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REVIEW ARTICLE

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Burch colposuspension

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Aims: To evaluate the historic and pathophysiologic issues which led to the development of Burch colposuspension, to describe anatomic and technical aspects of the operation and to provide an update on current evidence.

Methods: We have performed a focused literature review and have searched the current available literature about historic dimension, technical descriptions, and efficacy of Burch colposuspension.

Results: Burch colposuspension, performed either by an open or a laparoscopic approach, is an effective surgical treatment for stress urinary incontinence.

Conclusions: In current recommendations, Burch colposuspension remains an option for secondary treatment. Because midurethral slings have recently become under scrutiny, it may return as a first-line treatment procedure. Both open and laparoscopic Burch colposuspension should therefore nowadays be provided in fellowship programs worldwide.

KEYWORDS
Burch colposuspension, laparoscopy, midurethral sling, stress urinary incontinence

1 | INTRODUCTION

Burch colposuspension is a well-accepted technique for surgical management of stress urinary incontinence (SUI), especially when it is associated with urethral hypermobility. Originally performed as an open surgical procedure, it was long considered as the "gold standard" for the treatment of SUI, a condition defined by the International Continence Society as "the complaint of involuntary urinary leakage on effort or exertion, or on sneezing or coughing."[1] SUI is a highly prevalent condition estimated to affect 17-45% of adult women in industrialized countries and has a significant impact on women's quality of life. The latter aspect was highlighted in previous SUI definitions from the 1970s, where it was labelled as "the involuntary loss of urine that is a social or hygienic problem." These functional, non-life-threatening priorities have probably triggered the development of not only laparoscopic variations of Burch colposuspension but also alternative minimal invasive approaches, such as midurethral sling (MUS) procedure, which are now widely considered as the new "gold standard" for the surgical treatment of SUI.[2] However, as a consequence of the vaginal mesh debate, MUSs have come under scrutiny as well. After the FDA warning about the use of transvaginal meshes for pelvic organ prolapse repair in 2011, many products were withdrawn from the market under economic juridical and political pressure generated by numerous lawsuits following severe complications with this technique.[3] As a consequence of extensive medialization, the broad public does not seem to distinguish between mesh material used for MUS or for prolapse repair, which in some countries led to an overall ban of synthetic meshes. Such a development may drive surgeons to revert to

Alan Wein led the peer-review process as the Associate Editor responsible for the paper.

older techniques, Burch colposuspension being one of them. The aim of this review was to evaluate the historic and pathophysiologic issues which led to the development of Burch colposuspension, to describe anatomic and technical aspects of the operation and to provide an update on current evidence on outcome.

2 | METHODS

We performed a focused review of the literature and prespecified inclusion of previously published review articles, randomized controlled studies, case-control, and cross-sectional designs. Ethical approval was not required. To identify studies for the review, we searched the following electronic databases: PubMed and EMBASE through to June 30, 2018. The following keywords were used for the search as text words or title headings using the PubMed software for recent publications: colposuspension or burch or retropubic and SUI not marshall not cancer. Methodological search filters were not used, and we did not apply any language and date restrictions. The content of a total of 45 articles was included in our review (Figure 1) We have largely verified compliance of reporting in this review with the PRISMA statements.[4] We reported bias assessment from previous systematic reviews.

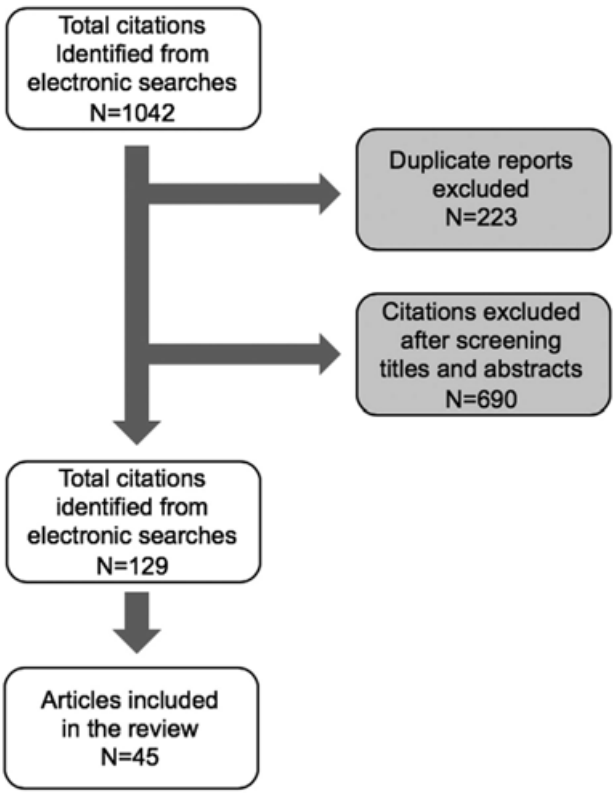

FIGURE 1 Literature search flowchart

2.1 | History of retropubic incontinence procedures

In 1864, Baker and Brown first presented an intervention for the correction of SUI, in which the tissue underneath the urethra was dissected and gathered to provide better anatomic support.[5] Since then, more than 200 alternative techniques and numerous modifications have been described. Pubovesical slingplasty colposuspension, was introduced by Goebel in 1910 and consists of a lifting of the areas adjacent to the bladder neck and the proximal urethra to the level of the space behind the pubic bone. The technique was intended to improve closure of the urethra.[6] In the 1940's Aldrige presented autologous slings for the bladder neck which were further developed by McGuire and Blaivas in the late twentieth century.[7–9] Sling materials have always varied widely, including synthetic or biological, autografts, cadaveric allografts, and animal xenografts. Kelly in 1913 and later Stoeckel in 1920 were the first to introduce anterior repair techniques including only suburethral stitches.[10,11] In 1949, Marshall and Marchetti developed a surgical cure for SUI, aiming retropubic elevation of the bladder neck through fixation of the endopelvic fascia at the pubic periosteum (MMK). This technique underwent numerous modifications in the following years, first by Hirsch and Cowan in 1979 and finally by Burch in 1961.[12,13] Simoultanously, anterior repair has been the most commonly performed operation for SUI for many years. However, not so long ago, anatomic, physiologic, and neurologic studies have demonstrated that this kind of procedure is unsuitable for this indication.[14,15] John Christopher Burch was a professor at Vanderbilt University Medical School and served as the Chair of the department of Obstetrics and Gynecology from 1944 until 1965 (Figure 2). During his career, he authored more than 150 articles and books including a classic on hysterectomy. He is known to have taught some 2000 medical students and trained more than 300 interns and residents. His colposuspension procedure was the result of a frustrating attempt to dissect sufficient periosteum in an elderly woman in whom he was trying to perform an MMK procedure. Burch improvised and finally performed an attachment at the level of the Cooper ligament.[14] His original description referred to the operation as a combined incontinence and prolapse repair. MMK, PVS, and the Burch colposuspension are traditional colposuspension approaches with long-term success rates in restoring continence.[12,16,17] The cure rates range from 65 to 90%, at one to 10 years follow-up.[18] However, there is limited evidence that longer-term outcome is poorer following MMK and PVS. Moreover, given the availability of long-term results of 20 years and more with Burch colposuspension, MMK, and PVS have largely been abandoned and at least MMK is no longer recommended for the treatment of SUI.[19,20] Over time, Burch colposuspension has been adapted for laparoscopy and

FIGURE 2 John Christopher Burch (1900-1977) Downloaded from https://www.library.vanderbilt.edu/specialcollections/history-of-medicine/throughtime/items/show/1943

modifications of the original technique, such as synthetic mesh use to secure paraurethral support, have been introduced.[21–23]

2.2 | Pathophysiology of stress urinary incontinence

Continence is preserved as long as the closure pressure of the urethra is superior to the pressure within the bladder.[24] The efficacy of the overall urethral closure pressure is ensured by the sum of the resting urethral closure pressure and the transmission of abdominal pressure during physical stress.[24] The closure pressure is provided by the interaction of the striated and smooth muscle of the urethral sphincter, the urethral mucosa, and the periurethral blood vessels. Defects of the periurethral muscle, a deterioration in blood supply and elasticity and the increasing atrophy of the urethral mucosa result in a decrease of the urethral closure pressure, occurring frequently with increasing age and estrogen deficiency.[24,25] When the intra-abdominal pressure rises, the adequate pressure transmission on the urethra is of utmost importance to preserve urinary continence. Such a transmission is only possible when the pubourethral ligaments and the muscles of the pelvic floor are attached in an orthotope manor.[26] After 1923, when Bonney published a manuscript largely based on surgical anatomy, in which he sought to explain the etiology of SUI in terms of failure of anatomic support, research about the etiology of SUI was neglected for a long time. Only in 1961, Enhörning was able to demonstrate pressure related factors of continence: the urethral pressure was higher than vesical pressure not only at rest but also during a rise in intra-abdominal pressure. The author hypothesized that it was the transmission of the intra-abdominal pressure to the bladder, the bladder neck, and the proximal urethra led to simultaneous increase in vesical and urethral pressure and the augmentation of urethral sphincter efficacy. This phenomenon could be observed as long as the proximal urethra was situated above the pelvic floor. Enhörning outlined that "In cases of stress incontinence this upper part of the urethra is often relaxed into a funnel and has then functionally become part of the bladder."[27] Topographic changes around the bladder neck, for example, with pelvic organ prolapse or by tissue damage, lead to alteration in the urethrovesical angle and a downward shift of the bladder base. The consequence would be an insufficient transmission of pressure, therefore resulting in incontinence (Figure 3). Decreased pressure transmission can also be the consequence of fibrotic scarification after surgery or irradiation, regular excessive strain, obesity or pelvic floor muscle deficiency.[28,29] In 1990, Ulmsten and Petros merged previous findings and results from their own experiments to their newly developed "integral theory of female urinary incontinence."[30] They postulated that "stress and urge symptoms may both derive, for different reasons, from the same anatomical defect, a lax vagina." In collaboration with the same authors, the first synthetic MUS was engineered around the integral concept.[31]

2.3 | Anatomy of the retropubic space

Knowledge of the anatomy is a prerequisite for an adequate performance, functional success, and avoidance of complications. This accounts for many of the procedures described above in general and Burch colposuspension in particular. The surgeon needs to master the structures of the retropubic space, also known as the "Cave of Retzius" or "Retzius' space," named after the Swedish anatomist Anders Retzius (1796-1860). It constitutes a virtual avascular preperitoneal space between the pubic symphysis and the urinary bladder, behind the transversalis fascia and in front of the peritoneum. Its lateral margins are delimited by the pubic bone and obturator internus muscle and it has yet to be dissected (Figure 4). Open surgical access to this area is obtained by dividing the rectus abdominis muscle along the midline raphe, separating the muscle strings laterally and entering between the rectus muscle and the peritoneum in the direction of the pubic symphysis. Then, the fatty connective tissue normally filling this space is bluntly dissected. Laparoscopically, this will be performed after opening the peritoneum. The space is dissected by repelling the connective and fatty tissue fibers behind the posterior pubic branch cranially to caudally and medially from the obturator internus muscle. The floor of the Retzius space is formed by the anterior vagina and its endopelvic and pubocervical fascia, stretching along the posterior symphysis

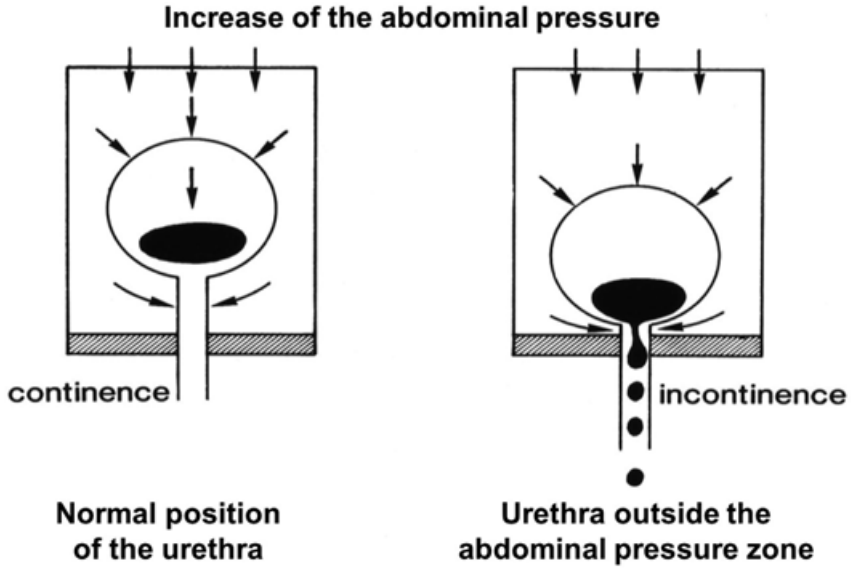

FIGURE 3 Pressure transmission theory

and inserting at the level of the arcus tendinous fasciae pelvis ("white line"). The proximal urethra lies in a midline on top of the endopelvic fascia beneath the symphysis. The pubourethral ligaments form the lateral part of the urethra and reach the urethrovesical junction as well as the extraperitoneal bladder portion proximally. An indwelling Foley catheter can be inserted in order to better delineate the bladder boundaries. The "white line," a tendinous arch originating at the posterior pubic symphysis, stretches along the internal side of the obturator internus muscle and inserts at the ischial spine. The endopelvic fascia is attached to the white line in order to ensure the anterolateral support of the vagina. Detachment at this level is at the origin of paravaginal defects. Lateral to the pubic tubercles, beneath the superior margin of the pubic ramus, is the iliopectineal line and Cooper's ligament. Laterally the following structures can be encountered: first the external iliac artery and vein and second the obturator neurovascular bundle, the latter exiting the pelvis through the obturator foramen. At this level, the so called "Corona mortis," an anastomosis between the inferior epigastric artery and the obturator arteries, represents a potential source of bleeding in case of an unforeseen lesion (Figure 5).

2.4 | The traditional open Burch colposuspension procedure

Over the years, several authors and surgeons have presented numerous modifications of the original operation described by Burch. The following paragraph summarizes the most commonly performed main steps with the claim to describe a standard procedure. Burch colposuspension aims to elevate the bladder neck and the proximal urethra back in the intraabdominal pressure area behind the pubic symphysis. This elevation allows significant improvement of pressure transmission on the urethra. According to Riss and

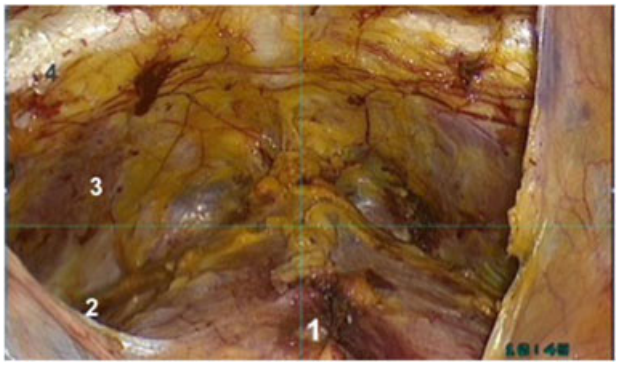

FIGURE 4 Complete deep dissection of the Retzius space (laparoscopic view). 1, Bladder (half full); 2, Arcus tendinous fascia pelvis; 3, Obturator muscle; and 4, Cooper ligament

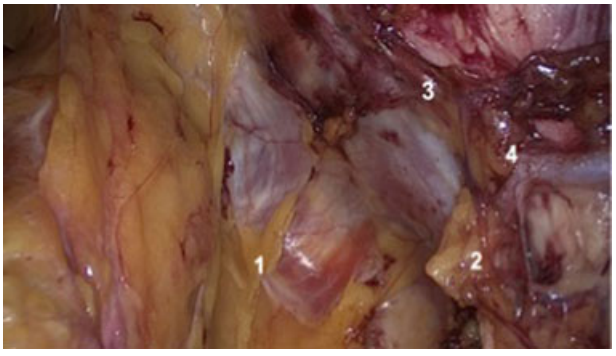

FIGURE 5 Pre- & paravesical space (laparoscopic view). 1, Arcus tendinous fascia pelvis; 2, Obturator pedicle; 3, Pubic bone; and 4, Corona mortis crossing the ligament, (anastomosis between obturator vessels and inferior epigastric vessels). Risk of dramatic hemorrhage if injury

colleagues, Burch colposuspension increases the functional urethral length as well as the urethral closure pressure, which is the reason why no other continence procedure achieves a comparable degree of reliance.[32] In addition, Burch colposuspension concomitantly treats mild forms of anterior wall prolapse (in accordance with the initial postulate by Burch). Sufficient mobility and capacity of the vagina represent prerequisites for the success of colposuspension and has to be considered particularly in patients after previous vaginal interventions.[33]

Some surgeons would perform the operation with an indwelling catheter in place, allowing intraoperative filling and emptying of the bladder. A half full bladder creates a light reflection at the upper limit of the retropubic space and is helpful for finding the right incision plane, particularly when a laparoscopic approach is chosen. Once the retropubic space is dissected, the bladder neck and the vaginal fascia underneath are identified. The bladder is mobilized to the opposite side. At each side of the bladder neck, two to four, preferably non-absorbable sutures are placed (Figure 6).[34] There is no consensus in the current literature regarding the suture material to be used. In their review on the subject, Smits-Braat reported equal cure rates of around 87% whether absorbable or permanent sutures were used.[35] Traditionally, the proximal sutures are located 2 to 3 cm lateral to the bladder neck, the distal sutures are placed 2 to 3 cm lateral to the proximal third of the urethra (Figure 7). They should apprehend the full-thickness of the vaginal wall, right under the mucosa. The loose ends of the sutures are then attached to the ipsilateral Cooper's ligament. With the help of an assistant, the vagina is elevated, and the knots gently adjusted on top of the Cooper's ligament without tension (Figure 8).

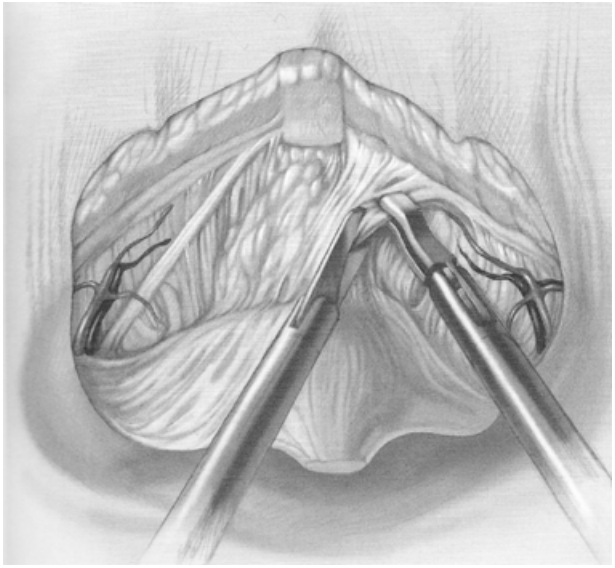

FIGURE 6 Suture placement during Burch colposuspension (with the permission from Georg Thieme Verlag KG)

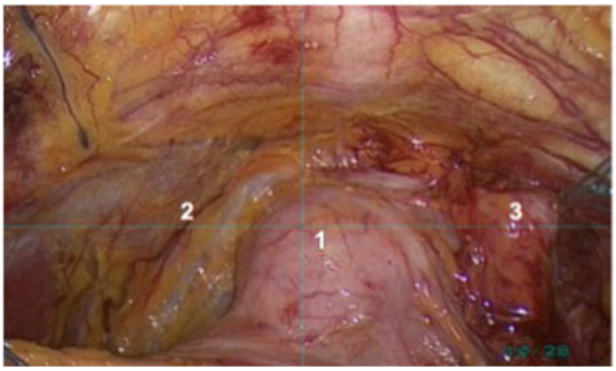

FIGURE 7 Burch colposuspension performed on the right side (laparoscopic view). 1, Bladder and 2, Burch suture not performed yet on the left side

Usually, the distal sutures are tied first. For an adequate distance control of the sutures, two fingers should be easily passed between the pubic bone and the urethra. A cystoscopy is then performed to rule out any potential damage to the bladder or the ureters.

2.5 | Outcome of Burch colposuspension and comparative studies

The wealth of data from comparative and observational studies assessing the outcome of Burch colposuspension has been reported in numerous textbooks and structured summary publications.[36,37] Since it first description in 1961, there has been a multitude of randomized controlled trials including Burch colposuspension. Fifty-five trials involving a total of 5417 women have been included in the current Cochrane review about open retropubic colposuspension.[38] Overall, cure rates were as high as 68.9% to 88.0% whereas recurrence rates remain low.[39,40] However, it has been reported that the cure rate of retropubic suspension techniques in general

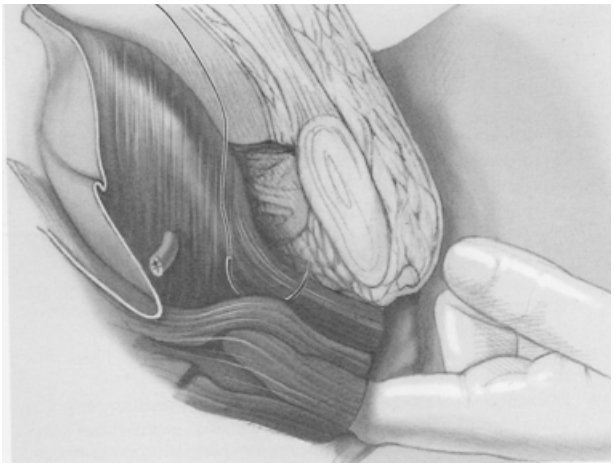

FIGURE 8 Vaginal assistance during Burch colposuspension (with the permission from Georg Thieme Verlag KG)

decrease steadily from 90% at 1 year to about 70% by 10 years postoperatively. After a decline, it seems to reach a plateau at 65-70% at a 20 year follow-up.[19] Burch colposuspension requires a certain amount of dissection in the retropubic space, which could explain potential hemorrhagic and infectious complications, erosions and sinus tract formation. One complication specific to the technique may be osteitis pubis, which probably occurs less frequently than in MMK, where rates are reported to be as high as 2.5. Long-term studies of the Burch procedure have shown a significant incidence of pelvic organ prolapse formation. Rectocele has been noted in 11-25% and enterocele in 4-10% of patients followed-up 10-20 years.[19] The risk of de novo detrusor overactivity has been reported between 5% to 27%. Voiding dysfunction occurs in up 22% of patients after Burch colposuspension.[19,41] The reoperation rate for patients who received Burch procedure was 5.5 per 1000 woman years with an cumulative hazard of 8.6% (CI 95% 7.8-9.5).[42]

2.5.1 | Open burch colposuspension and midurethral slings

When MUS were introduced on the market in the 1990s, their efficacy and complication rates were initially compared to open Burch colposuspension.[43] Ward and colleagues have conducted a prospective multicenter randomized trial of tension-free vaginal tape and colposuspension as primary treatment for stress incontinence with recruitment from 14 centers in the United Kingdom and Ireland.[44,45] After a 5 year follow-up both procedures are similar in terms of incontinence cure and quality of life improvement. In the colposuspension group, vault and posterior vaginal wall prolapse occurred more frequently.[46] Several studies have reported, that significantly more patients experienced delayed voiding after colposuspension.[44] Results from a recent systematic review supported by meta-analysis showed open colposuspension to have comparable subjective and objective outcomes to MUS procedures. Complications were similar with some differences in incidence. Assessment of risk of bias was described as difficult due to insufficient details provided by the authors, particularly on random allocation concealment and blinding.[38] The same review confirmed results from two older randomized controlled trials including assessment of both the retropubic and transobturator MUS placement.[47,48] In a nationwide cohort study, Foss Hansen and colleagues reported, that Burch colposuspension MUS had a similar risk of reoperation (6%).[49] Another study conducted by Holdø and colleagues showed a significantly lower cumulative rate of recurrence up to 12 years after retropubic MUS than after Burch colposuspension.[50] Manca and colleagues performed a cost-utility analysis comparing tension-free vaginal tape and open Burch colposuspension.[51] They found that, over a postoperative period of six months, there were no significant differences in terms of cost-efficiency between retropubic MUS and Burch colposuspension. In summary, open Burch colposuspension can be considered for those women in whom surgery for SUI is indicated and an open abdominal procedure concurrently performed.[37]

2.5.2 | Laparoscopic Burch colposuspension

A laparoscopic approach to colposuspension avoids numerous disadvantages associated with open surgery, one being the aesthetic aspect with regard to the abdominal scar. Minimal invasive techniques in general enable shorter length of hospital stay, faster recovery and return to activity.[52–54] Table 1 shows published level 1 and 2 evidence relating to laparoscopic colposuspension. The recent Cochrane review about laparoscopic colposuspension included 22 randomized controlled trials.[55] Cure rates of laparoscopic and open Burch colposuspension were similar although Su in 1997 found the open approach to be superior (97% vs 73% and 96% vs 80% cure rate, respectively).[56,57] Fatthy in 2001 compared the open technique to a modified laparoscopic approach with an 18 months follow-up and reported similar outcome (85% vs 88%).[58] Results from the Cochrane review, unsurprisingly, showed that laparoscopy was associated with lower morbidity, a shorter length of hospital stay, significantly fewer postoperative complications (RR 0.74, 95%CI 0.58-0.96), lower estimated blood losses, shorter duration of catheterization, and significantly less pain.[55] The laparoscopic operation took longer to perform compared to the open technique. However, the authors concluded by stating the uncertainty about the long-term performance of laparoscopic colposuspension and added that currently available evidence suggests that laparoscopic colposuspension may be as good its open counterpart at 2 years post-surgery (non-significant 5% lower relative subjective cure rate for laparoscopic colposuspension —RR 0.95, 95%CI 0.90-1.00 and statistically significantly lower objective cure rate following laparoscopic colposuspension —RR 0.91, 95%CI 0.86-0.96).[59] This conclusion seems to be valid when the laparoscopic approach is performed the same way as the open technique. However, different aspects of the laparoscopic technique have been compared including one versus two sutures. Two paravaginal sutures appear to be more effective than one.[60] Such systematic comparisons were complicated by a wide of range of modifications of surgical techniques over time and different lengths of follow-up. As for open Burch colposuspension, subjective cure rates of laparoscopic Burch colposuspension deteriorated over time from 67% to 71% and at 6 months to 36% to 52% at 10, respectively. Dumville and colleagues performed a cost-effectiveness analysis of open colposuspension versus laparoscopic colposuspension.[61] They concluded that the laparoscopic approach is not cost effective when compared with the open procedure

TABLE 1 Published level 1 and 2 evidence relating to laparoscopic colposuspension

Study reference	Typo	Comparator	*N/N* (*n*1:*n*2)	Follow-up	Cure (objective or subjective)/effect size	EL
Wallwiener et al[68]	RCT	Transpentoneal versus extraperitoneal	22 (2:2)	1-12 m	92% (s + o)	2
Ross et al[21]	RCT	Sutures versus mesh/ staples	69/69 (25:34)	1 y	91% versus 94%: RR 0.97: 95%CI 0.85. 1.11	2
Su et al[57]	RCT	Open colpo	92/92 (46:46)	6 m	80% versus 95%: $P = 0.044$(o)	2
Persson et al[60]	RCT	2 single bite versus 1 double bite sutures	161/2 (83:78)	1 y	83% versus 58%: $P < 0.001$	2
Piccione et al[69]						
Zullo et al[70]						
Zullo et al[71]						
Fatthy et al[58]	RCT	Sutures versus mesh/ staples	53/60 (27:26)	1 and 3 y	89% versus 75 % (o-at 1y) 70% versus 42% (o-at 2y) 58% versus 38% (o-at 3y):$P < 0.05$	2
Persson et al[62]	RCT	Open colpo	74/74 (34:40)	18 m	88% versus 85%: $P =$ ns (0 + s)	2
Cheon et al[72]	RCT	TVT	68/79 (31:370	1 y	87% versus 89% RR 0.98: 95%CI 0.82, 1.16	2
Ustun et al[63]	RCT	Open colpo	90/90 (47:43)	1 y	85% versus 86%: $P =$ ns (o)	2
Valpas et al[22]	RCT	TVT	46/46 (23:23)	3-24 m	83% versus 83%: RR1.00; 95%CI 0.77, 1.60 (s + o)	2
Valpas et al[73]	RCT	TVT	121/128 (51:70)	1 y		2
Valpas et al[74]						
Paraiso et al[64]						
Jelovsek et al[65]	RCT	TVT	71/72 (35:36)	12-43 m 12-88 m	97% versus 81% (0-at median 18 m) 43% versus 52% (s-at median 65 m)	2
Ankardal et al[75]	RCT	Open colpo Lao colpo (mesh)	184/211 (49:63:72)	1 y	90% versus 92% versus 63% (o) $P < 0.05$ open versus mesh	2
Ustun et al[76]	RCT	Open colpo	52/52 (26:26)	3-24 m	81% versus 81%: $P =$ ns	2
Kitchener et al[77]	RCT	Open colpo	242/291 (144:147)	2 y	80 versus 70% (o)	1
Dumville et al[61]						
Carey et al[78]	RCT	Open coloo	164/200 (766:88)	3-5 y	72% versus 78%: $P = 0.22$ (o at 6m) 69% versus 80%: $P = 0.38$(s at 2y)	2
Valpas A. et al.[79]	RCT	TVT	121/128	§_£	78% versus 94% $P < 0.028$	

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during the first 6 months following surgery but may be over 24 months.

Numerous trials have compared laparoscopic Burch colposuspension with MUS (4, 106-110).[62–65] There was no statistically significant difference in subjective cure rates within 18 months (RR 0.91, 95%CI 0.80-1.02). Objective cure rates tended to be higher for MUS (RR 0.92, 95%CI 0.85 = 0.99) although definition of objective cure varied widely between available studies. MUS placement was associated with shorter operating time, length of hospitalization, and time for resuming normal activity.

In summary, laparoscopic Burch colposuspension should remain in the hands of surgeons with appropriate training and expertise. Moreover, there is limited evidence concerning long term durability of laparoscopic colposuspension which should be considered when obtaining informed consent from the patient.

3 | CONCLUSION

Burch colposuspension has been shown to be a highly effective surgical treatment for SUI with low recurrence rates, although there is some loss of efficacy with time similar to other procedures. In the absence of robust data to guide management of persistent or recurrent SUI after failed MUS, Burch colposuspension remains an option for secondary treatment. However, in a survey among professionals, Burch colposuspension would have been chosen only by a minority of surgeons.[66] Open Burch colposuspension can be considered for those patients in whom a laparotomy is required concurrently with surgery for SUI. Concerning the laparoscopic approach, the conclusion from the Cochrane review was that the available evidence suggests that it may be as effective as open colposuspension two years postoperatively. The NICE guidelines include amongst their recommendations

that laparoscopic Burch colposuspension is not recommended as a routine procedure for the treatment of SUI in women. It was highlighted, that the procedure should be performed only by surgeons with appropriate training as well as expertise working in a multidisciplinary team, and women should be advised about the limited evidence. Finally, although various consensus statements of recognized scientific societies have stated that MUS can be safely used, media pressure might boost the comeback of Burch colposuspension as first-line surgical treatment for female SUI.[67] In the light of such a development, training in both open and laparoscopic Burch colposuspension should nowadays be provided in fellowship and training programs worldwide.

CONFLICT OF INTEREST

All the authors have nothing to disclose.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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