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Invasive therapy for bladder pain syndrome/interstitial cystitis (BPS/IC)

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Abstract

This chapter summarizes our present experience with invasive regimen in BPS/IC therapy. A broad spectrum of interventions including simple endoscopic procedures as well as extensive surgery are performed in this indication. Hydrodistension, fulguration of Hunner's lesions, sacral neuromodulation and cystectomy may all give significant symptom relief to BPS/IC patients, however, the efficacy is not perfectly predictable. Thus, patient selection is crucial, and our algorithms for precise selection of patients for each procedure still are improvable.

Summary of recommendations

1. Fulguration/electrocoagulation/-cauterization seems to be a very effective method to give significant symptom relief to patients with Hunner lesions. Similar effects were also described by some authors for patients with non-ulcer type of BPS/IC. The beneficial effect may even be durable for a year or longer in some patients.
2. Sacral neuromodulation may work well for urinary symptoms of BPS/IC, and durable efficacy has been demonstrated for these cases, however, the response for pain is not accurately predictable. The high rate of reoperations, explantations due to ineffectivity, and a considerable infection rate of 4–13% are drawbacks added to the high costs of the implanted system.
3. Major surgery has a delicate position in BPS/IC therapy. Since we still are not able to clearly define the exact origin of pain in BPS/IC, removal of the urinary bladder may not be the definite solution in all patients. However, response or even success rates appear to be >80% in most major series, which makes it reasonable to offer cystectomy to patients in whom all other treatment options have been ineffective, especially if they have a small fibrotic bladder.
4. Bladderhydrodistension under anesthesia may give temporary symptom relief in BS/IC. Combination with EMDA or hyaluronic acid seems to improve response rates. However, repeated urothelial damage by hydrodistension has the potential for bladder shrinkage, which may finally lead to cystectomy due to minimal bladder capacity.

1 Introduction

When conservative treatment strategies for BPS/IC fail, more aggressive approaches may be necessary. Endoscopic therapy for the BPS/IC bladder was first described in 1915 (ulcer fulguration by Hunner [1]). This method is still used with or without hydrodistension, often with temporary or, in rare instances, permanent success. Although original described for the treatment of voiding dysfunction, neuromodulation has proven useful in selected cases to treat the irritative voiding symptoms and pain/discomfort associated with BPS/IC. If all therapeutic efforts have failed, bladder reconstruction or urinary diversion may be considered.

2 Invasive procedures for therapy of bladder pain syndrome/interstitial cystitis (BPS/IC)

In the following the invasive procedures will be described and discussed in more details.

2.1 Endoscopic procedures of ablation

Endoscopic procedures appear to be best suited for those patients suffering from BPS/IC associated with Hunner lesions. One of the earliest reports of success came in 1985 when Fall reported that transurethral resection (TUR) of all BPS/IC bladder lesions led to initial disappearance of pain in all 30 patients and a decrease in urinary frequency in 21 (70%) [2].

In 2000, Peeker presented the outcome of 259 TURs of Hunner ulcers (HU) in 103 patients: 92 experienced amelioration, and in 40% symptom relief lasted more than 3 years. In the remaining patients, although symptom recurrence was common, the majority responded well to subsequent TUR [3].

Laser fulguration was first described in a preliminary report by Shanberg 1985, later presenting a larger series together with Malloy 1994: 27 patients were treated with a Nd:YAG laser delivering 20 to 25 W to Hunner ulcers. Of these, 21 (78%) improved immediately after laser therapy, however, symptoms recurred in 12/21 (57%) within 18 months. Thus, 33% of the initially treated patients showed permanent improvement [4]. The same group treated glomerulations and inflamed bladder areas in 59 patients without ulcers, and observed a 35% response rate of marked symptomatic improvement postoperatively. 50% of these responders developed symptom recurrence within 1 year [4].

Rofeim reported on laser fulguration of HU by Nd:YAG laser in 24 patients in 2001. All of them had symptom improvement after therapy, however, 11 patients (46%) required one to four additional treatments [5].

Hillelsohn reviewed the data of 59 BPS/IC patients treated with 106 fulguration procedures between 1993 and 2011. After a single treatment with an average followup of 33.8 months, 78% of patients reported improved or stable symptoms, similar to 77% of patients with multiple fulguration sessions. Multiple treatments in general did not lead to a decrease in bladder capacity [6].

Publications from the last years may not be well comparable to these older reports, since definition of BPS/IC has changed in the last decade from NIH criteria to less restrictive definitions and, thus, may include other sets of patients.

In 2013, Ryu published on 27 patients treated with deep electrocoagulation of HU with a ball-shaped electrode (40 V current). Two months after treatment, all symptoms/symptom scores were improved (VAS from average 5.8 to 1.9, PUF symptom 15.1 to 7.0, PUF bother 8.4 to 2.7). The number of responders was 94.1% at 2 months, 70% at five and 33.3% at 10 months. The patients had an average 2.9 lesions that were fulgurated. 4 patients underwent a repeat fulguration about 1 year after the first procedure, and HU location was different from the first treatment session in most cases [7].

Chennamsetty reviewed the outcome of 214 electrocauterization procedures in 76 patients (66 women, 10 men) performed by a single urologist from 1997 to 2013 [8]. Mean number of operations was 3 per patient. All patients underwent hydrodistension two times with a pressure of 80 to 100 cm H_2O for 2 minutes before electrocauterization was performed with a rollerball or a 6F electrode at 25 W. The mean time between operative sessions was 14.5 months. 84% of the 52 patients that responded to the follow up questionnaire rated electrocauterization as most beneficial. On a 10-point-visual analogue scale, pain decreased from a mean 8.6 to 2.6, frequency from 9.0 to 3.7, and urgency from 8.4 to 3.3. Marked improvement was reported by 56.3% of patients. Bladder capacity did not deteriorate after repeat electrocauterization procedures. 98% stated that they would undergo electrocauterization again.

Niimi reported on 191 newly diagnosed BPS/IC patients (155 women and 36 men) who underwent hydrodistension with fulguration between 2007 and 2013 [9]. 126 patients showed a Hunner lesion, 65 did not. Primary outcome was defined as symptom recurrence, which occurred at a mean 28.5 months in patients with Hunner type IC and 25.2 months in non-Hunner type IC. Similar findings were reported in 2006 by Kaneko who also observed a better response to the combination of hydrodistension and electrocoagulation in HU patients [10].

New diagnostic methods may improve visualization of Hunner lesions. Kajiwara used narrow band imaging technique (NBI) to optimally detect BPS/IC specific bladder lesions in 23 patients (19 women, 4 men) for a most complete electrocoagulation [11]. All patients experienced a substantial improvement in pain for a mean follow-up of 22 months. VAS pain scores decreased from a mean 7.3 to 1.2 points. 5 patients (22%) reported complete resolution of pain. 5/6 patients with symptom recurrence underwent a second treatment session with good response. The authors conclude that NBI may improve transurethral electrocoagulation therapy in BPS/IC patients.

In summary, fulguration/electrocoagulation/-cauterization seems to be a very effective method to give significant symptom relief to patients with Hunner lesions (HL), who, however, represent only a part of BPS/IC patients (this number varies in a broad range from 5 to >50% in different parts of the world). Similar effects were also described by some authors for patients with non-ulcer type of BPS/IC. The beneficial effect may even be durable for a year or longer in some patients.

However, many questions stay unresolved. In many reports, patients underwent hydrodistension before fulguration, which by itself is known to reduce symptoms of BPS/IC. The rest of the patients also had repeated bladder fillings for the coagulation procedure, thus, it cannot be ruled out that hydrodistension is responsible to a significant part for symptom improvement with these tissue ablative procedures.

Another unsolved question is if resection with the risk of perforation of a thin bladder wall is better than fulguration/coagulation (), and if complete treatment of all visible lesions is necessary to obtain the best effect. These questions have not been answered yet in a comparative study and may stay open, since a representative number of HU/HL patients may not be recruitable for a significant statistical conclusion. An individual solution, depending on sex, disease history, bladder anatomy, number and location of HU/HL and available instruments may be the best approach for treatment of BPS/IC patients.

2.2 Neuromodulation using implanted electrodes

Sacral neuromodulation (SNM) is a minimally invasive method performed by a programmable pulse generator implanted through the S3 foramen, usually after successful temporary percutaneous stimulation. This procedure was introduced as therapy for urinary urgency/frequency, urge incontinence and urinary retention. Urgency/frequency refractory to common therapeutic approaches is one of the characteristic symptoms of BPS/IC, so SNM was initially offered to BPS/IC patients who did not respond to other therapies.

Stimulation of S3 influences detrusor, sphincter and pelvic floor muscle activity. The mode of action of SNM is not fully understood, but is generally thought to be by activation of somatic afferent axons in the sacral spinal roots, direct inhibition of preganglionic neurons and/or inhibition of interneuron transmission in the afferent limb of the micturition reflex.

Experimentally, Wang showed in rats with hydrochloric acid-induced cystitis that SNM at level S1 reduced micturition frequency compared to controls, but not by inhibition of c-fiber activity (as rated by the number of fos-positive neurons) [12].

In 2001, Maher reported results of temporary percutaneous SNM of S3 sacral roots in 15 therapy refractory BPS/IC patients. In this group, mean bladder pain decreased from 8.9 to 2.4 points on the 10-point VAS, mean voided volume increased from 90 to 143ml, and mean number of daytime frequency decreased from 20 to 11, as did nocturia from 6 to 2 times. 73% of these patients requested to proceed to permanent electrode implantation [13].

Comiter reported in 2003 on a prospective study with 25 BPS/IC patients with treatment refractory disease. After an initial percutaneous SNM period, permanent implants were performed in 17/25 (68%) patients who demonstrated a >50% improvement of symptoms. After a mean follow up of 14 months, mean daytime frequency had improved from 17.1 to 8.7, as did nocturia from 4.5 to 1.1. Mean voided volume increased from 111 to 264 ml, and average pain decreased from 5.8 to 1.6 points. Improvement was maintained during the follow-up period in 16/17 patients [14].

Long-term results of SNM were first reported by Powell in 2010. 32 women and 7 men with therapy refractory BPS/IC had been treated between 2000 and 2004. In 22 (54%) a permanent generator was implanted after successful test stimulation. During long-term follow-up of 5 years, 19/22 (86%) of patients showed maintained symptom reduction, while 3 (14%) lost benefit over time. However, 50% of all devices required explantation [15].

More long-term results were reported by Gajewski: In the years from 1994 to 2008, 78 BPS/IC patients underwent primary peripheral nerve evaluation (PNE) on nerve roots S3/4. In 46 patients (59%) with a minimum symptom improvement of 50% a permanent SNM was implanted. The average follow-up of these patients was 61.5 months. The long-term success rate was 72% and the average improvement in Global Response Assessment was 80%. The explantation rate was 28%, the most common indication for removal was poor outcome (9 patients), followed by painful stimulation (4 patients). Mean time to explantation was 15.4 months, and there was no removal after 33 months of implantation. The overall success rate from the initial 78 patients was 43% [16].

Marinkovic reported on a favorable long-term outcome of 34 female patients that received a SNM between 2002 and 2004. With a median follow-up of more than 7 years they were able to show maintained efficacy with VAS scores reduced from an average of 6.5 to 2.4 and UF scores reduced from 21.6 to 6.6 over the whole observation period [17].

More long-term data have been reported from Ghazwani: 21 BPC/IC underwent PNE between 2002 and 2004, 11 of them (52%) were implanted with a permanent SNM. Symptom improvement was maintained in this patient group over the average follow-up of 6 years [18].

In 2011, the first meta-analysis on SNM for chronic pelvic pain was published: the majority of included articles (10/12) referred to BPS/IC patients. The percentage of patients who responded to test stimulation was 51 to 77%. The mean reduction of pain scores was between 40 and 72%. The reoperation rate ranged from 27 to 50% [19].

Peters reviewed reoperation rates in 407 patients with a SNM implant for different bladder diseases: 33% had at least one reoperation over a median follow-up of 28.9 months, of which 78 (19%) patients underwent a revision procedure, and 56 (14%) devices were explanted. The most common reason for reoperation was lack of efficacy/worsening of symptoms (87/134). BPS/IC patients had a higher reoperation rate than patients with other indications for SMN implantation [20].

In another study, Peters analyzed the levels of urinary chemokines of BPS/IC patients before and after SNM and correlated them to the change of symptoms. Symptom improvement was especially paralleled by reduction of MCP-1 (monocyte chemoattractant protein), but also significantly by sIL-1ra (secretory interleukin-1 receptor antagonist) and CCL5 (chemokine ligand 5). The authors conclude that chemokines have an important role as downstream effectors of SNM response and could serve as potential non-invasive measures of treatment response [21].

A single RCT for SNM exists, also performed by Peters and published in 2007. The authors implanted leads to the S3 root and to the pudendal nerve in 22 BPS/IC patients. Each lead was stimulated for 7 days in a test phase, and the better responsive lead was connected to a permanent generator implant. 17 (77%) of the patients showed symptom improvement in the test phase, 13 patients with the pudendal nerve lead (PNS) and 4 with the S3 lead. Symptom improvement was maintained over the follow-up period of 6 months. The overall reduction of symptoms was 59% for PNS and 44% for SMN, and voids improved by 41% (PNS) vs. 33% (SNM).

In conclusion, SNM is considered a fourth line option for BPS/IC treatment in the AUA guidelines with grade C recommendation for selected patients refractory to less invasive therapies. While urinary symptoms seem to respond well to SNM (for which SNM has also been approved by FDA) and durable efficacy has been demonstrated for these cases, the response for pain is not accurately predictable. Preoperative patient education is crucial, since questions regarding ideal patient candidacy and optimal technical considerations still remain unanswered. A test stimulation is mandatory, since only responders should be given a permanent implant. The high rate of reoperations, explantations due to ineffectivity, and a considerable infection rate of 4–13% [22], [23] are drawbacks added to the high costs of the implanted system.

2.3 Major surgery for BPS/IC: cystoplasty and urinary diversion

When all therapeutic attempts fail, the question arises if removal of the urinary bladder and/or urinary diversion would not be the solution to all problems and symptoms of BPS/IC. Since this undoubtedly is a major surgical intervention with the possibility of significant postoperative problems, patient´s selection and counseling is crucial to achieve the optimal outcome with any procedure.

Indications for major bladder surgery may vary: while the scarred, low-volume bladder is a good indication for a favorable outcome, the painful normal capacity bladder is not always a good candidate for bladder removal [24]. Nielsen reported that 2 patients, who had a small contracted bladder preoperatively while they were under anesthesia, were cured by supratrigonal cystectomy and ileocecocystoplasty while all 6 failed cases had a large bladder capacity. This goes well with my personal observations and other reports as well. Anyway, it is easier to indicate major bladder surgery, when normal bladder function is completely lost in the course of disease.

The first report of ileocystoplasty for IC bladder augmentation is from 1958 by Goodwin. While the first 2 patients had an excellent outcome, these were the only ones benefitting in a series of 14 patients [25].

Chong systematically reviewed indications and outcomes of cystectomy in non-malignant bladder conditions [26]. He found only limited and mostly retrospective studies with small numbers of patients. The main questions that still are unsolved are if supra- or subtrigonal cystectomy results in better outcome, and if the type of urinary diversion (ileal conduit, neobladder or pouch) may influence success. Five principal studies are cited in this review:

In 1998, Linn reported on 31 patients who underwent either sub- or supratrigonal cystectomy with Mainz pouch orthotopic bladder substitution for BPS/IC [27]. 82% of the patients who had undergone subtrigonal cystectomy were completely symptom free, compared to 100% with supratrigonal cystectomy.

Van Ophoven reported a 83% success rate defined by functional bladder capacity improvement, voiding frequencies and bladder symptoms after supratrigonal cystectomy with substitution enterocystoplasty [28]. Christmas observed a 100% success rate in 27 BPS/IC patients with cystectomy and bladder replacement by an ileal pouch [29].

Peeker highlighted a possibly crucial factor for the success of cystectomy in BPS/IC [30]: in his series of 13 patients, 100% of those who had classic "Hunner´s Ulcer" disease improved with supratrigonal cystectomy, compared to no improvement in the 3 patients with non-ulcerative disease. Similarly, Rössberger found a 82% response rate from different surgical procedures (continent and non-continent urinary diversion, supratrigonal ileocystoplasty and caecocystoplasty) in 47 patients with classic ulcerous BPS/IC, compared to only 23% in non-ulcerative disease [31].

Hughes reported on 32 patients (29 women, 3 men) who had undergone substitution cystoplasty after supratrigonal or subtotal cystectomy [32]. 90% of the women and all men with a preoperative bladder capacity <250cc showed excellent improvement after surgery, while the outcome in patients with larger capacities was definitely worse (28% response rate).

Andersen collected data of 34 women and 7 men with BPS/IC refractory to conservative therapies [33]. Five patients had primary cystectomy, 16 patients subtotal cystectomy with bladder augmentation and 20 supravesical urinary diversion without cystectomy. 13 patients underwent cystectomy at a later time due to persisting pain, an average 12 months after the initial procedure. Finally, 74% of patients were free of pain. In general, patients performed better when the duration of symptoms was shorter.

The results from 40 patients with supratrigonal cystectomy and augmentation ileocystoplasty were reported by Kim in 2014 [34]. All outcome parameters improved significantly after surgery: average pain score decreased from 8.3 to 1.3 on a 10-point-VAS, IC symptom index from 17.8 to 9.9, and IC problem index from 14.6 to 6.5. 5 patients required clean intermittent self-catheterization. However, 20% of patients were regarded as treatment failures. 2 patients developed Hunner´s lesions at the remnant bladder neck that were resected transurethrally. No preoperative factors were identified as significant for treatment failure, however, longer symptom duration showed a tendency for less beneficial outcomes.

Norus investigated patients who had undergone urinary diversion by ileal conduit with or without cystectomy [35]. From 20 patients with ileal conduit diversion without cystectomy, the bladder was removed subsequently in two for persistent symptoms. 58% of these patients that were available for followup were free of BPS/IC-symptoms, 42% had minimal symptoms. From the primary cystectomy group (3 patients), 2 were symptom free, while one suffered from severe symptoms. The authors conclude that ileal conduit diversion without cystectomy may be an appropriate option for BPS/IC patients refractory to other therapies.

Yang addressed the question if urethrectomy is necessary in BPS/IC patients [36]. In their series of 18 patients who underwent cystectomies with and without urethrectomy they were not able to observe improved outcomes when the urethra was resected.

However, bladder pain may not be improved after cystectomy. This makes counseling of BPS/IC patients difficult. Elzawahri analysed 11 patients with no pain relief after sub- or supratrigonal cystectomy with enterocystoplasty/continent urinary diversion [37]. When the ileal pouch was retubularized and used for as an ileal conduit, 10/11 (91%) of the patients experienced symptom relief. Luchey reported on 2 patients who had persistent pain after cystectomy with urinary diversion that was only alleviated when subsequent urethrectomy was performed [38].

The present reports demonstrate the delicate position of major surgery in the therapeutic options for BPS/IC. Since we still are not able to clearly define the exact origin of pain in BPS/IC, removal of the urinary bladder may not be the definite solution in all patients. However, response or even success rates appear to be >80% in most major series, which makes it reasonable to offer cystectomy to patients in whom all other treatment options have been ineffective, especially if they have a small fibrotic bladder.

It may be helpful to test the bladder with intravesical lidocaine instillation before removing it. Pain should disappear if the bladder is its point of origin [39], [40]. If pain persists with lidocaine, cystectomy is not recommended. However, this test is not standardized, and its value for pain resolution after cystectomy is not yet documented.

My personal algorithm for cystectomy decision is: Favourable:

- Small bladder capacity
- HL/HU
- Pain>urge (the definition for this may vary geographically)
- Pain resolution after intravesical lidocaine instillation

Unvafourable/questionnable:

- Large bladder capacity (with/without anesthesia)
- Urgency >>> Pain
- Pain persistence with intravesical lidocaine
- Pain site other than bladder (urethra, vagina, pelvis)
- LANSS Score gives high probability for neuropathic pain

From the accessible data, supratrigonal cystectomy may be as effective as subtrigonal cystectomy, avoiding the pitfalls of ureteral reimplantation as well as autonomic innervation to the bladder neck that is necessary for continence and micturition after orthotopic bladder reconstruction. Studies also suggest BPS/IC associated with Hunner lesions have superior outcomes after surgery. The type of urinary diversion may also play a role for ultimate success, but published data do not support a specific strategy at present.

My present personal strategy is: laparoscopic subtrigonal cystectomy with vaginal preservation and nerve sparing, if possible from patient´s age and overall condition creation of an orthotopic neobladder, in all other cases urinary diversion by ileal conduit.

In AUA guidelines, major surgery has received a recommendation Grade C based on level 3 evidence, whereas EAU guidelines rate cystectomy Grade A based on level 1 evidence.

2.4 Hydrodistension

Bladder hydrodistension has been an important diagnostic procedure in BPS/IC for many decades, however, the "disease-specific" glomerulations, petechial mucosal bleedings, that have been regarded as pathognomonic for BPS/IC, have been found in other conditions, too. Thus, the diagnostic value of hydrodistension has been questioned in recent years [41].

As early as in 1930, Bumpus first advocated the use of hydrodistension under general anesthesia in the management of interstitial cystitis [42], however, with variable success.

In principle, two techniques for bladder distension have been described: simple hydraulic filling and intravesical balloon hydrodistension (Helmstein balloon). For a long time, this procedure was not standardized, neither from infusion speed, maximum intravesical pressure or duration of hydrodistension. ESSIC defined a standard procedure for hydrodistension as a diagnostic procedure using a maximum intravesical pressure of 80 cm H_2O for 3–5 minutes, and glomerulations observed after hydrodistension were rated grade I to III with regard to their extension [43].

Despite the fact that hydrodistension gives temporary symptom relief for a variable time to a considerable number of BPS/IC patients, the mechanism for this is not understood. Partial sensory denervation of suburothelial nerve plexus by hydrodistension pressure was presumed to be the cause of symptom remission, and axonal degeneration has been observed in animal studies after bladder overdistension [44]. Chai found a significant increase of urinary heparin-binding epidermal growth factor (HB-EGF) and a significant decrease of urinary anti-proliferative factor (APF) after in vivo bladder stretch [45]. Bägli described an increased expression of RHAMM (receptor for hyaluronic acid mediated motility) after bladder stretch, which may be an early step for tissue repair in response to injured bladder tissue [46].

Autonomic responses, i.e. significant increases of systolic/diastolic blood pressure and heart rate, are typically found in patients with visible bladder lesions after hydrodistension, and these were concordant with symptom severity [7], [48].

Glemain reported on the results of 32 BPS/IC patients that were treated prospectively by continuous balloon dilatation of the bladder for 3 hours under epidural anesthesia. The intravesical pressure used was equal to patient's mean arterial pressure [49]. Pain resolution was maintained for 6 months in 60% of patients, and for 1 year in 43.3%. Results were better for patients with a cystometric bladder capacity ≥150cc before treatment.

Ballon dilatation of the bladder has not become as popular as hydrodistension, and no recent publications on this procedure have been found. Since it is performed without direct vision, it must be rated inferior and more risky than standard hydraulic distension during cystoscopy.

Hoke treated 106 BPS/IC patients with bladder hydrodistention, of whom 48 simultaneously received a transvaginal trigonal block with 0.25% bupivacaine/1% lidocaine under cystoscopic guidance [50]. Patients with and without trigonal block perceived a significant improvement in pain scores, with no difference between both groups. Distention times of 2 and >5 minutes did not give statistically different results.

Instead of general or spinal anesthesia, local anesthesia with electromotive administration (EMDA) of intravesical lidocaine was used for painless hydrodistension of the bladder [51]. For EMDA, a 16F Foley catheter with a central silver electrode is inserted into the bladder, the bladder is then washed with sterile water to remove all urinary ions. Subsequently, 100cc lidocaine 2% with 16 mg dexamethasone and epinephrine 0.5mg are instilled into the bladder. Two electrode pads are placed at the lower abdomen, and the cathode of the current generator is connected to these pads, whereas the anode is connected to the catheter. A pulsed direct current of 15 mA and 2500 Hz is applied to the intravesical solution for 20 minutes to achieve complete local anesthesia

Rosamilia reported on 21 women who underwent hydrodistension after EMDA with lidocaine and dexamethasone [52]. A good response was observed in 85% of patients 2 weeks after treatment, with 63% still responding at 2 months. 25% of patients were still free of symptoms at 6 months. The same regimen was used by Riedl in 13 patients, and 62% showed complete symptom resolution after an average 4.5 months [53].

Sequential therapy with hydrodistension and intravesical instillation of hyaluronic acid under general anesthesia was performed by several authors: Ahmad found a 74% response rate in 17 patients [54], and Shao reported on a 77.8% response rate at 6 and a 50% response rate at 9 months (compared to 33.3% and 20% with heparin instillations) [55]. Good immediate response with this regimen was also reported by Yang [56].

Bladder hydrodistension is not a riskless procedure. Bladder ruptures as well as vesical necrosis have been reported and have to be taken into account as severe complications requiring major surgery for repair [57], [58], [59].

In summary, hydrodistension under anesthesia may give temporary symptom relief in BS/IC. Combination with EMDA or hyaluronic acid seems to improve response rates. The procedure is minimally invasive and may be repeated at symptom recurrence, no data about effectiveness of repeat treatments exist. However, as with repeated resections, it has been observed that repeated urothelial damage by hydrodistension has the potential for bladder shrinkage, which may finally lead to cystectomy due to minimal bladder capacity.

3 Further research and conclusion

Invasive therapies harbor the potential to significantly reduce BPS/IC symptoms in patients not benefitting from conservative management. However, the answer to the question who should be exposed to the possibly harmful side effects of these regimens needs a better understanding of this complex disease. Only by defining algorithms that group patients to the best individual strategy for their disease will result in the highest possible efficacy of minor or major surgery for BPS/IC treatment.

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