Bladder Covering by Striated Muscle

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Abstract

Bladder acontractility caused by a lower motor neuron lesion is an irreversible and debilitating voiding disorder affecting a large number of relatively young people. In the following, based on our pilot study (Gakis et al., J Urol 185:593–9, 2011), we present the clinical long-term results in a multicenter setting concerning the Latissimus Dorsi Detrusor Myoplasty (LDDM) in patients with an acontractile bladder for whom there is no treatment alternative than lifelong clean intermittent catheterization (CIC). From May 2001 to February 2008, 24 patients (mean age: 37 years; range: 14–63; 15 males, 9 females) were enrolled in four clinical centers worldwide requiring complete CIC 4–8 times/day. The mean follow-up was 46 months (8–89) and was carried out by questionnaire and measurement of post-void residual urine volume (PVR). Seventeen of the 24 patients (70.8%) gained complete spontaneous voiding and do not require further CIC with PVR from 0 to 100 mL. In three patients (16.5%), the frequency of CIC was reduced from 4–6 times/day preoperatively to 2–4 times/day postoperatively with RUVs from 150 to 250 mL. Twenty-one of 23 patients (91.3%) have no recurrent urinary tract infections postoperatively (mean preoperatively: 7.8/year; 0–24). At present, four patients (12.5%) need CIC 4–6 times/day as before. No functional restrictions or chronic pain of the operated upper extremity were observed in any patient. Complete (n = 17) or incomplete spontaneous voiding (n = 3) was achieved in 20 of the 24 patients (83.3%). Recurrent urinary tract infections terminated in 21 of the 23 patients postoperatively (91.3%). These results have been maintained during the long-term follow-up period of up to 7.5 years.

40.1 Background

Most patients diagnosed with detrusor acontractility have a history of increasing residual volume (RV) or as described from the patients history that they were able to hold urine longer than the others, which suddenly tipped into retention. Also, bladder acontractility is supposed to be caused by a lower motor neuron lesion as an irreversible disorder [1]. The underlying pathological mechanism of bladder acontractility may be due to the damage to the detrusor muscle itself, its autonomic nerve supply or the spinal micturition center [1].

The primary treatment option is the lifelong clean, intermittent catheterization (CIC) with comorbidities as urethral laceration, recurrent urinary tract infection, occasional bladder perforation and possible renal function deterioration. Especially younger male see the lifelong catheterization as a psychological burden, which is often the reason for further worsening and additional side effects as hydronephroses and kidney failure in the long term as well as the socioeconomic effect [2].

Studies investigating restoration of voluntary bladder emptying by sacral neuromodulation demonstrated these approaches as not effective enough due to a lower motor neuron lesion [1, 3, 4]. If the treatment is started early enough as demonstrated in children, Intravesical Electrical Stimulation (IVES) seems to have a lasting beneficial effect [5].

In a long term study early animal study von Heyden et al. demonstrated: (1) the ability of the transposed latissimus dorsi muscle to evacuate a bladder-like reservoir; and (2) the regenerative potential of muscle and nerve after nerve transection and repair [6]. They were able to evacuate 63.8 ± 6.2% of the reservoir's volume by stimulation of the thoracodorsal

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nerve with a maximum pressure of 109.5 ± 18.6 cm H_2O. Four months later after reanastomosed for transcutaneous stimulation they recorded the pressure generation at regular intervals for 8 months 79.3 ± 12.1 cm H_2O (72.4% of the initial value) and were able to evacuate 48.3 ± 6.7% of total volume.

In the first clinical study Stenzl A et al. reported the successful Latissimus Dorsi Detrusor Myoplasty (LDDM) in three patients who had acontractile bladders related to spinal-cord injury and chronic overdistension for 2–5 years prior to the surgery [7]. On urodynamic assessment at 12 months after the operation bladder capacity was found to be 600 mL, 600 mL, and 650 mL, residual urinary volume 0 mL, 50 mL, 90 mL, and maximum flow rate 26 mL/s, 25 mL/s, and 18 mL/s, respectively [7].

As reported in the first clinical experience the indication is the detrusor acontractility, related to spinal trauma below the Th12, tethered cord syndrome, lumbar hernia of nuclei pulposi, megacystis/bladder outlet obstruction, sacral myelomeningocele, and idiopathic and chronic retention after hysterectomy. Patients with an upper motor neuron lesion should be excluded. In relation to the situation that patients might be doing a certain sport where they might need the latissimus dorsi muscle, the patient should be asked about sport preferences and activities such as golf, tree climbing or others.

Indications for the latissimus dorsi detrusor myoplasty [8]

- Bladder acontractility without upper motor neuron lesion
- No indication for neuromodulation
- Life expectancy greater than 10 years; the patient should be <60 years of age [9]
- No improvement of bladder dysfunction longer than 1 year
- Patient should be able to handle clean intermittent catheterization
- Catheterization greater than 1 year
- No infravesical obstruction
- Intact 12th intercostal motor nerve

In cases of equivocal urodynamic findings, sacral neuromodulation should be applied to rule out the presence of bladder hypocontractility rather than acontractility.

In the routine evaluation of the patient should include:

- Video-urodynamics
- Diagnostic urethrocystoscopy
- Excretory urography
- Electromyography of the lower portion of the rectus abdominis muscle
- Neurophysiologic assessment of the sacral district, including MRI or CT

40.2 Surgical Technique of LDDM

The harvesting and transplantation of the latissimus dorsi muscle is carried out simultaneously by two surgical teams (urologic and plastic surgeons) [6]. After a generous zigzag-shaped incision in the axilla, which enables the essential long dissection of the neurovascular thoracodorsal pedicle, the latissimus dorsi muscle, the main branches of its supplying thoracodorsal vessels and the nerve of the latissimus dorsi muscle have to be completely elevated. The neurovascular bundle is not transsected until the recipient vessels and nerve had been prepared for microanastomosis. The urological team freed, via an extraperitoneal midline abdominal or Pfannenstiel incision, the bladder down to trigone. Subsequently, both ischial bones and insertions of the sacrospinal ligaments become visual, where individual stiches are placed to become the base attachment for the transferred latissimus dorsi muscle.

After identifying the lowest motor branches of the intercostal nerve and the ipsilateral inferior epigastric artery and vein, the transferred latissimus dorsi muscle was microsurgically anastomosed immediately. The latissimus dorsi muscle was attached to the above structures in the pelvis by the preplaced sutures [10–12] (Fig. 40.1).

40.3 Postoperative Care

Initially the bladder was drained by a transurethral catheter and subsequently by CIC for a total of 3 months. Afterwards, under physiotherapeutic guidance, the patients were instructed to void by voluntarily contracting the lower abdominal muscles. Catheterization intervals were gradually increased depending on the residual urinary volumes. In the follow-up the vascularization and function was monitored by Doppler-ultrasound and urodynamic assessment [10, 11].

Although the LDDM has been performed primarily in one center over the last two decades, the numbers of published cases remains low. There have been requests to improve the outcome related to the invasiveness of the surgery in order to find more precise investigation methods/criteria to minimize failure [13]. However, a success rate of over 83% (complete (n = 17) or partial spontaneous voiding (n = 3) was achieved in 20 of the 24 patients) with a follow-up time of up to 7.5 years, which appears satisfactory. In 50% of those patients where the authors reported failure, major postoperative complications were recorded (Clavian III), Table 40.1 [12].

Therefore it might be not be an aspect of the preoperative evaluation which determines the outcome as was suggested during the pre-operative investigation [14]. Eight of 15 male patients (53%) that underwent a LDDM, later underwent a

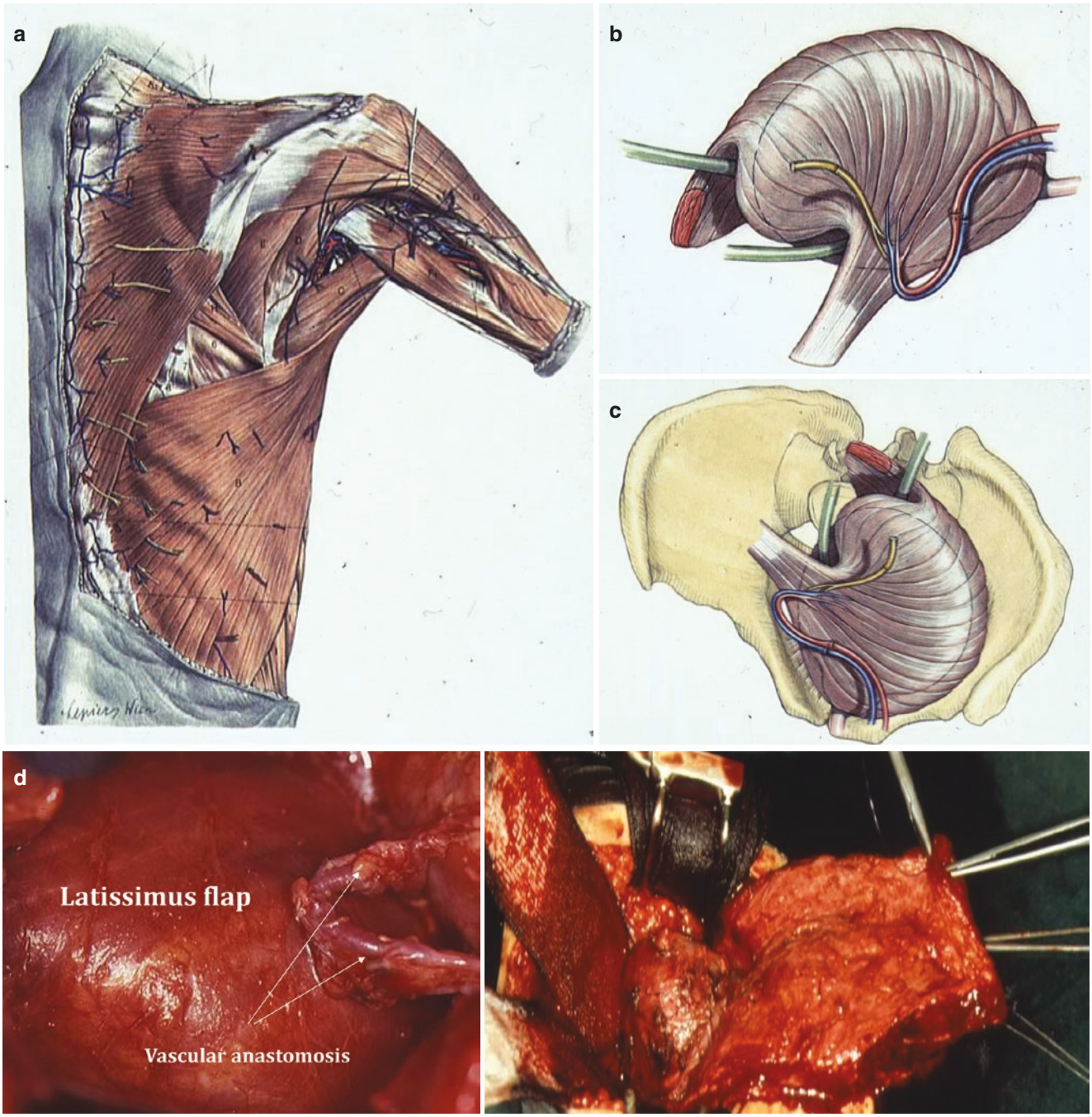

Fig. 40.1 (**a**) Latissimus dorsi muscle before harvesting. Sutures mark original length of muscle. (**b**) Fixation of latissimus dorsi muscle in pelvis (broken line). (**c**) Schematic drawing of position of muscle around bladder with neurovascular connections. (**d**) Final intraoperative aspect of muscle in pelvis with neurovascular connections (right side)

TURP. Of those patients, five voided RV after the initial LDDM surgery and suffered increasing RV. They underwent a TURP with the result of regaining complete voiding afterwards. Another patient who voided with a high residual was able to micturate after the TURP residual free. Also, it remains unclear, if those patients were identical to those with the grade III Clavien complications and did not gain any improvement after the TURP (Tables 40.2, 40.3, 40.4, 40.5, and 40.6).

Overall the LDDM procedure is an option for a specific group of patients with an acontractile detrusor to undergo this procedure. The surgery should be performed in a centres of excellence as these primary published reports have recommended [11, 12]. The success rate lies between 83 and 90%

Table 40.1 Main etiologies for bladder acontractility

Etiology	Number of patients
Spinal trauma	9
Tethered-cord syndrome	4
Lumbar hernia of nuclei pulposi	3
Megacystis and BOO	2
Idiopathic	4
Voiding dysfunction post hysterectomy	1
Sacral myelomeningocele	1

(70% voiding without residual and 12% of 50% voiding). In those who do not void completely after 4 months, a TURB of the prostate or the bladder neck should be performed if there is a sign of any subvesical obstruction. The postoperative complication rate seems to be high with around 37% Clavien Grade III, but related to the invasiveness to the surgery and the possible improvement in QoL acceptable for those patients who want to stop self-catheterisation.

Table 40.2 Preoperative parameters

Patients	Mean age in a (range)	Frequency of CIC/d (range)	PVR in mL (range)	Time of CIC prior to LDDM in a month (range)	Mean number of UTI/a (range)
24	37 (14–63)	5.0[1] (4–8)	486 (250–800)	55 (17–195)	10 (0–24)

SNM sacral neuromodulation, *CV* complete spontaneous voiding postoperatively, *PV* partial spontaneous voiding postoperatively, *NV* no voluntary voiding postoperatively, *preop.* preoperatively, *pat.* patients

Table 40.3 Pre- and postoperative clinical results

Total (n = 24)	Gender ♂:♀	CIC/24 h preop.	CIC/24 h postop.	UTI/a preop.	UTI/a postop.	PVR (in mL) preop.	PVR (in mL) postop.
17	11:6	5.1 (4–7)	0	10.4 (0–24)	0	486 (250–800)	25 (0–100)
3	3:0	5 (4–6)	3.3 (2–4)	7.5 (5–10)	0	400 (300–500)	200 (150–250)
4	2:2	5 (4–6)	4.8 (4–6)	17 (10–24)	2 pat. w/o UTI	583 (400–800)	575 (400–700)

CIC clean intermittent catheterization, *UTI* urinary tract infections, *PVR* post-void residual urine volume, *preop.* preoperatively, *postop.* postoperatively

Table 40.4 Postoperative adjuvant treatment

Total (n = 24)	Specific drug intake (cholinergics, antibiotics)	Functional restrictions of upp. extremity	TUR-P (in days postoperatively)	Patient satisfaction (1-excellent; 6-very bad)	Vesico-renal reflux
17	None	None	5 (38–1609)	1.8 (1–4)	None
3	1 (nitrofurantoine)	None	1 (132)	2 (1–3)	None
4	None	None	2 (202 and 420)	6 (6)	None

Table 40.5 Pre-and postoperative detrusor pressure during voiding and uroflowmetry

Patients	Preoperative max. P_{det} Mean/median in cm H_2O (range)	Postoperative max. P_{det} Mean/median in cm H_2O (range)	Postoperative uroflow Mean/median in mL/s (range)
CV	34.5/31 (0–90; n = 11)	58.4/57 (30–120; n = 7)	22/18.5 (10–50; n = 8)
PV	53.3/25 (15–120, n = 3)	60/60 (60–60, n = 1)	10 (2–13n = 1)
NV	35/35 (20–50, n = 2)	34.7/25 (20–59, n = 3)	–

max. P_{det} maximum detrusor pressure

Table 40.6 Major postoperative complications related to the surgical result of voiding graded according to the modified Clavien-classification for surgical interventions of 2004 [15]

	Number of patients	Number of major complications	DVT	PE	PA	CS	WHD	PS
N	8	9	1	1	3	1	1	2
Grade	–	–	I	II	IIIa (2) IIIb (1)	IIId	IIId	IIIb
CV	5	6	1	–	2	1		2
PV	1	1	–	1	–	–		–
NV	2	2	–	–	1	–	1	–

CV complete spontaneous voiding, *PV* partial spontaneous voiding, *NV* no voluntary voiding, *DVT* deep vein thrombosis, *PE* pulmonary embolism, *PA* pelvic abscess requiring temporary drainage, *CS* compartment syndrome of the non-operated shoulder, *WHD* wound healing disorder, *PS* persistent seroma of the operated shoulder requiring surgical intervention

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