Observational studies with data on urinary complications following penile inversion vaginoplasty were included. Exclusion criteria included: narrative reviews, case reports/series including less than five patients, trauma-indicated or congenital surgery, studies not involving urinary complications, and supplement articles. Articles containing alternate vaginoplasty surgery techniques such as those involving bowel flaps or peritoneum were excluded as penile inversion vaginoplasty involving penile and scrotal skin is more commonly performed in gender affirming surgery, and these alternative techniques have unique complications. References from prior systematic reviews were included in the title and abstract screening.

Titles and abstracts were screened independently by two authors for full-text review. Any disagreements were resolved by a third author. The following data were included: number of patients, age at surgery, length of follow-up, and patient satisfaction. Urological complications captured in our review included: UTI, urethral stricture, meatal stenosis, urethral injury and other surgical complications, urinary retention, incontinence, poor or splayed stream, irritative symptoms, and revision surgeries for urinary complications. In the studies included, urological complications were either patient-reported outcomes or surgeon's reports of outcomes. See Supplementary Table 3 for PICOTS criteria.

Statistical analysis

DerSimonian-Laird random effects models were used to pool the Freeman-Tukey double-arcsine-transformed urinary complication percentages for each complication. The 95% confidence intervals were calculated using Wilson's method. Summary statistics for the pooled cohort were estimated using weighted sampling based on the cohort size for each study. All statistical analyses were conducted using R version 4.1.1.

Risk of bias

In accordance with Cochrane recommendations [16], risk of bias for individual non-randomized studies was appraised using all domains of the ROBINS-I tool [17]. Two authors independently assessed each study for risk of bias, and any discrepancies were resolved by consensus. Studies

with critical risk of bias were specified to be removed from quantitative synthesis. Funnel plots were generated to examine the risk of publication bias for all meta-analyses.

RESULTS

Search results and study characteristics

The PRISMA flow diagram for study selection is shown in Figure 1. A total of 843 unique records were screened after 776 duplicates were removed. After title and abstract screening, 133 articles moved onto full-text screening. The proportionate agreement was 86% in title and abstract screening. A third reviewer resolved any differences in title and abstract screening. Of these, 27 articles were pooled for quantitative synthesis comprising of 3388 patients.

Risk of bias

The risk of bias for each study based on the ROBINS-I tool is provided in Supplementary Table 2. Of the 27 articles, 2 were low risk, 21 were moderate risk, and 4 were severe risk of bias. The primary cause for at least moderate risk of bias was bias due to confounding factors and bias in measurement of outcomes.

Urinary complications

Mean age at the time of vaginoplasty was 36.2 ± 4.5 years (range 24-44 years). Mean follow-up was 2.6 ± 2.7 years (range 0.15-7.8 years). Overall patient satisfaction ranged from 80-100% (median satisfaction 96.1%). Urological complications following penile inversion vaginoplasty are summarized in Table 2. The three most common urological complications were poor/splayed stream, meatal stenosis, and irritative symptoms: frequency, urgency, nocturia.

Of the studies that reported urinary tract infection in penile inversion vaginoplasty (PIV), the rates ranged from 0%-32%, with 32% being an outlier (studies n=10). The remaining reported rates of UTI ranged from 0% to 15%. The median was 4.4%, and the pooled average of UTIs was 5.6% (95%CI: 2.7-9.4%).

Of the studies that reported urethral strictures (n=11), the complications rate ranged from 0% to 18.3%. The median was 7.1%, and the pooled average of urethral strictures was 4.6% (95%CI: 1.2-9.8%).

Meatal stenosis occurred from 1.1% up to 40% after PIV (studies n=17), with 40% as an outlier; the remaining reported rates of meatal stenosis occurring between 1.8% and 14.8%. The median rate of meatal stenosis was 4.4%, and the pooled average of meatal stenosis was 6.9% (95%CI: 2.7-12.7%).

Of the studies that reported urinary retention requiring catheterization (n=5), the complications rate ranged from 0% to 13.9%. The median out of these studies was 6.8% and the pooled average was 5.1% (95%CI: 0.3-13.8%).

Urinary incontinence can occur in 1.1% to 27.3% of patients after PIV, with median reported incidence 9.1%, and pooled average of 8.7% (95%CI: 3.4-15.6%). Urinary incontinence was reported in 8 studies.

Poor or splayed stream occurs in 1.8% to 33.2%, with 33.2% being an outlier. The remaining reported rates of poor or splayed stream ranged from 0% to 22.5% (studies n=10). The median in the data set for poor or splayed stream was 10.2% and the pooled average was 11.7% (95%CI: 5.7-19.3%).

Surgical complications

Surgical complications are summarized in Supplementary Table 1. There was no standardized surgical complication grading system used in the publications. Of the reported surgical complications, the most common surgical complications were wound dehiscence (n= 9 studies, range 0.6% -33%, median 6.7%), vaginal stenosis (n=6 studies, range 2.1%-18%, median 3.05%), urethral injury (n=15 studies, range 0.6%- 10.9%, median 5%), and rectal injury (n=11 studies, range 1.1%-7.5%, median 2.3%). Of the studies that reported neovaginal fistulas (n=13), urethrovaginal fistulas ranged from 1.5% to 4.5% (median 2.55%) and rectovaginal fistulas ranged from 0.3% to 3.6% (median 1.15%). Many studies did not have any fistulas in their sample. The most common urinary revision surgeries were meatoplasty (n= 10 studies, 0.4%-15%, median 5.3%), and urethral revision (n=5 studies, 1.5%-27%, median 7.1%).

DISCUSSION

There is limited high-quality data available on the surgical risks and urinary complications of vaginoplasty which makes it difficult to counsel patients and educate physicians on the expected post-operative course. We performed the largest systematic review and meta-analysis to date examining urinary complications after penile inversion vaginoplasty. Twenty-seven studies regarding penile inversion vaginoplasty were examined and analyzed for urinary complications. Our systematic review, which included all studies reporting on the prevalence of urinary complications, suggests that the overall risk of complications is low and of minor severity. These complications could be managed by a general urologist in most cases. Of 3388 patients, the mean prevalence of reported urinary complications ranged between 5.0 and 11.9% in non-randomized studies with an overall intermediate risk of bias. The most common urological complications included poor/splayed stream (11.7% [95%CI 5.7-19.3%]), meatal stenosis (6.9% [95%CI: 2.7-12.7%]), and irritative symptoms (frequency, urgency, nocturia) (11.5% [95%CI: 2.6-25.1%]). Other urinary complications included retention requiring catheterization (5.1% [95%CI: 0.3-13.8%]), incontinence (8.7% [95%CI: 3.4-15.6%]), urethral stricture (4.6% [95%CI: 1.2-9.8%]), and UTI (5.6% [95%CI: 2.7-9.4%]). Further, many of these complications like UTI, splayed stream and meatal stenosis are of minimal morbidity and can be readily treated with antibiotics or meatal dilators.[3] Urethral dilation is a short-term solution for an urgent situation of acute retention, and most patients with non-resolving meatal stenosis can be treated definitively with

meatoplasty (5.3%), and urethral revision surgery (7.1%). Majority of the pooled studies had moderate risk of bias.

There are multiple explanations of why there is a relatively low complication rate for this gender affirming surgery. Firstly, after PIV, the distance from the urethral meatus to the bladder is still longer than a cis-female urethra, which may be a preventative factor against UTIs [18]. Second, the urethra is spatulated widely during the surgery to decrease the rate of retention and stenosis. Furthermore, if strictures are present, they can be corrected at the time of gender affirming surgery. Finally, the prostate decreases in size from feminizing hormone therapy, which can lower the rates of retention and bladder outlet obstruction [19].

There may be under-reported urinary complication rates, especially in studies from the earlier decades. Patients often travel for surgery and long-term consistent follow-up may therefore be limited [9]. Additionally, complications may be treated at local institutions and therefore are not captured in study follow-up. Furthermore, there are a small number of transgender patients who are post radiation or who have bladder outlet obstruction secondary to benign prostatic hyperplasia (BPH). They will not be captured in this review but will be at higher risk of complications and would need general urologic management.

Together, in our review, we summarized 27 studies and 3383 patients after penile inversion vaginoplasty; with robust data of urinary complications due to the large sample size. Moreover, we conducted the largest systematic review and meta-analysis of comprehensive urinary complications following female transgender surgery. Overall, these findings support the notion that penile inversion vaginoplasty is associated with low rates of urinary complications, and most patients are satisfied after surgery. However, our review suggests that patients should be advised that urinary complications can occur and may need conservative, medical or surgical management. Ultimately, our findings provide useful data summaries for patients and healthcare practitioners to aid in treatment decisions and managing realistic surgical expectations. General urologists can treat and manage most of these complications, and they should do so in a trans inclusive environment. This includes referring to the patient by their name which may be different then the legal name, avoiding questions around transition not relevant to their care, as well as including resources in the clinic where trans people are represented [20].

The findings in this study should be interpreted in the light of the following methodological limitations. First, in the studies included in this meta-analysis, the primary outcome of urinary complications was not reported in a standardized method. For example, urinary complication rates were reported from research questionnaires, patient-reported outcomes, which can introduce a risk of reporting bias and prohibits analysis of symptom severity. However, surgical correction rates had direct clinical indications, which was more objective than reported urinary symptoms. To account for this, we abstracted the surgical correction rate whenever possible. Future work should therefore implement standardized definitions and methods of reporting surgical and urinary complication, which would allow a

better understanding of outcomes after PIV and other gender affirming surgeries [21]. Second, urinary complications were pooled based on the reported complication rate in the articles and zero-event studies were excluded if the outcome was not mentioned. Given a potential of a zero-complication rate for a specific outcome, the actual urinary complication rate may be lower than what is reported in this review. Finally, the overall study quality was medium (most studies had moderate risk of bias and 4 studies had a severe risk of bias). For this reason, randomized, large, or prospective studies are required for certainty with regards to these outcomes. Further studies are also needed to examine how to best manage the urinary complications.

CONCLUSIONS

PIV is the gold standard vaginoplasty technique with excellent patient outcomes. We have presented the largest meta-analysis on the urinary complications of PIV and have shown that complication rates are low. Complications that do arise are well within a general urologist's skillset. However, there remains a need for standardization of data collection in vaginoplasty surgery and by improving data, we will better understand the true prevalence of urinary complications. As such, urologists and other healthcare practitioners can use this systematic review to counsel patients pre- and post-operatively on managing surgical expectations.

References

1. G. S. Gender reassignment surgery: An overview. *Nat Rev Urol*. 2011;8(5 PG-274-281):274-281. doi:http://dx.doi.org/10.1038/nrurol.2011.46
2. M.E. B, W.B. van der S, R.S. van der P, et al. Surgical Outcome after Penile Inversion Vaginoplasty: A Retrospective Study of 475 Transgender Women. *Plast Reconstr Surg*. 2016;138(5 PG-999-1007):999-1007. NS -
3. M.E. B, W.B. van der S, M. de V, B.I. W, M.-B. B. Penile Inversion Vaginoplasty with or without Additional Full-Thickness Skin Graft: To Graft or Not to Graft? *Plast Reconstr Surg*. 2017;139(3 PG-649e-656e):649e-656e. doi:http://dx.doi.org/10.1097/PRS.0000000000003108
4. S.R. B, M. A, S.D. M, et al. Outcomes and Predictors of Revision Labiaplasty and Clitoroplasty after Gender-Affirming Genital Surgery. *Plast Reconstr Surg*. 2019;144(6 PG-1451-1461):1451-1461. doi:http://dx.doi.org/10.1097/PRS.0000000000006282
5. De Vries ALC, McGuire JK, Steensma TD, Wagenaar ECF, Doreleijers TAH, Cohen-Kettenis PT. Young adult psychological outcome after puberty suppression and gender reassignment. *Pediatrics*. 2014;134(4):696-704.
6. Patient-reported complications and functional outcomes of male-to-female sex reassignment surgery. *Arch Sex Behav*. 2006;35(6 PG-717-727):717-727. doi:http://dx.doi.org/10.1007/s10508-006-9104-9
7. S.E.R. H, M.-B. B, J.M. S, M. O, M.E. B. Outcome of Vaginoplasty in Male-to-Female Transgenders: A Systematic Review of Surgical Techniques. *J Sex Med*. 2015;12(6 PG-1499-1512):1499-1512. doi:http://dx.doi.org/10.1111/jsm.12868
8. Nassiri N, Maas M, Basin M, Cacciamani GE, Doumanian LR. Urethral complications after gender reassignment surgery: a systematic review. *Int J Impot Res*. 2020;(PG-). doi:10.1038/s41443-020-0304-y
9. Aizura AZ. Feminine transformations: Gender reassignment surgical tourism in Thailand. *Med Anthropol*. 2010;29(4):424-443.
10. J.C. G, R.M. V, A. Q, D.J. S, D. K. Feminizing genitoplasty in adult transsexuals: Early and long-term surgical results. *BJU Int*. 2007;100(3 PG-607-613):607-613. doi:http://dx.doi.org/10.1111/j.1464-410X.2007.07017.x
11. T.W. G, M.A. A, E.C. O, G.P. M, A. R, M.L. B. Postoperative Complications following Primary Penile Inversion Vaginoplasty among 330 Male-to-Female Transgender Patients. *J Urol*. 2018;199(3 PG-760-765):760-765. doi:http://dx.doi.org/10.1016/j.juro.2017.10.013
12. P.C. D, D. E, S. H, et al. Complications of the neovagina in male-to-female transgender surgery: A systematic review and meta-analysis with discussion of management. *Clin Anat*. 2018;31(2 PG-191-199):191-199. doi:http://dx.doi.org/10.1002/ca.23001
13. Bustos SS, Bustos VP, Mascaro A, et al. Complications and patient-reported outcomes in transfemale vaginoplasty: An updated systematic review and meta-analysis. *Plast Reconstr Surg Glob Open*. 2021;9(3).
14. O.J. M, K. A, J. M-J, P. C, F. N. Complications and Patient-Reported Outcomes in Male-to-Female Vaginoplasty-Where We Are Today: A Systematic Review and Meta-Analysis. *Ann Plast Surg*. 2018;80(6 PG-684-691):684-691. doi:http://dx.doi.org/10.1097/SAP.0000000000001393

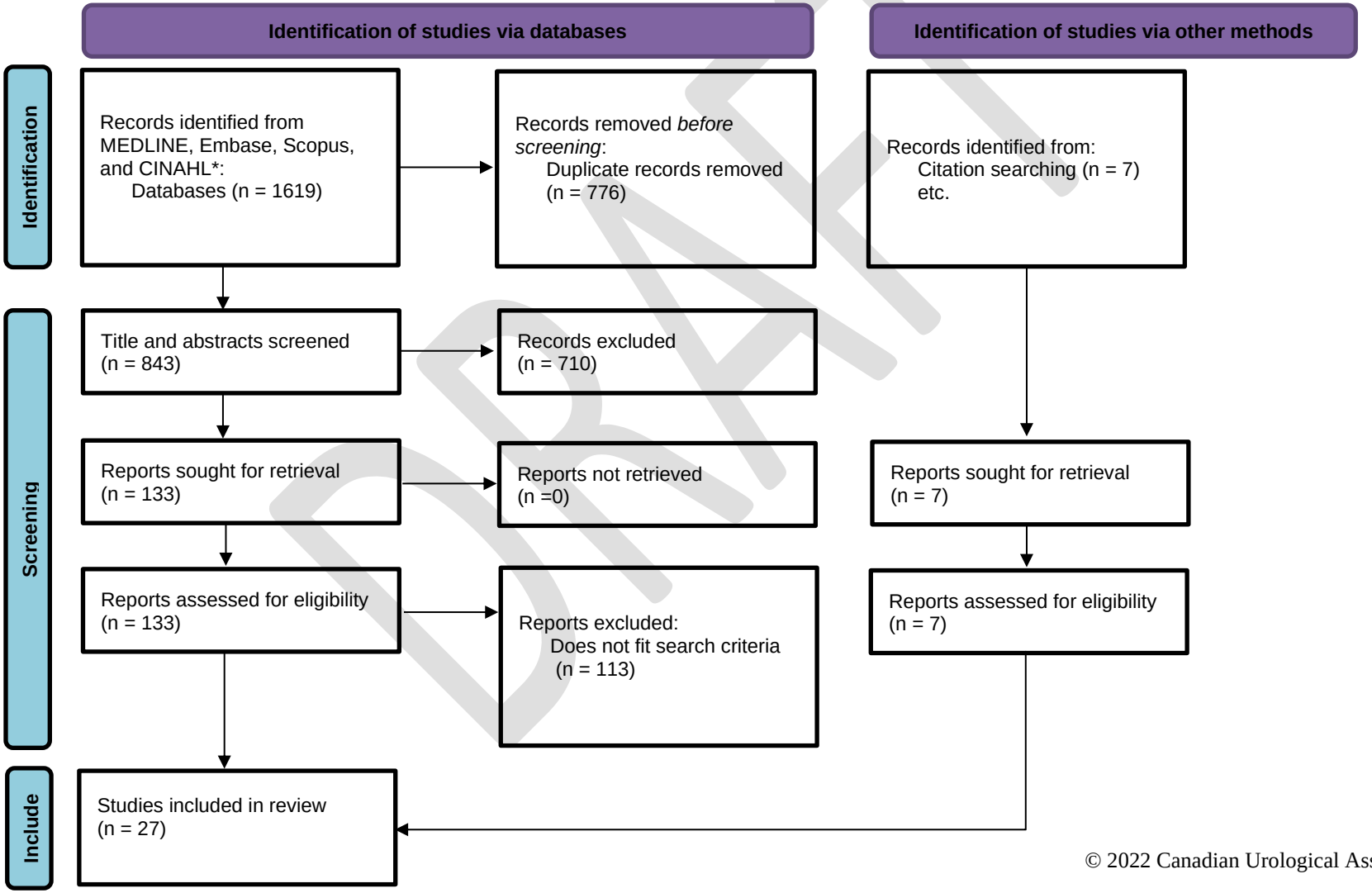
15. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Int J Surg*. 2021;88:105906.
16. Higgins J, Thomas J, Chandler J, et al. Cochrane Handbook for Systematic Reviews of Interventions Version 6.1 (updated September 2020). Cochrane, 2020. *Available from Training.cochrane.org/handb*.
17. Sterne JA, Hernán MA, Reeves BC, et al. ROBINS-I: A tool for assessing risk of bias in non-randomised studies of interventions. *BMJ*. 2016;355. doi:10.1136/bmj.i4919
18. Abelson B, Sun D, Que L, et al. Sex differences in lower urinary tract biology and physiology. *Biol Sex Differ*. 2018;9(1):1-13.
19. Jin B, Turner L, Walters WAW, Handelsman DJ. Androgen or estrogen effects on human prostate (vol 81, pg 4290, 1996). *J Clin Endocrinol Metab*. 1997;82(2):413.
20. Anderson K, Krakowsky Y, Potter E, Hudson J, Cox AR. Adult transgender care: A review for urologists. *Can Urol Assoc J*. 2021;15(10):345.
21. Cocci A, Frediani D, Cacciamani GE, et al. Systematic review of studies reporting perioperative and functional outcomes following male-to-female gender assignment surgery (MtoF GAS): a call for standardization in data reporting. *Minerva Urol e Nefrol Ital J Urol Nephrol*. 2019;71(5):479-486.
22. Amend B, Seibold J, Toomey P, Stenzl A, Sievert K-D. Surgical reconstruction for male-to-female sex reassignment. *Eur Urol*. 2013;64(1):141-149.
23. Blanchard R, Legault S, Lindsay WRN. Vaginoplasty outcome in male-to-female transsexuals. *J Sex Marital Ther*. 1987;13(4):265-275.
24. Bouman FG. Sex reassignment surgery in male to female transsexuals. *Ann Plast Surg*. 1988;21(6):526-531.
25. Buncamper ME, Van Der Sluis WB, Van Der Pas RSD, et al. Surgical Outcome after Penile Inversion Vaginoplasty: A Retrospective Study of 475 Transgender Women. *Plast Reconstr Surg*. 2016;138(5):999-1007. doi:10.1097/PRS.0000000000002684
26. S. C, B. B, S. L, et al. Postoperative complications of male to female sex reassignment surgery: A 10-year French retrospective study. *Ann Chir Plast Esthet*. 2019;64(1 PG-24-32):24-32. doi:http://dx.doi.org/10.1016/j.anplas.2018.08.002
27. Eldh J. Construction of a neovagina with preservation of the glans penis as a clitoris in male transsexuals. *Plast Reconstr Surg*. 1993;91(5 PG-895-3):893-895. NS -
28. Falcone M, Timpano M, Ceruti C, et al. A Single-center Analysis on the Learning Curve of Male-to-Female Penoscrotal Vaginoplasty by Multiple Surgical Measures. *Urology*. 2017;99(PG-234-239):234-239. doi:10.1016/j.urology.2016.07.012
29. Gaither TW, Awad MA, Osterberg EC, et al. Postoperative Complications following Primary Penile Inversion Vaginoplasty among 330 Male-to-Female Transgender Patients. *J Urol*. 2018;199(3):760-765. doi:10.1016/j.juro.2017.10.013
30. Goddard JC, Vickery RM, Qureshi A, Summerton DJ, Khoosal D, Terry TR. Feminizing genitoplasty in adult transsexuals: early and long-term surgical results. *BJU Int*. 2007;100(3):607-613.
31. P. H, G. S, P. C, et al. Impact of sex reassignment surgery on lower urinary tract function. *Eur Urol*. 2005;47(3 PG-398-402):398-402. doi:http://dx.doi.org/10.1016/j.eururo.2004.10.008
32. Huang TT. Twenty years of experience in managing gender dysphoric patients: I. Surgical

management of male transsexuals. *Plast Reconstr Surg*. 1995;96(4):921-930.
33. Ives GC, Fein LA, Finch L, et al. Evaluation of BMI as a Risk Factor for Complications following Gender-affirming Penile Inversion Vaginoplasty. *Plast Reconstr Surg - Glob Open*. 2019;7(3):1-8. doi:10.1097/GOX.0000000000002097
34. Karim RB, Hage JJ, Bouman FG, de Ruyter R, Van Kesteren PJ. Refinements of pre-, intra-, and postoperative care to prevent complications of vaginoplasty in male transsexuals. *Ann Plast Surg*. 1995;35(3):279-284.
35. Krege S, Bex A, Lümmen G, Rübben H. Male-to-female transsexualism: A technique, results and long-term follow-up in 66 patients. *BJU Int*. 2001;88(4):396-402.
36. J.A. L, D.C. E, P. C-D, et al. Male-to-Female Gender Reassignment Surgery: An Institutional Analysis of Outcomes, Short-term Complications, and Risk Factors for 240 Patients Undergoing Penile-Inversion Vaginoplasty. *Urology*. 2019;131((Levy, Edwards, Cutruzzula-Dreher, McGreen, Tarry, Belkoff, Rumer) Hahnemann University Hospital, Department of Urology, Philadelphia, PA, United States(Akanda) Philadelphia College of Osteopathic Medicine, Philadelphia, PA, United States PG-228-233):228-233. doi:http://dx.doi.org/10.1016/j.urology.2019.03.043
37. Loree JT, Loree JT, Burke MS, et al. Transfeminine Gender Confirmation Surgery with Penile Inversion Vaginoplasty: An Initial Experience. *Plast Reconstr Surg - Glob Open*. Published online 2020:1-7. doi:10.1097/GOX.0000000000002873
38. Massie JP, Morrison SD, Van Maasdam J, Satterwhite T. Predictors of patient satisfaction and postoperative complications in penile inversion vaginoplasty. *Plast Reconstr Surg*. 2018;141(6):911e-921e. doi:10.1097/PRS.0000000000004427
39. Neto RR, Hintz F, Krege S, Rübben H, vom Dorp F. Gender reassignment surgery - A 13 year review of surgical outcomes. *Int Braz J Urol*. 2012;38(1):97-107. doi:10.1590/S1677-55382012000100014
40. Opsomer D, Gast KM, Ramaut L, et al. Creation of clitoral hood and labia minora in penile inversion vaginoplasty in circumcised and uncircumcised transwomen. *Plast Reconstr Surg*. 2018;142(5):729E-733E. doi:10.1097/PRS.0000000000004926
41. Papadopulos NA, Zavlin D, Lellé JD, et al. Combined vaginoplasty technique for male-to-female sex reassignment surgery: Operative approach and outcomes. *J Plast Reconstr Aesthetic Surg*. 2017;70(10):1483-1492. doi:10.1016/j.bjps.2017.05.040
42. Perovic S V, Stanojevic DS, Djordjevic MLJ. Vaginoplasty in male transsexuals using penile skin and a urethral flap. *BJU Int*. 2000;86(7):843-850.
43. Raigosa M, Avvedimento S, Yoon TS, Cruz-Gimeno J, Rodriguez G, Fontdevila J. Male-to-Female Genital Reassignment Surgery: A Retrospective Review of Surgical Technique and Complications in 60 Patients. *J Sex Med*. 2015;12(8):1837-1845. doi:10.1111/jsm.12936
44. Revol M, Servant JM, Banzet P. Surgical treatment of male-to-female transsexuals: a ten-year experience assessment. *Ann Chir Plast Esthet*. 2006;51(6):499-511. doi:10.1016/j.anplas.2006.02.006
45. Stein M, Tiefer L, Melman A. Followup observations of operated male-to-female transsexuals. *J Urol*. 1990;143(6):1188-1192.
46. Tavakkoli Tabassi K, Djavan B, Hosseini J, Ghoreifi A, Ershadi M, Hosseini E. Fold-back perineoscrotal flap plus penile inversion vaginoplasty for male-to-female gender

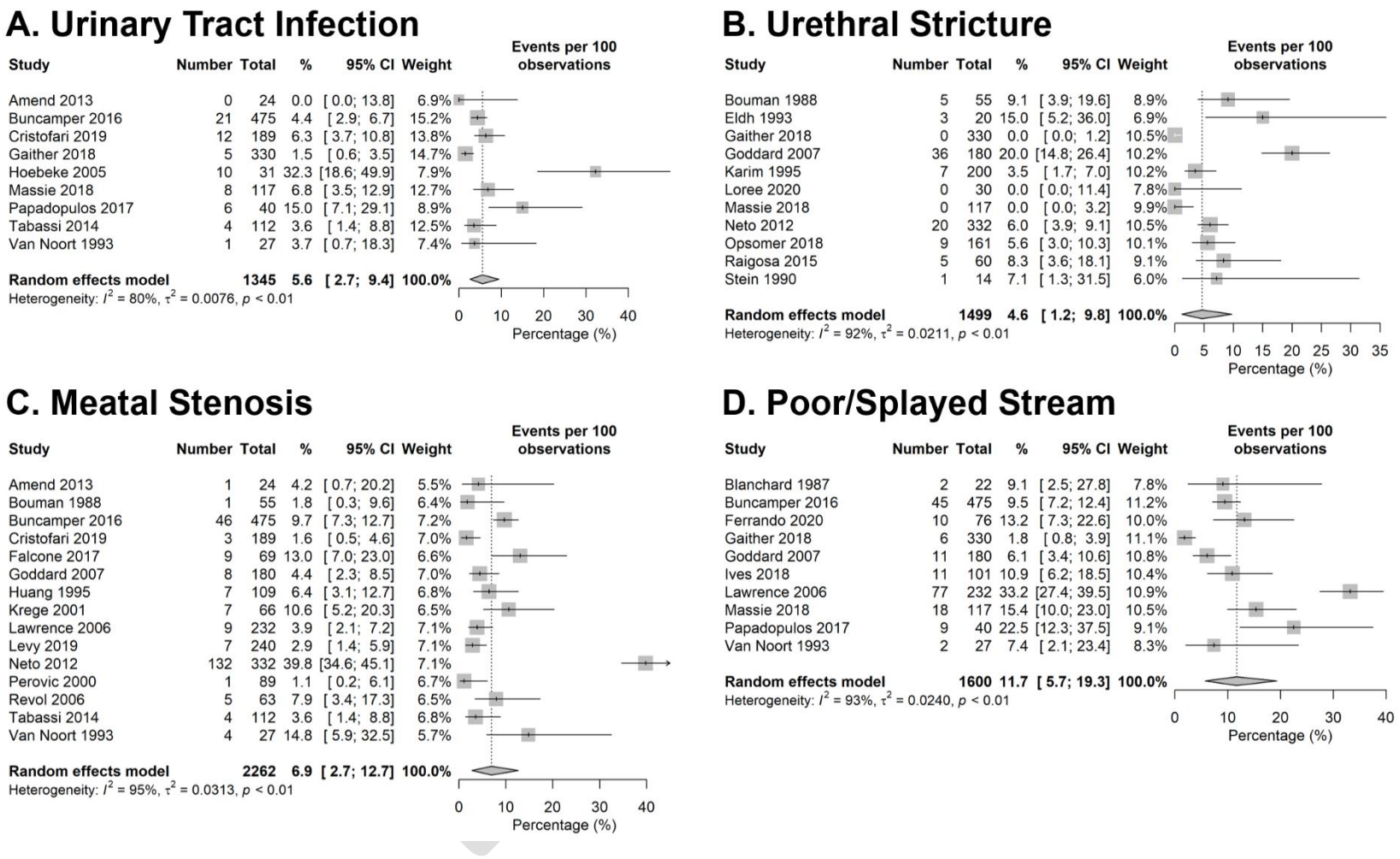
reassignment surgery in circumcised subjects. *Eur J Plast Surg*. 2014;38(1):43-48. doi:10.1007/s00238-014-1038-1
47. van Noort DE, Nicolai J-P. Comparison of two methods of vagina construction in transsexuals. *Plast Reconstr Surg*. 1993;91(7):1308-1315.

Figures and Tables

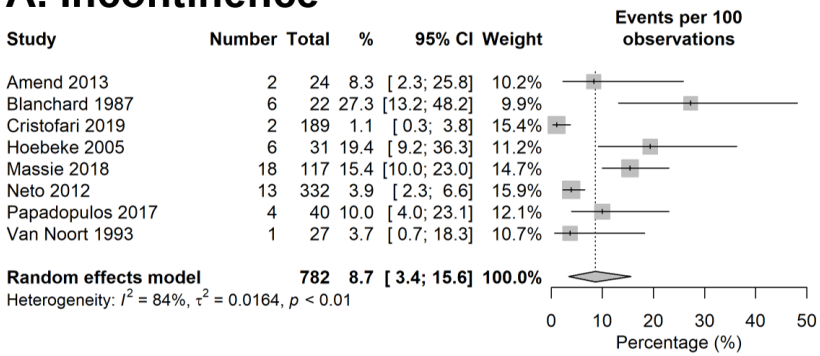
Figure 1. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and other sources. Adapted from Page MJ, et al. BMJ 2021;372:n71. For more information, visit: *http://www.prisma-statement.org/*.



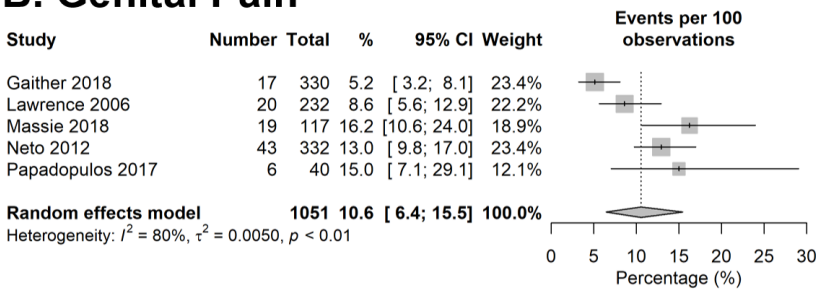
Figures 2a and 2b. Urinary complications of penile inversion vaginoplasty.



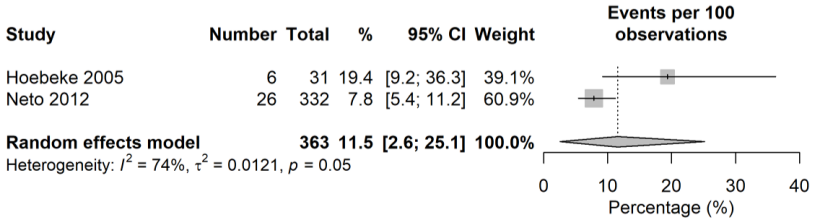
A. Incontinence



B. Genital Pain



C. Irritation



D. Retention

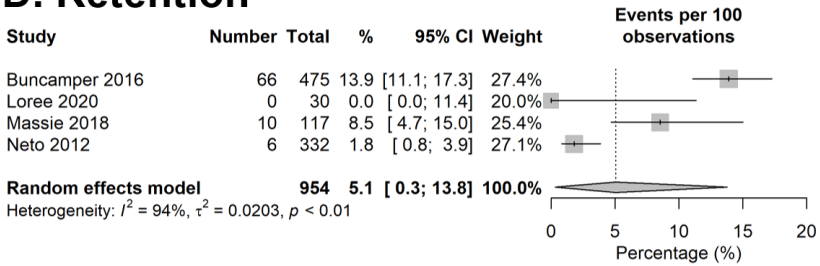


Table 1. Search strategy from Embase Classic + Embase 1947 to July 17, 2020	
Search line	**Search terms**
1	exp Sex reassignment procedures/
2	Transsexualism/su
3	(Gender affirm* adj3 surger*).tw,kw.
4	((transit* or gender*) adj3 (surg* or procedure* or operation*)).ti,kw.
5	Sex change*.tw,kw.
6	Gender reassignment*.tw,kw.
7	Transsex*.tw,kw.
8	Gender change*.tw,kw.
9	Transgender*.tw,kw.
10	Transvestism*.tw.kw.
11	Gender identity disorder*.tw,kw.
12	Genitoplast*.tw,kw.
13	Vaginoplast*.tw,kw.
14	Neovagina*.tw,kw.
15	Vagina/su
16	(Penile inversion* adj3 vaginoplast*).tw,kw.
17	Scrotal inversion vaginoplasty.tw,kw.
18	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12
19	13 or 14 or 15
20	18 and 19
21	16 or 17 or 20

Table 2. Study characteristics on studies including the prevalence of urinary complications after penile inversion vaginoplasty

Study	Patient characteristics			Urinary complications							
	n	Mean patient age at surgery (range)	Mean followup length in years (range)	UTI	Urethral stricture	Meatal stenosis	Retention	Incontinence	Poor or splayed stream	Irritative symptoms (frequency, urgency, nocturia)	Patient satisfaction
Pooled Statistics				5.0% 0–15%	5.7% (0–18.3%)	10.8% (1.1–40%)	8.6% (0–13.9%)	6.6% (1.1–27.3%)	11.9% (1.8–33.2%)	8.8% (7.8%, 19.3%)	
Amend 2013[22]	24	39.1 (20–54)	3.3 (1.6–5.8)	0%	–	4.2%	–	8.3%	–	–	100%
Blanchard 1987[23]	22	32.3 (22.8–59.5)	4.4 (0.5–11.8)	–	–	–	–	27.3%	9.1%	–	90.4%
Bouman 1988[24]	55	28[**] (10–60)	2.33 (0.16–6.25)	–	9.1%	1.8%	–	–	–	–	98.2%
Buncamper 2016[25]	475	38.6[†] (18.1–70.8)	7.8[†] (1.0–15.9)	4.4%	–	9.7%	13.9%	-	9.5%		-
Cristofari	189	36.8 (19.9–	1.4 (12–59)	6.3%	–	1.6%	-	1.1%	-	-	98.4%

2019[26]		64.7)									
Eldh 1993[27]	20	34 (20–67)	5.8 (0.5–30.0)	–	15%	–	–	–	–	–	–
Falcone 2017[28]	69	33.5† (SD 10.2)	5† (SD 3.2)	–	–	13.0%	–	–	–	–	–
Gaither 2018[29]	330	35† (18–76)	0.25† (0.3–6.1)	1.5%	0%	–	–	–	1.8%	–	–
Goddard 2007[30]	180	41† (19–76)	0.15† (0.02–0.96)	–	18.3%*	4.4%*	–	–	5.6%*	–	80%
Hoebeke 2005[31]	31	–	–	32.3%	–	–	–	19.3%	–	19.3%	–
Huang 1995[32]	109	32.3 (18–71)	–	–	–	7.4%*	–	–	–	–	–
Ives 2019[33]	101	42	0.25 (0.25–0.50)	–	–	–	–	–	10.9%	–	–
Karim 1995[34]	200	(18–71)	–	–	3.5%	–	–	–	–	–	
Krege 2001[35]	66	36.8† (20–57)	–	–	–	10.6%	–	–	–	–	

Lawrence 2006[6]	232	44 (18–70)	3 (1–7)	–	–	3.9%	–	–	33.2%		
Levy 2019[36]	240	33 (SD 23)	0.24 (SD 0.37)	–	–	2.9%	–	–	–		
Loree 2020[37]	30	37 (SD 5.4)	1.27 (SD 9.9)	–	0%	–	0%	–	–	–	92.0%
Massie 2018[38]	117	38 (16–78)	1.75 (1.1–2.8)	6.8%	0%	–	8.5%	15.4%			94%
Neto 2012[39]	332	36.7 (19–68)	–	–	6.0%	40.0%	5.0%	4%	–	7.8%	
Opsomer 2018[40]	161	38.2 (18–69)	2.4 (0.9–3.9)	–	5.6%	–	–	–	–	–	–
Papadopulos 2017[41]	40	38.6 (26–50)	0.5	15.0%	–	–	–	10.0%	22.5%	–	–
Perovic 2000[42]	89	28 (18–56)	3.6 (0.3–6.0)	–	–	1.1%	–	–	–	–	–
Raigosa 2015[43]	60	28 (19–50)	2.0 (1.2–3.8)	–	8.3%	-	–	–	–	–	

Revol 2006[44]	63	33 (22–56)	1.3 (0.2–6.6)			7.9%					
Stein 1990[45]	14	31.4 (23–49)	1.8 (0.4–4)		7.1%						100%
Tavakkoli-Tabassi 2014[46]	112	25.8 (SD 3.3)	1.1 (0.5–2.0)	3.6%		3.6%					85.7%
Van Noort 1993[47]	27	24 (21–57)	2.58** (0.1–8.6)	3.7%		14.8%		3.7%	7.4%		100%

*The full study population was not assessed for the outcome, and the population event rate is assumed from the sample event rate. **Estimated based on data given. †Median value provided if mean was unavailable. SD: standard deviation.