Review Article

Surgical Treatment of Interstitial Cystitis in Women

M. Hohenfellner, P. Black, J. F. Linn, S. E. Dahms and J. W. Thüroff

Johannes Guttenberg-University, Mainz, Germany

Abstract: Interstitial cystitis is a clinical entity that has been known for a century, but its pathophysiology remains largely unknown and the optimal treatment is a matter of ongoing discussion. A successful strategy for treatment relies on precise appraisal of symptoms, clinical findings and histology, as well as on the patient's individual personality. The least invasive treatment possible should be chosen, and only after conservative options have been exhausted should a surgical solution be considered. In this respect, anatomical bladder capacity plays an important role. A large capacity indicates the potential for conservative treatment and may be regarded as a negative predictor for the outcome of orthotopic bladder substitution. In contrast, a small anatomical capacity is unlikely to respond to conservative therapy, but is associated with a high probability of successful orthotopic bladder substitution.

Keywords: Bladder augmentation; Interstitial cystitis; Orthotopic bladder substitution; S3 neurectomy; Surgical treatment; Urinary diversion

Introduction

Although interstitial cystitis as a clinical entity has been known about for a century its pathophysiology remains largely unknown, and the optimal treatment is a matter of ongoing discussion. Numerous different surgical procedures have been employed over the decades. Most, such as transurethral bladder over-distension or ulcer fulguration, are obsolete, but they have made an important contribution to our under-standing of the disease and have served as the basis for new and more effective developments. This paper reviews the literature on the current surgical treatment of interstitial cystitis.

Clinical Management

Before proceeding to surgical treatment, it is generally agreed that conservative treatment possibilities should be exhausted. The clinical management is complicated by several factors.

First, the entity itself is difficult to define, and not all patients who are assigned the diagnosis of interstitial cystitis present with the same disease [1]. Pelvic pain, sensory urgency and frequency are usually prominent symptoms, but patients with a large anatomical bladder capacity are included as well as those with small, contracted bladders. Secondly, difficulties arise in distinguishing between cause and effect, regarding the significant interaction between somatic disease and personality that often accompanies the condition [2–4]. Thirdly, highly invasive surgical approaches to inter-stitial cystitis have led to disastrous outcomes in the past [5,6].

Surgery should not be viewed as an early form of treatment, but we believe that the initial outlining of a step-by-step approach to interstitial cystitis should raise the possibility of surgery in the event of conservative failure. The patient will then be more willing to go through with the variety of conservative options indicated. In addition, diagnostic tests that distinguish where conservative therapy is likely to fail can significantly shorten the patient's therapeutic course.

Correspondence and offprint requests to: Dr Marcus Hohenfellner, Department of Urology, University of Mainz, 55101 Mainz, Germany.

Diagnostic Evaluation

The diagnostic work-up should be extensive and include psychological and pathophysiologic aspects [7]. It is essential to obtain a thorough history that includes information about family and professional environments, nutritional habits and any previous conservative treatments. This aids in gaining an overall impression of the patient and her wishes. The disastrous outcome of futile surgery for pelvic pain and/or bladder discomfort when the pelvic organs actually are not the origin but rather the target of pathologic sensations must be avoided [5].

The clinical work-up must also be complete. Urinary tract infections, urinary calculi, pelvic tumors, neurological disorders, and especially carcinoma in situ of the bladder, all of which can mimic the symptoms of interstitial cystitis, must be ruled out [3,8–11]. Cystoscopy is performed under general anesthesia in order to biopsy the bladder for related histopathology and to exclude carcinoma in situ, and to measure the anatomical bladder capacity (cessation of flow at a filling pressure of 80 cmH$_2$O) [12,13]. When the bladder is found to be small and contracted with a low anatomical capacity, long and erratic trials of conservative treatment can be avoided, as they will never be able to restore the compliance of the chronically inflamed and consequently disintegrated bladder wall. In this way, anatomical bladder capacity serves as a prognostic tool for the value of conservative treatment, but it is also an important decision aid for the choice of surgical approach [13]. Surgical approaches aimed at restoring bladder function may be considered in patients with an adequate anatomical bladder capacity, but reconstructive surgery is necessary to patients with reduced capacity [12–16].

Neurological Procedures

The clinical symptoms of urgency and pain in interstitial cystitis correlate with histopathologic findings of altered bladder innervation [3,17–20]. Surgical procedures that manipulate the innervation in order to reduce the bladder's hypersensitivity and restore its storage function have been implemented at different neural levels. Bilateral neurectomy of the S3 spinal nerve and anterolateral chordotomy are two procedures that in principle may still be considered effective.

Parasympathetic Surgery

Heimburger et al. demonstrated in clincial trials in the late 1940s that the principal innervation of the human bladder arises from segments S2–S4, with the third sacral nerve being the most important [21]. Based on these findings and the disappointing long-term results of sympathetic surgery for interstitial cystitis, several groups began evaluating parasympathetic surgery in the early 1950s.

Having previously studied the innervation of the neurogenic bladder and its surgical modification, Moulder and Meirowsky, a urologist and a neurosurgeon, respectively, at Vanderbilt University [16,22,23] performed a bilateral S3 sacral block with procaine on patients with interstitial cystitis in order to predict the effects of sacral rhizotomy. A bilateral S3 neurectomy was performed if symptoms were alleviated and bladder capacity increased. This procedure was performed on 3 patients in total, and a follow-up was reported in 1969 [15,16]. All 3 were free of symptoms and had an average bladder capacity of 275–500 ml.

Milner and Garlick [24] and Mason et al. [25] performed the Moulder/Meirowsky procedure on a total of 10 patients, and reported their results with a follow-up of 15 months (range 6–18 months). The functional bladder capacity increased from 108 to 311 ml in the 6 patients in the first group. Five were completely free of symptoms, and 1 experienced relief of frequency but persistence of pain and bleeding because of mucosal cracking and ulceration. This was the only patient in the series who had undergone earlier surgical treatment in the form of partial cystectomy [24]. In the second group, Mason et al. considered the outcome successful in 3 of 4 patients. In a third report, a good result was achieved with a follow-up of 5 years in 1 patient with a left-sided S2 and a bilateral S3 sacral rhizotomy [26].

Bohm and Franksson modified the procedure by sectioning only the dorsal sacral roots, rather than the entire S3 spinal nerve [27]. Having previously defined the spinal segments carrying the sensory afferents of the bladder [28], they concluded, based on clinical investigations, that pathologic changes in the sacral nerve roots may be the source of pelvic pain [29]. As the symptoms of interstitial cystitis relate to hypersensitivity and pain, they conducted a trial in 7 patients in whom the dorsal root alone was sectioned. This was done uni- or bilaterally on one to three segments, with the side and number of segments depending on symptoms and endoscopic findings. One additional patient underwent unilateral sectioning of the dorsal and ventral sacral S3 spinal nerve. The outcome was inconclusive and there was no difference between uni- and bilateral rhizotomy. Only 1 patient experienced complete pain relief, a second had only minimal residual pain, and the remaining 6 continued to suffer from considerable pain. A return to normal micturition frequency was observed in 1 patient, the voiding interval increased to 2–4 hours in 5 patients, and frequency persisted in 2. The bladder volume remained unchanged and cystoscopically detectable lesions persisted in all patients, although in 2 they healed on the side of the rhizotomy.

When viewed together, these studies on sacral rhizotomy include 22 patients. The following complications and side effects were encountered: a post-

operative wound infection in 1, an atonic bladder of 1 month's duration in 1 [25], temporary hypalgesia in 2, perineal numbness in 1, and absent Achilles reflex in 1 [24].

Anterolateral Chordotomy

Anterolateral chordotomy is the most central type of denervation that has ever been performed for interstitial cystitis. In 1923 Frazier and associates performed what was probably the first case, on a 33-year-old woman suffering from 'intense vaginal and bladder pain extending down to sole of left foot . . . probably due to ulcers in bladder' [30]. Right unilateral chordotomy of the fifth thoracic segment led to complete pain relief for almost 1 year. A second chordotomy of the left third thoracic segment was performed following a right-sided recurrence of pain. The patient was free of symptoms for the subsequent follow-up of 8 years. She experienced adverse effects in the form of transitory urinary retention and weakness of her lower limbs for about 3 weeks. Complete loss of pain persisted, as did her loss of temperature sensation below a line 2 inches above the umbilicus [30].

Nesbit reported success in all 4 patients whom he subjected to anterolateral chordotomy, after a mean follow-up of 11 months (range 3–24) [31]. Although no significant complications or adverse effects have been reported and the procedure has been positively reviewed by others [3,32,33], no further reports have followed, probably because the very invasive nature of this procedure.

Reconstruction of the Lower Urinary Tract with Bowel Segments

Bladder Augmentation/Orthotopic Bladder Substitution

Bladder augmentation or orthotopic bladder substitution are widely viewed as the most suitable procedures when a surgical reconstruction is deemed necessary. This is derived not only from the benign nature of interstitial cystitis, which renders radical surgery in the small pelvis superfluous, but also from an esthetic point of view. The technique has, however, also produced the most controversial results, with success rates varying between 25% [6] and 100% [2,34,35] (Table 1). Three issues must be addressed in a critical apraisal of these discrepancies: indication, surgical approach to the detrusor, and the method of augmentation/substitution.

The problem in assessing the indication for orthotopic bladder substitution lies in the definition of interstitial cystitis, as most reports do not describe in detail criteria for characterizing the disease. A comparison of the different reports on surgical therapy is thus made impossible. Anatomical bladder capacity is one parameter that is included by several authors in their preoperative diagnostic work-up. The results of orthotopic bladder substitution vary in relation to anatomical bladder capacity, as was first recognized by Nielsen et al. [6]. In their group of 8 patients surgical outcome was successful in both patients with a bladder capacity of 200 ml on cystoscopy, but the procedure was a failure in 6 others with a mean anatomical bladder capacity of 524 ml (400–675 ml). A similar pattern has been observed by other authors [36–38] (Table 2), but does not appear to apply to subtrigonal cystectomy [39].

Table 1. Results of supra- or subtrigonal bladder resection and augmentation

Reference	Cystectomy (supra-/subtrigonal)	Number of patients	Success rate (%)	Follow-up (months)
Bejany [34]	Sub	5	100	52
Badenoch [41]	Supra	9	55	?
Bruce [35]	Supra	8	100*	36
Freiha [66]	Supra	6	67	23
Goodwin [60]	Supra	2 (3)	100	18
Guillonneau [43]	Supra	8	88/75[‡]	23
Hohenfellner [50]	Sub	17	82/71[§]	73
Hohenfellner [50]	Supra	6	100	26
Holm-Bentzen [44]	Supra	6	83	60
Kontturi [36]	Supra	12	83	56
Nielsen [6]	Supra	8	25	10
Nurse [47][†]	Supra	24	70	?
Nurse [47][‡‡]	Supra	12	83	?
von Garrelts [37]	Supra	13	93	40
Webster [38]	Supra	19	63	38

* One patient required reoperation because of insufficient bladder resection.
One of 3 patients died on the 10th postoperative day from acute coronary thrombosis.
[‡] Seven patients are free of symptoms; 1 of these has stress incontinence grade III.
[§] Fourteen patients are free of symptoms; of these, 2 required conversion (1 due to stress incontinence grade III and 1 due to chronic pyelonephritis).
[†] Without preoperative trigonal biopsies.
[‡‡] With preoperative trigonal biopsies.

Table 2. Preoperative anatomical bladder capacity and postoperative results

Reference	Mean preoperative anatomical bladder capacity (ml)	
	Successful outcome	Failure
Goodwin [59]	50	0
Kontturi [36]	186	300
Nielsen [6]	200	524
von Garrelts [37]	'all contracted'/93% success	
Webster [38]	192	362

Concerning the surgical approach to the detrusor, there is an unspoken but widespread agreement that at least the supratrigonal part of the bladder should be resected. The outcome was universally unfavorable in the few reports in which the detrusor was not resected [36,40]. A recurrence of symptoms necessitating subsequent revision has been described in 2 cases [35,38]. Symptom relief was then achieved by resection of the bladder remnant down to the trigone (by Bruce et al. [35]) and down to the bladder neck (by Webster and Maggio [38]). We have performed secondary supravesical diversion in 3 patients who presented with persistence of symptoms following ileal bladder augmentation without detrusor resection in other institutions.

Supratrigonal resection of the bladder is performed by most authors [6,35–38,40–46]. A few perform subtrigonal resection in some [44,47] or all [34,39] of their patients. The advantage of trigone preservation is that the ureteral orifices are left in situ, obviating ureteral reimplantation with its associated complications. The disadvantage is that the trigone may be the source of symptom persistence or recurrence.

Histopathologic findings and clinical results may aid in decision making. In a group of 18 patients, Hunner described lesions as being located in the free portion of the bladder (the trigone represents the fixed portion) in all cases [48]. In another group of 223 patients, Hand found approximately half of all minor lesions to be located in the trigone-base area, whereas most advanced lesions involved either the entire bladder or just the dome [3]. Trigone involvement was described by Smith and Dehner in 2 of 28 cases [49], by Nurse et al. in 13 of 25 [47] and by Nielsen et al. in 1 of 7 patients [6].

Only a few investigators [40,47], however, have attributed failure to the preserved trigone. Indeed, the above-mentioned success rates between 25% and 100% (Table 1) were all achieved with supratrigonal detrusor resection, thus eliminating the resection line as the exclusive determining factor. This was confirmed in our study on 23 patients, of whom 17 underwent subtrigonal and 6 supratrigonal cystectomy. After a mean follow-up of 73.1 months, 12 of the patients with subtrigonal cystectomy had results rated as excellent, 1 as fair, and 4 as failure (2 patients were asymptomatic but suffered

from complications). In the supratrigonal group all 6 patients had excellent results after a mean follow-up of 25.5 months [50]. Preoperative trigonal biopsy has been suggested by Nurse et al. as a basis for determining the need for trigone resection [47]. Whitmore and Gittes summarize their strategy as follows: 'the trigone is saved if it is not too diseased' [11].

A wide variety of bladder augmentation techniques have been attempted over the years, but a review of the literature reveals that neither the type of bowel segment used nor the shape formed has a significant influence on the outcome. Functional urodynamic considerations dictate that detubularization should be standard regardless of which type of bowel segment is used [51,52].

The first patient subjected to ileocystoplasty by Goodwin was a woman with a 10 year history of intractable interstitial cystitis. Among the first 14 patients having this type of bladder augmentation, only the outcome of this woman and of a second woman also with interstitial cystitis was rated as excellent. Good to excellent results were also reported by others using ileum [35,37,38,41,43], ileocecum [6,8,10,36,38,45], cecum [37,44], right colon [38,41] and sigmoid colon [35–37,43,45] regardless of whether these segments were detubularized [6,35,36,38,43] or not [8,10,11,36, 37,43–45]. On the other hand, failures have also been reported with the same techniques [6,36–38,41,43].

Augmentation enterocystoplasty can lead to the same complications in interstitial cystitis as in other conditions [53], and so the reader is referred to the relevant literature.

Folsom et al. have provided an additional noteworthy report [54]. They describe a surgical accident performed in 1923 in which the bladder was inadvertently resected down to the trigone, with the remnant being closed over an 18 Fr catheter. The patient experienced complete symptom relief, with alleviation of frequency, nocturia and pain. The procedure was then repeated in 7 cases up to 1940, with all patients recovering normal bladder capacity and achieving cure of symptoms at follow-up varying from a few months to 17 years. Two patients developed vesicoureteral reflux as a sequel of the operation, 1 requiring bilateral surface ureterostomy.

Ureterocolic Implantation

Ormond, in 1935, referred to other surgeons as having performed ureterocolic implantation 'in exceptionally severe and stubborn cases' of interstitial cystitis, but did not indicate a reference [55]. Counsellor (1937) peformed the same procedure in 5 patients with a 1-year history of interstitial cystitis who had undergone extensive conservative and surgical treatment. Given a follow-up of more than 1 year in 4 cases (1–8 years), all 5 had an excellent outcome. In this preantibiotic era, Counsellor endorsed preoperative intraperitoneal vaccination and implantation of one ureter at a time, according to the technique of Coffey. Subsequently, other investigators confirmed the efficacy of this

procedure [3,41,42,56]. Badenoch lost 2 of 6 patients to chronic renal failure [41], but other large series of ureterosigmoidostomy fail to demonstrate a similar complication rate [57–61].

Ureterosigmoidostomy has experienced a renaissance in reconstructive and oncological urology, partly due to a modification of the classic procedure whereby the sigma–rectum junction is detubularized (Mainz pouch II) [62]. It is conceivable that this method may also be applicable in selected cases of interstitial cystitis.

Cutaneous Urinary Diversion

The most invasive treatment option for interstitial cystitis is urinary diversion with bowel segments. This is usually reserved for cases when previous bladder augmentation or substitution has failed, or when orthotopic substitution is unsuitable (e.g. severe stress incontinence, inability to perform transurethral catheterization, or evidence of trigonal or urethral interstitial cystitis [3,47,49]), although it has also been used as the primary approach [7].

The absolute necessity for a thorough preoperative psychological and pathophysiologic evaluation in this context cannot be overemphasized, as is highlighted by reports of patients with persistent symptoms after cystectomy and urethrectomy [7], or with severe persistent projection of pain in the small pelvis after complete pelvic evisceration combined with urinary and fecal diversion [5].

One pathophysiologic aspect has been elucidated by Lotenfoe et al. As in orthotopic substitution, this group has been able to correlate the outcome of urinary diversion as a primary approach to interstitial cystitis to the anatomical bladder capacity [7]. They treated intractable interstitial cystitis by urethrectomy, cystectomy and the creation of a continent colonic urinary reservoir (Florida pouch). The success rate was only 20% in 5 patients with a large bladder capacity (>400 ml), but 88% in 17 patients with small bladder capacity (<400 ml) [7].

Three further issues must be addressed in a critical appraisal of urinary diversion as a treatment option: the necessity for cystectomy, the value of diversion as a secondary procedure following unsuccessful orthotopic bladder augmentation/substitution, and the type of urinary diversion.

Cystectomy would seem unnecessary given the observation that symptoms of interstitial cystitis are relieved when urine is no longer stored in the bladder. This observation was first made by Simpson and Tait in 1870 [63], after they created a temporary vesicovaginal fistula in 3 patients 'to put the bladder in a state of complete physiological rest'. The patients experienced immediate relief of pain [63]. Hunner reported a patient who was free of symptoms as long as she had a cystostomy [48]. These initial reports have been substantiated by later publications of symptoms alleviation following different types of permanent incontinent

and continent urinary diversion without cystectomy [3,14,41,64,65]. Wishard et al. reported one failure of such a procedure [66]. The majority of evidence thus indicates that cystectomy is not necessary when urinary diversion is performed. Colpocystotomy or secondary cystectomy may, however, become necessary for the management of pyocystis, as was reported by Freiha et al. in 2 cases [65].

Four groups have reported performing urinary diversion following failed orthotopic bladder augmentation/substitution [6,12,41,42]. It appears that the results were satisfactory in all four groups, but only one describes the outcome explicitly [42]. Three patients have presented to our institution with persistent symptoms following ileal bladder augmentation without detrusor resection in outside hospitals. All 3 were converted to a continent urinary diversion in the form of a Mainz pouch I. Two exhibited a good result, but the third had to undergo deconversion to an incontinent urinary diversion because of extensive pain when catheterizing her pouch. We were able to show that her problems had stemmed from recurrent inflammation of the bowel segment used to create the continence mechanism. Light microscopy demonstrated changes similar to those of interstitial cystitis. It remains unclear whether interstitial cystitis may recur in transposed bowel segments [41,64,67,68], or whether this type of tissue reaction may affect to varying degrees all bowel segments that are exposed to urine [69].

As indicated above, a variety of different techniques of urinary diversion have been successfully used in the treatment of interstitial cystitis. Ileal conduits have provided good results for several groups in the past [41,65,70], yet we believe that continent urinary diversion in whichever form, orthotopic or cutaneous, is the method of choice whenever indicated, as it provides the maximum preservation of body image.

Conclusion

Extensive work has been done on interstitial cystitis, which has been known now for a century. Indeed, some of the contemporary hypotheses regarding its pathophysiology were formulated more than 50 years ago. Numerous surgical procedures have been tested over the decades, only to prove ineffective. They have, however, guided further developments and form the groundwork for treatments currently employed. Interstitial cystitis should be appreciated as a conglomerate of different diseases with similar symptoms, but with different pathophysiologic and anatomical bases. A successful strategy for treatment relies not only on the precise knowledge of symptoms, clinical findings and histology in each patient, but also on the patient's individual personality. The least invasive treatment possible should be chosen.

This review describes a variety of potentially effective surgical treatments. Probably the most important consideration is the anatomical bladder capacity

(capacity under anesthesia). A large capacity should lead to conservative treatment initially, which may eventually be followed by surgery. On the other hand, a large capacity is a negative prognostic indicator for supratrigonal bladder resection and augmentation, as well as for urinary diversion. Patients with a small anatomical bladder capacity have been shown to do well after supratrigonal resection combined with bladder augmentation. Alternative procedures are ureterocolic implantation and continent urinary diversion. Incontinent urinary diversion as a primary choice seems to be outdated.

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