

Our Experience in Medially Based Gluteus Maximus Muscle Flap Transfer for Stool Incontinence

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Rezumat

Experiența noastră privind transferul de lambou muscular din mușchiul fesier mare (gluteus maximus) cu pedicul medial pentru incontinența fecală

Introducere: Incontinența fecală este definită ca eliminarea involuntară sau inadecvată de materii fecale lichide sau solide. Este o afecțiune cu un impact negativ major, care generează probleme atât fizice, cât și psihologice, afectând calitatea vieții. **Obiective:** Scopul acestui studiu este de a evalua eficacitatea utilizării unui lambou muscular din mușchiul fesier mare (gluteus maximus) cu pedicul medial în controlul incontinenței anale și de a compara această metodă cu alte tehnici care utilizează lambouri din același mușchi. De asemenea, studiul urmărește evaluarea activității electrice a mușchiului transferat în stare de repaus, prin intermediul electromiografiei.

Metode: În studiu au fost incluși 22 de pacienți cu incontinență fecală, proveniți din ambulatoriul Secției de Chirurgie Generală a Spitalului Kasr El Aini (Facultatea de Medicină, Universitatea din Cairo). Toți pacienții au fost programați pentru intervenția de reconstrucție cu lambou din mușchiul fesier mare în cadrul unității de chirurgie colorectală.

Rezultate: Pacienții au prezentat o ameliorare clinică a continenței în perioada post-operatorie; scorul de continență Wexner s-a îmbunătățit de la o medie preoperatorie de 16,2 la o medie postoperatorie de 7,10 ($p=0,005$), iar gradul Farag s-a îmbunătățit de la o medie preoperatorie de 4,5 la o medie postoperatorie de 2,2 ($p=0,004$).

Concluzie: Transpoziția unilaterală a mușchiului fesier mare cu pedicul medial reprezintă o procedură eficientă pentru îmbunătățirea scorurilor de continență și a parametrilor fiziologici anorectali la majoritatea pacienților cu incontinență fecală. Tracțiunea persistentă exercitată asupra neosfincterului duce la dezvoltarea unui tonus muscular de repaus similar cu cel al sfincterului anal extern (EAS), aspect confirmat prin evaluări electromiografice postoperatorii.

Cuvinte cheie: incontinență fecală, lambou muscular, mușchiul fesier mare (gluteus maximus)

Abstract

Background: Fecal incontinence is defined as the involuntary or inappropriate passage of liquid or solid stool. It is a distressing condition, resulting in both physical

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and psychological problems that affect quality of life. **Objectives:** The objective of this study is to assess the effectiveness of medially based gluteus maximus muscle flap in the control of anal incontinence and compare it with other methods of gluteus maximus flap. Also, assessment of the electrical activity of the transferred muscle using electromyography during rest.

Methods: 22 patients with fecal incontinence were enrolled from the outpatient clinics of the General Surgery Department, Kasr El Aini Hospital, Faculty of Medicine, Cairo University. All patients had gluteus maximus muscle flap in the elective list in the colorectal unit.

Results: Our patients show clinical improvement in continence status postoperatively, with a Wexner continence score improving from a preoperative mean of 16.2 to a postoperative mean of 7.10 ($p=0.005$), and a Farag grade improving from a preoperative mean of 4.5 to a postoperative mean of 2.2 ($p=0.004$).

Conclusion: Unilateral medially based gluteus maximus transposition is a successful procedure for improving continence scores and anorectal physiologic parameters in most patients with faecal incontinence. Persistent traction on the neo-sphincter develops resting muscle tone similar to that of the EAS, as assessed by post-operative EMG.

Keywords: stool incontinence, muscle flap, gluteus maximus muscle

Introduction

Fecal incontinence is defined as the involuntary or inappropriate passage of liquid or solid stool. It is a distressing and demoralizing condition, resulting in both physical and psychological problems, including social restrictions, loss of self-esteem, altered body image and loss of skin integrity, all of which detrimentally affect quality of life (1).

The true prevalence of fecal incontinence in the community remains uncertain, with considerable variation in published data largely due to differing case definitions. For anal incontinence (incontinence of flatus and feces), this is thought to be approximately 2% to 17% (2). Fecal incontinence may result from dysfunction in any component of the continence mechanism, including sphincter function, rectal sensation, rectal capacity and compliance, colonic transit, stool consistency, and cognitive or neurologic control (3).

The etiology of fecal incontinence is diverse and includes congenital anomalies, obstetric injury, surgical or accidental trauma, iatrogenic causes, colorectal disease, and neurological disorders involving the cerebral, spinal, or peripheral nervous systems. Other contributing factors include diarrhea, laxative abuse, and fecal impaction (4). Additionally, anatomical fecal incontinence should be differentiated from functional reasons causing retention with overflow (5).

According to Norton (2010), initial management is conservative and focuses on dietary, medical, and psychological interventions to improve continence and quality of life (6). Patients with severe fecal incontinence who fail conservative therapy are generally classified into two broad surgical categories. The first includes patients with an identifiable anatomic

sphincter defect, who may achieve a 40–60% long-term success rate following overlapping sphincteroplasty, with the best outcomes observed in the absence of pudendal neuropathy (7).

The second group includes patients with extensive sphincter damage, significant muscle loss, or pudendal neuropathy who are not suitable candidates for direct sphincter repair. With the increasing prevalence of fecal incontinence and the development of newer treatment approaches, patients with severe incontinence are now rarely limited to permanent stoma formation (8). Neosphincter procedures using autologous muscle transposition have become an important reconstructive option for these patients (10).

New treatment approaches include: sacral nerve neuromodulation, Non-invasive nerve stimulation and anal barrier devices (8).

In the first half of the twentieth century, the gluteus maximus muscle was the most commonly used muscle for transposition procedures. In 1902, Chetwood first described the use of the gluteus maximus muscle and fascial slings to reinforce the sphincter mechanism in children (10).

The technique was later modified to anchor the free ends of the fascia encircling the anus to the gluteus maximus muscle on each side. This created a fascial ring around the anal canal, allowing patients to tighten the neo-sphincter by contracting the gluteus muscle (11).

The gluteus maximus muscle has many advantages over the gracilis muscle, as it is well vascularized and supplied by the inferior gluteal artery. It is larger and stronger than the gracilis muscle and provides more bulk to help strengthen the anal canal. It is activated during walking, thereby functioning as a significant adjunct to the external sphincter. Finally, mobilization

of the gluteus muscle does not impair gait or pelvic stability (12).

Electromyography (EMG) is the recording and analysis of electrical activity in striated muscle, used to differentiate between normal, denervated, reinnervated, and myopathic muscle. In all subjects, the external anal sphincter demonstrates tonic contraction, with the degree of tone varying with posture and activity. Considerable inter individual variation exists, and even within the same subject, resting tone may fluctuate over time. Although the resting tone may be minimal, it is never completely absent (13).

The resting tone of the external anal sphincter (EAS) may be attributed to its vertical stretch between the pulling force of the puborectalis muscle and the fixation of its lower fibers to the perianal skin via the longitudinal muscle. This continuous mechanical stimulation resembles the principle underlying dynamic graciloplasty. In addition, the puborectalis muscle is constantly stimulated by the weight of the rectum and its attachment to the presacral fascia, contributing further to the maintenance of resting tone (14).

A variety of electrode types are used for EMG. Each has different properties and capabilities. The most common electrodes used in the pelvic floor are surface and concentric needle (CNE) (15).

Methods

This prospective study was conducted between August 2018 and October 2020 and included 22 patients presenting with varying degrees of stool incontinence. All patients were recruited from the surgical outpatient clinic of Kasr Al Ainy Hospital. The study was approved by the Ethical Committee of Cairo University Hospitals.

All patients and their families were thoroughly informed about the role of gluteus maximus muscle transposition as a treatment option for severe anal incontinence, particularly in cases where the anal sphincters were absent or severely damaged. Written informed consent was obtained from all participants.

The primary objective of the study was to evaluate postoperative functional improvement in continence using the Wexner score, which is an indirect indicator of quality of life. Secondary objectives included postoperative assessment of electromyography (EMG), defecography, and anorectal manometry parameters.

Patients were eligible for inclusion if they had fecal incontinence that persisted despite primary sphincter repair and conservative management, demonstrated a normal reactive preoperative EMG of the gluteus maximus muscle, and had an external anal sphincter

defect involving more than 50% of the muscle thickness as confirmed by endoanal ultrasound or pelvic MRI. Exclusion criteria included neurological impairment affecting both gluteus maximus muscles, and belonging to a vulnerable population.

During the initial visit, a detailed clinical history was obtained, including onset and severity of incontinence, history of trauma, previous operations for anorectal malformations or colorectal disease, obstetric trauma (such as episiotomy), and any prior attempts at surgical repair.

Stool incontinence was defined as the involuntary passage of liquid or solid stool during wakefulness or sleep. Patients were asked about their awareness of stool passage to differentiate between active and passive incontinence. The severity of incontinence was assessed using the Wexner score (16) and Farag's grading system (17).

Clinical examination included inspection of the perineal skin for soiling, scars from previous operations or episiotomies, and the presence of a gaping anus, which may indicate significant sphincter dysfunction. Anal deformities resulting from prior anorectal surgery were also documented. Patients were asked to strain to assess for abnormal perineal descent, rectal prolapse, or genital prolapse. Digital rectal examination was performed to evaluate stool consistency, resting and squeeze sphincter tone and puborectalis function.

Preoperative assessment included endoanal ultrasonography or pelvic MRI to determine the extent of sphincter damage. All patients underwent pre and postoperative anorectal manometry using a multi-channel water perfused catheter with both continuous and stepwise pull through techniques to measure maximum resting pressure (MRP) and maximum squeeze pressure (MSP). Anorectal manometry plays a crucial role in evaluating the function of the anorectal region, encompassing both motor and sensory aspects (18). Defecography was also performed pre and postoperatively to evaluate anal canal length and diameter.

The operation was performed under general anaesthesia without muscle relaxants to preserve muscle tone. Patients were positioned in the jack knife prone position. Dissection of the gluteus maximus muscle was carried out with careful preservation of the neurovascular bundle located at the deep surface of the muscle. The muscle was then tunneled around the anal canal using blunt dissection.

The dissected portion of the gluteus maximus muscle was detached from its insertion at the gluteal tuberosity of the femur (medially based), split into two slips, and routed subcutaneously first to the ipsilateral



and then to the contralateral para anal tunnels. The two ends of the split muscle were overlapped and sutured together around the anal canal to create a neosphincter.

Postoperative follow up was performed early after surgery and then weekly in the outpatient clinic to detect any complications such as wound infection or dermatitis. All patients were subsequently followed monthly for six months using clinical assessment to evaluate the degree of incontinence and to perform the saline enema retention test. Postoperative investigations, including electromyography (EMG), defecography, and anorectal manometry, were performed once, at one month after surgery. MRI defecography was arranged for patients who showed clinical changes during the follow-up.

Results

22 patients were included in our study with different degrees of fecal incontinence. Patients were in different age groups ranging from 5-65 years with a mean age of 29.8 (± 19.21). Our study included 13 male patients and 9 female patients with an approximate ratio of 3:2.

Causes for stool incontinence include: 6 patients had traumatic injury, 4 females had traumatic injury

during normal delivery, 6 children with high imperforate anus, 4 patients post hemorrhoidectomy, and 2 Hirschsprung cases.

The diversity of aetiologies underlying fecal incontinence reflects the complexity of the continence mechanism, as impairment may arise from dysfunction in sphincter integrity, rectal sensation, rectal capacity and compliance, colonic transit, stool consistency, or cognitive and neurologic control.

As shown in *Table 1*, there is a significant improvement in the degree of continence as detected from improvement of the grade of continence (P -value < 0.004) and the improvement of the continence score (P -value < 0.005), which is highly significant. Comparisons between quantitative variables were done using the non-parametric Mann-Whitney test. P -values less than 0.05 were considered statistically significant. The Wilcoxon signed-rank test was used to compare serial measurements.

As shown from *Table 2*, there is a change in maximum resting pressure in manometry MRP preoperative (mean 22.3 ± 4.2) and postoperative (mean 45.8 ± 13), which is highly significant.

As shown from *Table 3*, there is a change in MSP preoperative (mean 54.4 ± 9.5) and postoperative (mean 91.6 ± 20.6), which is highly significant.

AS shown in *Table 4*, there is a change in anal

Table 1. Descriptive statistics for all patients according to Wexner score and Farag's grade pre and postoperatively

		Mean	SD	Median	Minimum	Maximum	P value
Wexner score	pre	16.20	3.19	16.00	10.00	20.00	0.005
	post	7.10	2.33	7.00	4.00	10.00	
Farag's grade	pre	4.50	0.53	4.50	4.00	5.00	0.004
	post	2.20	0.92	2.50	1.00	3.00	

Table 2. Comparison between pre and post MRP (maximum resting pressure).

Parameter		Mean	SD	P-value	Sig.
MRP (maximum resting pressure)	preoperative	22.3	4.2	<0.001	HS
	postoperative	45.8	13		

canal length (ACL) preoperative (mean $2.3 \pm .3$) and postoperative (mean 3.1 ± 0.4), which is significant.

AS shown from *Table 5*, there is a change in anal canal diameter ACD preoperative (mean $1.6 \pm .2$) and postoperative (mean 1.1 ± 0.4), which is significant.

Descriptive analysis of the electrical activity we found on the neo-sphincter: in our study, post-operative EMG, 19 cases had electrical activity; 12 of them had normal muscle tone with regular waves at rest; 4 cases showed insertional activity; 3 cases showed partial segmental denervation; and the remaining 3 cases showed complete denervation and muscle fibrillation.

In our study, the motor unit action potential MUP of the neo-sphincter shows a mean amplitude value of 539 μ V and a mean duration of 3.65 ms.

As shown in *Table 7*, 13 of our patients got post-operative infection, and 9 got good recovery with no postoperative wound infection.

Discussion

Management of stool incontinence should be initiated within a multidisciplinary framework, with a tailored plan that accounts for the underlying etiology, patient age, anticipated long term consequences of each intervention, and the expected clinical benefit. A stepwise, pyramidal approach is recommended, beginning with non invasive modalities and advancing to invasive procedures only when necessary (5).

The gluteus maximus muscle flap (GMF) is one of the earliest surgical techniques described for the management of fecal incontinence, first introduced by Chetwood (10). The gluteus maximus offers several advantages: it has robust vascularity supplied by the superior and inferior gluteal arteries, provides substantial muscular bulk capable of reconstructing the full length of the anal canal, and participates naturally in voluntary squeeze and ambulation. This functional synergy facilitates neuromuscular retraining, enabling patients to recruit the transferred muscle during anal sphincter contraction (19).

In 2008, Farid demonstrated that the medially based GMF provides a longer muscle strip - approximately 7.7 cm - suitable for wrapping around the anal canal, compared with the distally based flap, which

Table 3. Comparison between pre- and post-MSP (maximum squeezing pressure).

Parameter		Mean	SD	P-value	Sig.
MRP (maximum resting pressure)	preoperative	54.4	9.5	0.002	HS
	postoperative	91.6	20.6		

Table 4. Comparison between pre- and post-ACL (anal canal length).

Parameter		Mean	SD	P-value	Sig.
ACL (anal canal length)	preoperative	2.3	.3	0.011	S
	postoperative	3.1	.4		

Table 5. Comparison between pre and post-ACD (anal canal diameter).

Parameter		Mean	SD	P-value	Sig.
ACD (anal canal diameter)	preoperative	1.6	.2	0.011	S
	postoperative	1.1	.4		

Table 6. Analysis of the postoperative EMG.

	Mean	Standard deviation	Median	Minimum	Maximum
EMG duration(ms)	3.65	1.29	3.00	2.50	7.00
EMG amplitude (uv)	539.00	136.17	500.00	390.00	800.00

Table 7. Analysis of wound infection.

Wound infection	Number	Percent
yes	13	59.09 %
No	9	40.9 %

yields only about 4.5 cm. He also reported no functional advantage to the distally based flap, while noting that it introduces additional technical challenges (20). The purpose of surgery is to correct anatomy by creating a neosphincter to replace the defective one.

Our study included 22 patients aged 5 to 65 years, with a mean age of 29.8 years; 13 were male, and 9 were female. Although the sample size is relatively small, largely due to strict inclusion and exclusion criteria and the fact that surgical intervention is generally reserved as a last-line option for managing anal incontinence, we believe the cohort adequately reflects our clinical experience. The outcomes also highlight important considerations and potential pitfalls that may be addressed and avoided in future cases.

In the present study, there was no mortality and no

major postoperative morbidity. The only postoperative complication observed was mild-to-moderate wound infection, which occurred in 13 patients. Notably, neither of the two diverted patients developed wound infection. Although the overall infection rate appears relatively high, this can be explained by our broad definition of wound infection, in which even minimal seroma was classified as infection. Furthermore, the close proximity of the perineal wound to stool passage at the anal verge, combined with the challenges of maintaining optimal wound hygiene - particularly in younger patients - likely contributed to the increased rate.

This may also be related to the use of subcutaneous sutures for wound closure rather than interrupted sutures, and to preoperative diversion, which may have played a protective role. Nevertheless, our infection rate differs from previous studies: Farid (2003) reported a rate of 27.3% without diversion (21); Farag (2000) reported 9% (22); Farid (2008) reported 10% in medially based GMF (20); and Abou-Zeid (2000) reported 10% (23).

In our study, the male-to-female ratio was approximately 3:2, which is comparable to other studies reporting ratios of 8:1, 6:4, 10:1, and 9:8, respectively (19,22,24,25).

Postoperative clinical improvement was observed in 20 patients, with varying degrees, while 2 patients showed no improvement. Among the diverted patients, one failed the retention enema test prior to reversal. In total, 3 patients experienced complete failure, whereas 19 demonstrated improvement, yielding an overall success rate of 86.3%. This was reflected in the significant reduction in incontinence grade from a mean of 4.50 ± 0.53 preoperatively to 2.20 ± 0.92 postoperatively ($P = 0.004$), and incontinence score from 16.20 ± 3.19 to 7.10 ± 2.33 ($P = 0.005$). Similarly, the mean preoperative Wexner continence score was 17.8 ± 2.1 , which decreased significantly to 4.06 ± 4.2 postoperatively in Abdelnaby M 2017 (25).

These results compare favorably with previous reports, where success rates ranged from 60% to 88%. Hultman (2006) reported successful restoration of continence in 18 of 25 patients (72%) (26), while Guelinckx (1996) reported satisfactory continence in 4 of 6 children and in the only adult included (71%) (19).

Regarding anal pressures, highly significant improvements were observed in both resting and maximum squeeze pressures. Mean resting pressure increased from 22.3 ± 4.2 to 45.8 ± 13 ($P < 0.001$), while maximum squeeze pressure increased from 54.4 ± 9.5 to 91.6 ± 20.6 ($P = 0.002$). These findings are consistent with those of Farag and Farid (1999), who reported significant improvements in both

MRP and MSP (22), as well as with those of Amer (2013) (24) and Farid et al. (2000) (21). Conversely, Pearl (1991) noted that clinical improvement may occur even without changes in resting pressure, provided voluntary squeeze pressure is restored (27).

Defecography in our study demonstrated significant postoperative changes in anal canal dimensions. Anal canal length increased from 2.3 ± 0.3 cm to 3.1 ± 0.4 cm ($P = 0.011$), while anal canal diameter decreased from 1.6 ± 0.2 cm to 1.1 ± 0.4 cm ($P = 0.011$). Similar findings were reported by Farag (22), who also observed significant postoperative increases in anal canal length.

Postoperative EMG findings showed electrical activity in 19 cases: 12 demonstrated normal muscle tone with regular resting waves, 4 showed insertional activity, 3 showed partial segmental denervation, and 3 showed complete denervation with fibrillation potentials. The 3 patients with complete denervation are the same ones who showed no improvement in their continence status, which supports the postoperative assessment of the transposed muscle using EMG. Furthermore, EMG can be performed intraoperatively in the following studies to provide an intraoperative prediction of postoperative improvement.

The motor unit action potential (MUP) of the neosphincter in our study had a mean amplitude of $539 \mu V$ and a mean duration of 3.65 ms. These values are comparable to those reported by Jian (2015), who found mean amplitudes and durations of $572.7 \mu V$ and 9.0 ms in normal sphincters (28), and by Podnar (2000), who reported average values of $405 \mu V$ and 5.5 ms in healthy subjects (29).

Conclusion

Unilateral medially based gluteus maximus transposition is an effective surgical technique for improving continence scores and anorectal physiologic parameters in patients with fecal incontinence. The procedure demonstrated no major mortality or morbidity in our series, apart from mild-to-moderate wound infections that did not require a diverting colostomy.

Transposition of the gluteus maximus muscle around the anal canal to create a neosphincter resulted in measurable electrical activity in the muscle, though to varying degrees among patients.

Based on these findings, we recommend unilateral rather than bilateral gluteus maximus transposition, as preserving the contralateral muscle provides a valuable reserve for potential future reconstruction should the initial procedure fail.

Limitations

Our study was a retrospective, descriptive, single-centre experience with an established technique, which limited analysis of procedural outcomes and comparisons with other centres and techniques. Additionally, the absence of a validated FIQL-type instrument was one of the limitations to our study.

Causes of fecal incontinence in our study were variable, and our statistics did not include separate analyses for each group. Clinical follow-up was conducted for 6 months. However, postoperative investigations were performed only once, after a month, and longer clinical follow-up would strengthen the technique's outcome.

Conflicts of Interest

The authors declared no potential conflicts of interest.

Financial Disclosure

All authors have declared that no financial support was received from any organisation for the submitted work. All authors have declared that they have no financial relationships at present or within the previous three years with any organisations that might have an interest in the submitted work. All authors have declared that there are no other relationships or activities that could appear to have influenced the study.

Ethical Statement

The study was approved by the Ethical Committee of Cairo University Hospitals. Consent for treatment and open-access publication was obtained or waived from all participants in this study. All authors have confirmed that this study did not involve animal subjects or tissue.

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