Chapter 23
Bladder Outlet Injection for Urinary Incontinence

Selcuk Yucel and Linda A. Baker

Abstract Urinary incontinence in children is multifactorial, and thus numerous medical and surgical modalities exist to treat it. In patients with congenital incompetence of the bladder neck/sphincteric mechanism or leak from a continent catheterizable channel, a viable minimally invasive option is cystoscopic-guided injection of bulking agents. In this chapter, indications, surgical techniques, complications, and outcomes of bulking agent injection therapy for urinary incontinence will be discussed.

Keywords Urinary incontinence • Pediatric • Infant • Child • Injection therapy • Bladder outlet • Bladder neck • Bulking agent

Numerous pathological states can lead to urinary incontinence in children. The multifactorial nature of this problem requires both a complete analysis of the contributing factors and a logical approach to correct them.

Factors to consider in the incontinent child include [1]:

- What is the total quantity of urine produced daily? Does the quantity exceed the capacity of the urinary system?
- Is the bladder capable of storing urine?
  - What is the bladder capacity and detrusor compliance? Is there increased bladder contractility, such as in neurogenic bladder, infection, or detrusor hypertrophy?

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  - Is the bladder outlet resistance low, such as an incompetent sphincteric mechanism because of congenital malformation, trauma, iatrogenic injury, or neurogenic deficiency?

- Is the bladder effectively emptying?
  - Is there decreased detrusor contractility, as seen in neurogenic states?
  - Is there increased outlet resistance, such as in urethral strictures, posterior urethral valves, or detrusor-sphincter dyssynergy?

Pediatric urologists are often faced with challenging congenital birth defects in which the incompetence of the bladder neck/sphincteric mechanism causes or contributes to the incontinence. Multiple medical and surgical management options exist, indicating that one simple solution does not exist to cure outlet incompetence. One viable alternative is the injection of bulking agents in the bladder outlet.

Indications and Contraindications

Indications for bladder outlet bulking agents include bladder outlet incompetence with associated urinary incontinence. Specific pathological states with these problems often include neurogenic bladder, cloacal exstrophy, classic bladder exstrophy, epispadias, cecoureterocele, urethral duplication, or ectopic ureter with maldeveloped bladder outlet. In some cases, the bladder outlet incompetence is combined with a deficiency in bladder capacity because of maldevelopment and/or the absence of normal bladder cycling to stimulate bladder growth. Thus, in addition to improving bladder outlet resistance, an additional indication and goal of bladder outlet injection surgery may be to promote bladder growth and increase bladder capacity. A recent review claims that bladder neck injection should be the first-line treatment to increase the bladder outlet resistance in children [2]. More controversial indications include giggle or stress incontinence in children. An extension of this technique has been the injection of leaking catheterizable channels.

Contraindications would include hemodynamic instability or untreated UTI. A relative contraindication is the past history of multiple bladder outlet surgeries, as the success rates are greatly diminished in this population.

Preoperative Investigation

The preoperative assessment of the child incontinent of urine includes a thorough history and physical examination, with attention to voiding and bowel habits. The initial orifice evaluation may include a urinalysis, uroflow, and a postvoid bladder scan. A detailed voiding and elimination diary should be completed, with an

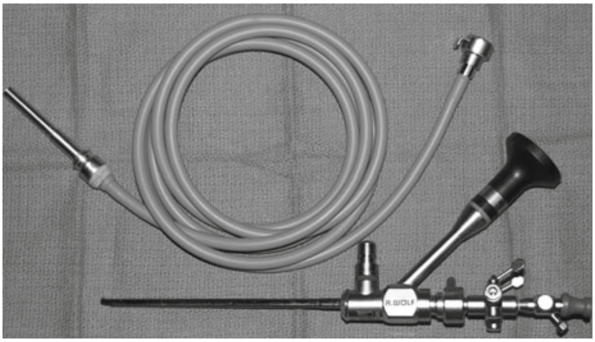

Fig. 23.1 An example of an offset cystoscope. The working channel is straight so that the injection needle is not bent

assessment for vaginal voiding. If indicated, therapy should include behavioral modifications and laxative therapy. Further evaluation is tailored to the considered diagnoses. Videourodynamics is typically necessary to evaluate bladder capacity, bladder compliance, detrusor leak point pressure, and bladder instability. In cases with a high index of suspicion for an anatomical basis for the incontinence, radiological imaging is warranted, often including renal/bladder sonogram, DMSA, and VCUG. Further tests, such as MRI, may be needed to further delineate the anatomy.

Preoperative Patient Preparation

Once cleared for surgery and meeting NPO restrictions, an oral sedative is given to prevent separation anxiety. The physician may choose to give IV antibiotics preoperatively.

Specific Instrumentation

Most cystoscopic suites are equipped with a monitor for video camera imaging, which allow multiple viewers, teaching, optical magnification, and video recording. A fiber-optic xenon light source is also required. Cystoscopic irrigant (sterile normal saline or sterile water) should be warmed to body temperature to diminish hypothermia. Several companies manufacture pediatric endoscopic equipment, including Wolf, Storz/Olympus, and ACMI. Rigid pediatric cystoscopes range from 5 Fr to adult sizes, and the pubertal status of males should be noted to help judge the equipment needed. Pediatric cystoscopes with an offset lens allow straight entry into the working channel for the use of the injection needle (Fig. 23.1). However, a normal cystoscope can also be used by passing the needle from the working channel with some needle bending. Injection needles, ranging from 3 Fr to 5 Fr, can be made of plastic with a metal beveled tip or of complete metal depending on the manufacturer. The needle selection depends upon the bulking agent used. Some older bulking agents with higher viscosity, such as Teflon and bioglass, required a larger diameter needle and also a gun to accomplish the injection.

The ideal injectable material for the urinary tract is nonmigrating, durable, biocompatible, nontoxic, noncarcinogenic, nonteratogenic, easily injectable, and affordable. The first injectable material used to treat urinary incontinence was Teflon (PTFE-polytetrafluoroethylene) in 1985 [3], but it is now not in use due to risks of distant particle migration and granuloma formation. After Teflon, glutaraldehyde cross-linked bovine collagen (Zyplast, Contingen), silicone particles (polydimethylsiloxane) (Macroplastique), dextranomer particles in 1 % sodium hyaluronan solution (Deflux), synthetic calcium hydroxyapatite particles in glycerine, and sodium carboxymethylcellulose (Coaptite) have been developed for injection.

Transurethral injection of the male bladder outlet is technically easier than the female outlet, primarily due to the differential urethral length. The short female urethra makes stabilizing a cystoscope and simultaneously positioning and injecting the bulking agent somewhat challenging. To address this issue, a non-endoscopic periurethral injection device was created for adult females, called the Zuidex system (Q-Med, Uppsala, Sweden) [4–7]. The Zuidex system consists of a special implacer, which is a device that mounts four 21 G needles and four syringes of Zuidex (gel of dextranomer microspheres and nonanimal stabilized hyaluronic acid (NASHA)). The implacer has four lateral holes for the insertion of four needles. A protective sheath covers the needles during sheath insertion into the urethra. Once in the midurethra, the sheath is retracted, exposing the needles and permitting lateral needle movement. Each needle and syringe is individually positioned submucosally and the Zuidex is injected. One short-term report on three females suggests its usefulness in girls as well [8], but the system has been withdrawn from the market due to its low efficacy and periurethral abscess formation resulting in urethral obstruction requiring multiple surgeries for a satisfactory voiding [9–11]. A recent review has noted that the success rate of a blind midurethral paraurethral bulking agent injection is less than the success rate of cystoscopically guided proximal urethra or bladder neck injection [12].

Operative Technique

Multiple approaches have been described, depending on (1) from where the leakage is occurring (transurethral leak or continent catheterizable stoma leak) and (2) the postsurgical anatomical configuration (open versus closed bladder neck or presence versus absence of continent catheterizable channel). Three basic options include (1) the retrograde transurethral approach, (2) the antegrade approach via a catheterizable channel, or (3) the suprapubic access approach (Figs. 23.2 and 23.3). Perineal paraurethral approaches for transurethral leaking have basically been abandoned.

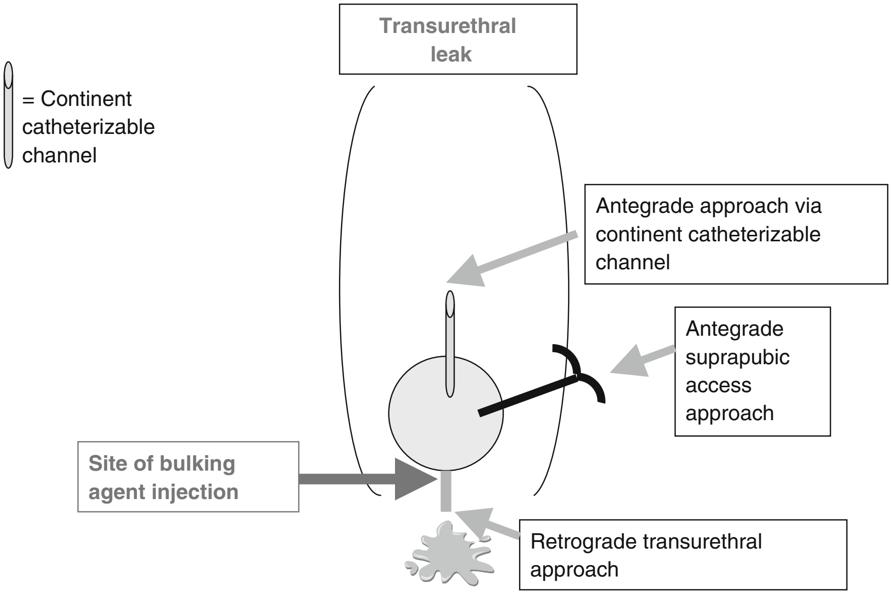

Fig. 23.2 Potential operative approaches to the child with transurethral urinary incontinence due to bladder outlet intrinsic deficiency

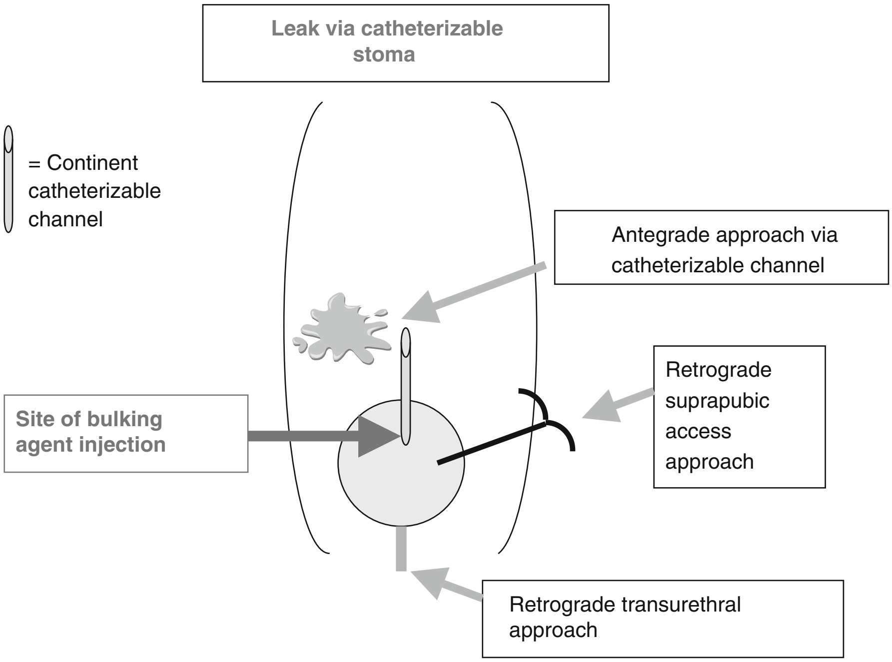

Fig. 23.3 Potential operative approaches to the child with urinary incontinence via catheterizable stoma

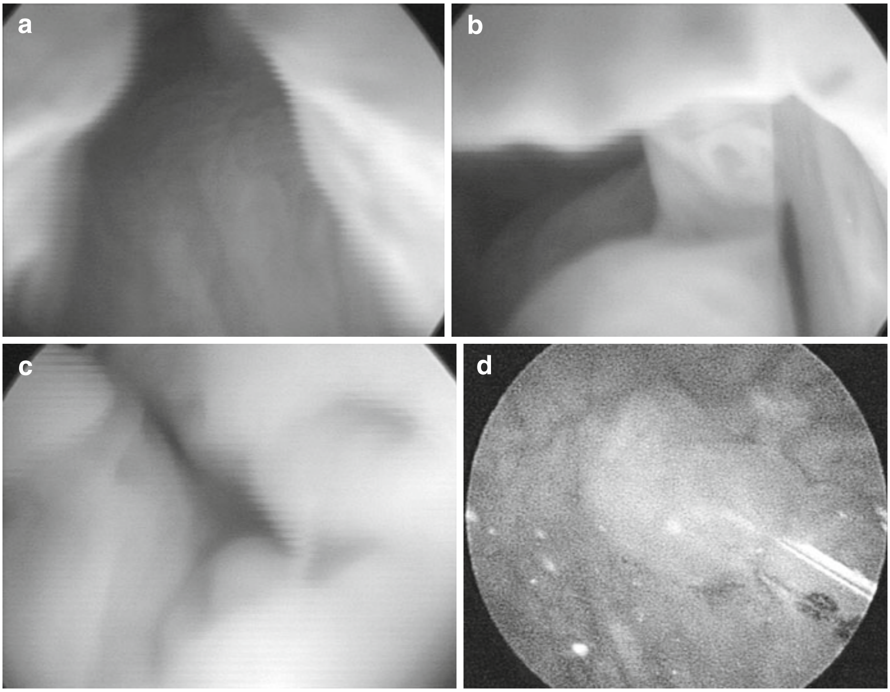

Fig. 23.4 Bladder neck injection for urinary incontinence. (**a**) Transurethral view of incompetent keyhole bladder neck. (**b**) Via the transurethral cystoscope, Deflux was injected into the bladder neck area. (**c**) After transurethral bladder neck injection, the urethral mucosa appears coapted. (**d**) A cystoscope was passed into the appendicovesicostomy, and the bladder neck injection site is viewed

Transurethral Leak

Retrograde Transurethral Approach

The patient is in the dorsal lithotomy position. The lubricated cystoscope is introduced into the urethra and bladder, inspecting for additional anomalies and bladder neck appearance. In males, the needle is inserted submucosally at the level of verumontanum and advanced to the bladder neck [13]. Recently, injection below the verumontanum is also advocated [14]. In females, the scope is positioned in the midurethra, and the needle injection occurs submucosally from bladder neck to the midproximal urethra. Circumferentially, the injection sites may be at two symmetrical points [15], at three points [16], or at multiple points [13]. Regardless of the injection number, the aim is to see complete coaptation of the bladder neck and proximal urethra (Fig. 23.4).

Antegrade Approach

This approach is performed via the continent catheterizable channel. With the patient in the supine position, the lubricated cystoscope is introduced into the catheterizable tunnel with careful manipulation not to harm the continent channel. The bladder neck and posterior urethra are inspected. The injection needle is introduced submucosally at the bladder neck and advanced towards the verumontanum if it can be seen in males and towards the midurethra in females.[12] Injection can be done at two [17], three, or four points to obtain a well-coapted bladder neck.

Antegrade Suprapubic Access Approach

This is an alternative and adjunctive technique to gain temporary suprapubic puncture access to the bladder via a 2 mm laparoscopic trocar. The injection needle is inserted into the laparoscopic trocar, and antegrade bladder neck injection is observed via a cystoscope in the continent catheterizable channel [18]. Injection is done as described above. Since the procedure is done through a laparoscopy port, it has been reported to be performed at the same session with laparoscopic antegrade continence enema with no additional complications [19].

Leak via Catheterizable Channel

Catheterizable Channel Injections

These injections can be approached and performed in a similar fashion as that for transurethral leaking [20]. It is convenient to position the patient in the lithotomy position to permit simultaneous access to the channel and the urethra.

Antegrade Approach via Continent Catheterizable Channel

With the cystoscope in the channel, the walls and opening of the channel into the bladder are inspected. The needle is introduced submucosally 2–3 cm from the orifice and advanced to the orifice at the bladder. Injection is slowly performed until the whole proximal channel wall is elevated including the orifice at the bladder. Injection can be repeated at multiple locations circumferentially until the whole intramural channel is coapted [21].

Retrograde Transurethral Approach

With the cystoscope placed transurethrally, the orifice of the catheterizable channel in the bladder is inspected. The needle is placed into either the patulous channel at 6 o'clock position or a few millimeters below the orifice and advanced further along the intramural channel. Injection is continued until the orifice elevates and is coapted.

Antegrade Suprapubic Access Approach

If a cystoscope cannot be passed via urethra (impassable urethral strictures or closed bladder neck), the suprapubic access approach as described above can be performed temporarily.

Urine should be continuously diverted by an indwelling catheter for 7–14 days postoperatively. However, it should not be placed via the site of injection so as to avoid molding of the injection mound. Thus, a suprapubic tube may be necessary.

Postoperative Management

Bladder outlet injection is an outpatient procedure. Continence is expected to be regained or improved right after the injection, or sometimes it may take a few months until the bladder grows under increased bladder outlet pressure. The length of follow-up after a successful bladder neck injection is variable. Long-term duration of implant is different for every material. The published series with the longest follow-up period reported is 13 years (mean 7 years); they observed the highest recurrence of incontinence within first year [14, 22], particularly in the first 6 months (79 % vs. 56 %) [23]. They concluded that failure after 1 year is significantly related to deterioration of bladder dynamics and requires urodynamic investigations. [24] VCUG can be done to detect de novo VUR after increased bladder outlet resistance in case of febrile UTIs [25].

Complications

Since different materials have different material-specific complications such as migration of implanted particles to lungs and brain for Teflon, teratogenicity of silicone particles, and complete volume loss of collagen, only common complications of bladder neck injection will be covered in this section.

A recent report has demonstrated an interesting complication of submucosal calcifications in 4 of 31 children who underwent bladder neck injection with glutaraldehyde cross-linked collagen as the bulking agent. They found that calcifications at the bladder neck or urethra appear more than 7 years after very high volume injections (mean 21 cc) [26]. A similar complication has been reported from the periurethral injection of hyaluronic acid and dextranomer particles. Severe periurethral abscesses obstructing the bladder outlet have occurred following periurethral injection with Zuidex leading to its withdrawal from the market. However, a similar complication has not been reported yet following bladder neck injections that are performed with cystoscopic guidance [9].

The most important complication is the persistence of incontinence. Bladder neck injection success rates vary from 5 to 50 %, depending on the sex, previous bladder neck surgery, previous bladder augmentation, primary disease-causing incontinence, catheterization, and follow-up period. Previous bladder neck surgery, male sex, no augmentation, bladder exstrophy, and transurethral catheterization seem to have worse outcomes [14, 15, 17, 22, 25].

Catheterizable channels may require additional interventions due to leakage. In 2011, a study of 179 children undergoing continent catheterizable channel creation with a mean 6 years of follow-up shows that 39 % required surgical revision with time, including 8 % who received injection of bulking agent. [27] Few published reports exist on outcomes of injections for catheterizable stomas [20, 21, 25]. In the series, the success rate was 79–86 % at mean follow-up of 12–15 months for leaking catheterizable stomas [21, 28].

Approximately one-third of patients who achieve initial continence with bladder neck injection of bulking agents deteriorate in the first year and become wet [14]. In 2006, a large series demonstrated success rates of 79 % (48 of 61 patients) at 1 month, 56 % (31 of 55) at 6 months, 52 % (24 of 46) at 1 year, 51 % (18 of 35) at 2 years, 52 % (16 of 31) at 3 years, 48 % (12 of 25) at 4 years, 43 % (9 of 21) at 5 years, 36 % (4 of 11) at 6 years, and 40 % (2 of 5). [23] The mechanisms of this initial success with later failure have not been elucidated, but implant displacement with or without volume loss seems conceivable. Another study from the same group notes that no predictors for failure could be detected other than sex, since girls do better than boys. The same study suggests that recurrence of incontinence after 1 year may be related to bladder deterioration [24].

Repeated injections to the bladder neck may cause more difficult open bladder neck surgery. However, a recent study challenges this idea, and 24 out of 89 children with prior bladder neck injections underwent continence surgeries including artificial sphincter, slings, and bladder neck surgeries with no complications. They also note that additional injections are unnecessary after a completely failed bladder injection [29]. Hence, no more than two injections to the bladder neck have been recommended [14].

Bladder neck injection can be an attractive surgical alternative for persistent incontinent cases with prior anti-incontinence surgeries such as bladder neck reconstruction or wraparound sling procedures. Although this procedure is with almost no complication, its efficacy is controversial with around 25 % success rate with a single injection. Unfortunately, additional injections do not raise the success rate in this specific patient group and are not generally recommended [30, 31].

Urinary retention after transurethral injection or inability to catheterize a channel after stomal injection has not been reported. Postoperatively, bladder compliance and upper tracts should be monitored. Increased bladder outlet resistance can cause vesicoureteral reflux and hydroureteronephrosis [25].

Author's Remarks

The success rates in adults with stress urinary incontinence have not been repeated in children with low bladder outlet resistance. This may be due to the multifactorial nature of incontinence in children with congenital birth defects. In many cases, bladder outlet injection failures are directly related to the anatomical or congenital functional abnormality of the bladder rather than the material injected or the technique preferred. Better success in injecting catheterizable stomas supports this idea although clinical experience is quite limited. However, the literature implies that there are some patients who definitely benefit from bladder neck injections; studies to define these children are warranted. Nevertheless, the long-term studies showing submucosal calcifications with collagen injections clearly warn the surgeons, patients, and families about the possibility of side effects related to bulking agents.

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