

ORIGINAL ARTICLE

PROXIMALLY BASED VERSUS DISTALLY BASED GLUTEUS MUSCLE FLAP IN TREATMENT OF END STAGE FECAL INCONTINENCE

By

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Aim: To compare proximally based versus distally based gluteus maximus muscle flap transposition in patients with end stage fecal incontinence.

Methods: Between August 2005 and August 2007, this prospective randomized study was performed on twenty patients with an end stage anal incontinence. They were sixteen men and four women with an age ranging from 7 to 31 years. A proximally based gluteus maximus flap (group III) was carried out in ten patients while, a distally based flap (group I) was done in the other ten. Patients were followed up for 6 - 18 months both subjectively and objectively with evaluation of their incontinence score, anorectal manometry, saline enema test and magnetic resonance imaging (MRI).

Results: Overall, 6/10 patients (60%) in group I and 8/10 patients (80%) in group II were clinically improved with down staging of their incontinence scores from C3 to 0 (P 0.003 & 0.0001 respectively).

This was confirmed by the significant changes in anorectal manometry and saline enema test. MRI done one month postoperatively showed disruption in three patients.

Conclusion: Proximally based gluteoplasty appears to be an excellent encirclement procedure that restores voluntary squeeze pressure as well as rectal sensation when compared with unilateral distally based gluteoplasty.

Keywords: Soiling, anal canal, sphincter reconstruction.

INTRODUCTION

Fecal incontinence is a distressing condition that may result from a variety of causes including trauma, surgery, and congenital malformation. When the anal sphincter has been denervated or damaged beyond the scope of direct repair, sphincter reconstruction using healthy adjacent muscle may be warranted in properly selected patients.⁽¹⁾

Chetwood (1902) and more extensively Stone (1929) described the use of the gluteus muscle for anal sphincter

repair either as a muscle sling around the anal canal or indirectly through interposed fascial grafts.^(2,3)

In 1944, Bistrom reinforced the usefulness of the gluteus muscle for anal sphincter plasty.⁽⁴⁾

Gluteus maximus muscle is ideally suited for transposition to the perianal region as it is a well-vascularized muscle, acts as a natural synergist of the external sphincter and provides adequate muscle bulk around the anal canal. The gluteus maximus muscle is activated during walking,

which keeps continuous contraction even without electric stimulators. This is in addition to the fact that its inferior half can be readily harvested without detriment to gait or pelvic stability.⁽²⁾

Gluteus muscle transposition has the advantage of the use of a non-neuropathic muscle to augment the anal sphincter, improving the resting and squeeze pressures and elongating the high-pressure zone.⁽⁶⁾

In the majority of reports, distally based gluteus maximus flaps were created bilaterally because of the inadequacy of length obtained from a one-sided flap 3-7. Meanwhile certain other authors recommended the use of a proximally based flap 8-10. However, there is no consensus regarding which flap is longer and thus more suitable for transposition.⁽¹⁾

The aim of the present study was to compare the efficacy of proximally based versus distally based gluteus maximus muscle flap transposition in restoration of anal function and its effect on the quality of life in patients with end stage fecal incontinence.

PATIENTS AND METHODS

This prospective study included 20 patients with end stage fecal incontinence. It was conducted between April 2005 and April 2007. All patients were referred to our colorectal surgery unit suffering from stage C3 incontinence according to Pescatori scoring system for fecal incontinence.⁽¹⁵⁾ They were 16 males and 4 females with an age ranging from 7 - 31 years (mean 18.00 ± 6.83 years). Ten patients underwent previous surgical trials for sphincter reconstruction with unacceptable results. Diverting stoma was carried out in other sex patients at the time of perineal trauma without trials for surgical sphincteric reconstruction.

All patients underwent complete history taking, thorough clinical examination with inspection of the anal region & per rectal examination to assess the integrity of the anal sphincter as well as pressure during squeeze and straining, in addition to laboratory investigations in the form of anorectal manometry, endoanal ultrasonography, pelvic magnetic resonance imaging (MRI) and surface electromyography of both glutei muscles. Quality of life was assessed in all of our patients using Fecal Incontinence Quality of Life (FIQL) questionnaire (Rockwood TH et al, 2000). This questionnaire includes 29 items and 4 scales (life style, coping and behavior, depression and self perception & embarrassment scales). Each scale is calculated by its mean that ranges from 1 - 5 where 1 presents the lowest functional status.

Patients and their families were told about the exact nature

of their problem and the available options of treatment in this study and all of them agreed and signed an informed consent.

Patients were then randomly classified using the closed envelope method into two groups

Group I: included 10 patients for whom a unilateral distally based gluteus maximus muscle flap was carried out.

Group II: included 10 patients for whom a unilateral proximally based gluteus maximus muscle flap was carried out.

Mechanical preparation of the colon was done in all patients using low residue diet 5 days preoperatively and colonic lavage every 6 hours 2 days before the operation. All patients received 1 g cefotaxime and 500 mg metronidazol 2 hours before, during and after the operation for at least 3 days.

With the patients under general anesthesia and in jack-knife position, a modified S-shaped skin incision was performed starting from the back of the middle of the sacrum to the infra-gluteal fold. The inferior gluteal nerve and its accompanying vessels supplying the gluteus maximus were identified and safeguarded. In the proximally based flap, the inferior half of the muscle was detached from its insertion at the iliotibial tract and the posterior gluteal tubercle of the femur (Fig.1). The muscle was dissected proximally to the neurovascular pedicle (Fig.2). This dissected flap was then flipped over and placed across the anus through a created tunnel (Fig.3), and the length of the muscle that projected beyond the anus was measured. In the distally based flap, the inferior half of the muscle was separated at its origin close to the sacrum and coccyx, and it was dissected distally to the neurovascular pedicle. The dissected flap was placed across the anus, and the length of the muscle that projected beyond the anus was likewise measured. In both procedures, the inferior gluteal nerves were dissected loose from the sciatic nerves to avoid tension. Postoperatively, patients received fluids intravenously, nothing was allowed per mouth for 3 days. Thereafter, they started low residue diets for 2 weeks. Biofeedback retraining was started at the beginning of the fourth postoperative week using the computerized program of Sandhil Biolab anorectal manometry pressure for visual and auditory feedback in the form of weekly one-hour sessions for 8-10 weeks. Patients were followed both objectively and subjectively for about 6-18 months (mean, 10.80 ± 3.44 months) using clinical assessment, manometric studies, saline infusion tests and magnetic resonance imaging (MRI). Results were considered satisfactory if patients were completely continent, incompletely satisfactory if

continence was assisted with medications, enemas or suppositories to regulate evacuation, and disappointing when total incontinence was still present.

All data were collected and statistically analyzed using SPSS version 10. Quantitative data were assessed by paired t-test and qualitative data were assessed using chi square test. Values were expressed as mean and standard deviation. P-value <0.05 was considered significant.

RESULTS

The present study included 20 patients with stage C3 incontinence according to Pescatori scoring system (15) for fecal incontinence of mean duration 4.35 ± 3.32 years. They were 16 males and 4 females with a mean age 18.00 ± 6.83 years. The main etiology was congenital in 4 patients (anorectal malformation with unsuccessful pull through operations), postoperative in 6 patients (anorectal surgery for congenital megacolon, sacrococcygeal teratoma, fistulectomy, and hemorrhoidectomy), and following severe perineal trauma in 10 patients (Fig. 4).

Patients were randomly classified by the closed envelop method into two groups:

Group I comprised 10 patients, 8 males and 2 females with a mean age 17.90 ± 8.56 years (ranging from 7-31 years) and mean disease duration 4.40 ± 3.56 years (ranging from 2 to 12 years). Patients in this group were submitted for distally based gluteoplasty.

Group II comprised 10 patients, 8 males and 2 females with mean age 18.10 ± 5.02 years (ranging from 10-26 years) and mean disease duration 3.80 ± 3.22 years (ranging from 1-10 years). Patients in this group were subjected to proximally based gluteoplasty.

There was no significant difference among the studied groups regarding age, sex and disease duration.

There was no perioperative mortality in both groups. Postoperative morbidity in group I, was related mainly to wound infection in the para anal incisions in 4 patients (40%) that were treated by wound drainage, local dressings with the use of systemic antibiotics. Disruption of muscle sling had occurred in 3 patients (30%), who were re-operated upon using the contra-lateral gluteus muscle. moreover; 3 patients (30%) experienced persistent gluteal pain that fairly responded to oral analgesics and 4 patients (40%) developed perianal dermatitis due to early postoperative soiling. While, in group II, postoperative complications were mainly in the form of wound infection in 1 patient (10%), persistent gluteal pain in 2 patients (20%) and perianal dermatitis in 2 patients (20%). The

overall morbidity had occurred in 6 patients (60%) in group I versus 4 patients (40%) in group II (P 0.074) Table 1.

On the other hand, the mean length of muscle flaps that projected beyond the anal canal was 4.5 ± 1.08 cm in group I versus 7.7 ± 0.95 cm in group II (P 0.001).

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After biofeedback retraining, results obtained in group I, were satisfactory in 4 patients (40%), incomplete satisfactory in 2 patients (20%), whereas, 4 patients (40%) reported disappointing results. While, in group II, 6 patients (60%) experienced satisfactory results, 2 patients (20%) experienced incomplete satisfactory results, whereas, the last 2 patients (20%) reported disappointing results. Overall, 6/10 patients (60%) in group I and 8/10 patients (80%) in group II were clinically improved with down staging of their incontinence scores from C3 to 0 (P 0.003 & 0.0001 respectively).

postoperatively, anorectal manometric studies for patients in group I, showed marked increase in mean resting pressure (MRP), mean squeeze pressure (MSP) and functional anal canal length (FAC) which was more significant in MSP and FAC when compared to preoperative values (P 0.06, 0.0005 & 0.002 respectively), while all patients in group II, showed significant increase in MRP, MSP, FAC (P 0.002, 0.0001, 0.0001 respectively),

also all patients in both groups had a postoperative significant increase in mega rectum score compared to preoperative levels Table 2.

As regards saline enema test (200 ml.), there was a significant improvement with positive results in 5 and 7 patients in group I & II respectively (P 0.01 & 0.012) Table 3.

Also, postoperative MRI studies demonstrated intact gluteus maximus slings in all patients except for those who developed postoperative muscle disruptions (Fig. 5).

As regards the quality of life scoring system, it was noticed that there was no significant difference between preoperative and postoperative scores in patients in group I as regards life style score (p=0.19), coping and behavior score (p=0.3), or depression and self perception score (p=0.17), meanwhile, there was a significant improvement in embarrassment score (p=0.046) and (Fig. 6). While in group II, there was postoperative significant improvement in life style score (p=0.3), coping and behavior score (p=0.009), depression and self perception score (p=0.034), and embarrassment score (p=0.001) Table 4.

Table 1. Postoperative complications in the studied groups p≤ 0.05 is significant.*

| | G I | G II | Chi-square test | |
|--------------------------|------------|------------|-----------------|--------|
| | (n=10) | (n=10) | X ² | p |
| Anal canal perforation | 1 (10.0 %) | - | 1.053 | 0.31 |
| Perianal wound infection | 4 (40.0 %) | 1(10%) | 5.0 | 0.025* |
| Gluteal wound seroma | 2 (20.0 %) | - | 2.22 | 0.14 |
| Gluteal pain | 3 (30.0 %) | 2 (20.0 %) | 0.27 | 0.61 |
| Muscle disruption | 3 (30.0 %) | - | 5.0 | 0.025* |
| Gluteal wound keloid | - | 1 (10.0 %) | 1.053 | 0.31 |
| Defecation problems | 4 (40.0 %) | 2 (20.0 %) | 2.4 | 0.12 |
| Total complicated cases | 6 (60.0 %) | 4 (40.0 %) | 3.2 | 0.074 |

Table 2. Comparison of preoperative and postoperative manometric parameters.

| | | Pre | Post-operative | | | | ANOVA | |
|---------|------|--------------|----------------|--------------|---------------|--------------|-------|-----------|
| | | | 3 m | 6 m | 12 m | 18 m | F | P |
| Resting | G I | 17.2 ± 7.52 | 23.5 ± 6.31 | 36.4 ± 19.0 | 37.8 ± 26.8 | 40.1 ± 29.8 | 2.45 | 0.06 |
| | G II | 22.5 ± 2.07 | 40.9 ± 13.8 | 48.5 ± 16.7 | 52.9 ± 16.5 | 53.6 ± 17.0 | 3.26 | 0.002* |
| Squeeze | G I | 45.0 ± 6.93 | 91.1 ± 46.5 | 105.5 ± 48.3 | 123.38 ± 41.7 | 125.5 ± 42.9 | 6.23 | 0.0005*** |
| | G II | 42.4 ± 6.6 | 102 ± 40.7 | 121.4 ± 38.5 | 126.1 ± 37.0 | 129.2 ± 39.9 | 10.62 | 0.0001*** |
| FACL | G I | 1.83 ± 0.564 | 2.94 ± 0.83 | 2.88 ± 0.88 | 2.98 ± 0.68 | 3.05 ± 0.61 | 4.9 | 0.0023** |
| | G II | 2.02 ± 0.439 | 3.33 ± 0.33 | 3.42 ± 0.34 | 3.45 ± 0.36 | 3.43 ± 0.3 | 29.43 | 0.0001*** |

Table 3. Comparison between preoperative and postoperative saline enema test.

| | | preoperative | postoperative | Chi-square | |
|----------------|------|--------------|---------------|------------|--------|
| | | | | χ^2 | P |
| Satisfactory | G I | - | 5 (50.0 %) | 6.66 | 0.01* |
| | G II | - | 7 (70.0%) | 9.47 | 0.012* |
| Unsatisfactory | G I | 10 (100%) | 5 (50.0 %) | | |
| | G II | 10 (100%) | 3 (30%) | | |

Table 4. Comparison between preoperative and postoperative FIQL in the group II.

| | Life style score | Coping and behavior score | Depression and self perception score | Embarrassment score |
|----------------|------------------|---------------------------|--------------------------------------|---------------------|
| Pre operative | 2.0 ± 0.35 | 2.07 ± 0.34 | 2.43 ± 0.3 | 2.0 ± 0.41 |
| Post-operative | | | | |
| 3 m | 2.7 ± 0.73 | 3.02 ± 0.53 | 2.74 ± 0.54 | 2.42 ± 0.54 |
| 6 m | 2.9 ± 0.78 | 3.25 ± 0.53 | 2.61 ± 0.74 | 2.73 ± 0.74 |
| 12 m | 2.88 ± 0.54 | 2.94 ± 0.77 | 2.6 ± 0.22 | 3.26 ± 0.66 |
| 18 m | 3.28 ± 0.79 | 3.36 ± 0.93 | 3.06 ± 0.53 | 3.46 ± 0.65 |
| ANOVA | | | | |
| F | 3.18 | 4.3 | 3.2 | 6.7 |
| P | 0.03* | 0.009** | 0.034* | 0.001** |

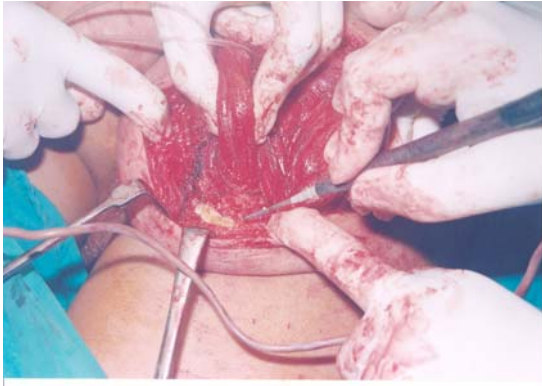


Fig 1. Detachment of proximally based flap from its insertion.

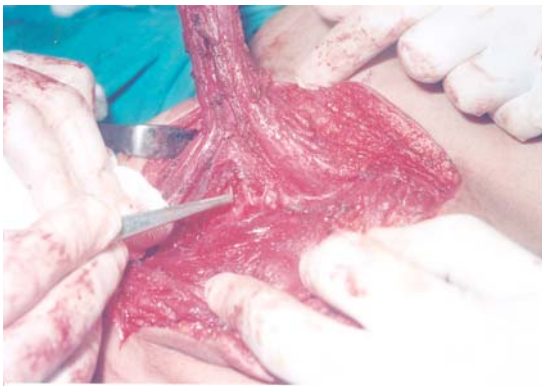


Fig 2. Detection and Identification of the inferior gluteal nerve.

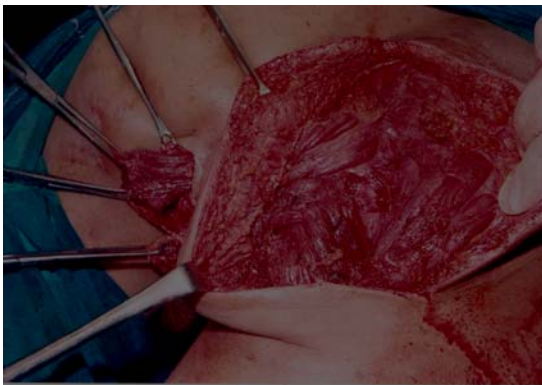


Fig 3. Transposition of the muscular flap through the perineal tunnel.

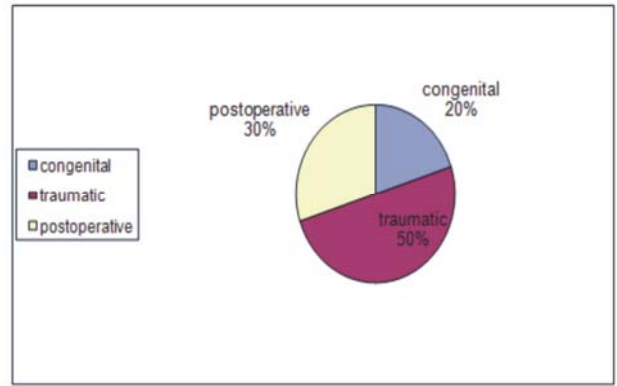


Fig 4. Distribution of patients with stage (C3) as regards the aetiology.



Fig 5. Integrity of muscular wrapping after 1 month postoperatively of the same patient by MRI.

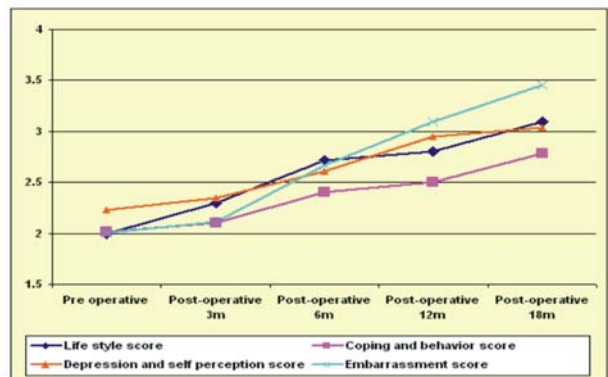


Fig 6. Significant improvement in postoperative embarrassment score ($p < 0.05$) in group I.

DISCUSSION

Maintenance of continence depends upon multiple anatomical and physiologic factors and on a sophisticated interaction between the central and peripheral nervous system and the muscular system. These factors include intact sensorium and cognition, physical and psychological well-being, and anatomical and physiological integrity of the ano-rectal area, internal sphincter, external sphincter, and pelvic muscles including puborectalis. Disruption of any of the above factors may result in varying degrees of FI (Altomare et al., 2001).

Adequate sphincteroplasty for damaged anal sphincter usually restores the function with gratifying results; however, for fecal incontinence secondary to congenital anomalies or muscular denervation, or when direct sphincteric repair is not possible, other techniques are required for achieving certain degrees of continence (Devesa et al., 1992).

Myoplasty, especially unstimulated gluteoplasty and graciloplasty, have acquired a place in restoring anal continence. However, the results of the later have been far from satisfactory (Rosen et al., 1997).

The gluteus maximum muscle is ideally suited for transposition to the perianal region. It is a well-vascularized muscle supplied by the inferior gluteal artery and innervated by the inferior gluteal nerve. It is a natural synergist of the external sphincter. Compared with the gracilis muscle, the gluteus maximus muscle is larger and stronger. It provides adequate muscle bulk around the anal canal. The gluteus muscle is activated during walking, which helps to maintain its trophic status and keeps continuous contraction even without electric stimulators. The inferior half of the muscle can be readily harvested without detriment to gait or pelvic stability (Guelinckx et al., 1996).

Gluteus muscle transposition has the advantage of using a non-neuropathic muscle to augment the anal sphincter, so that, improving both resting and squeeze pressures as well as elongating the high-pressure zone (Farid et al., 2000).

In this study, we present a comparison between unilateral distally and proximally based gluteoplasty in patients with end stage anal incontinence. By reviewing the literature, this comparative study has not been discussed before in spite of several studies that evaluated each technique separately.^(7,8,10-12)

Although, the procedures we performed were followed by neither postoperative mortality nor major morbidity, the incidence of complications like wound infection, peri-anal dermatitis and muscle necrosis and disruption were higher

in distally based gluteoplasty when compared to proximally based technique. This might be due to the intraoperative difficulties and more stretching of the limited muscle flaps around the anal canal. This was more evident when we used the proximally based gluteus flaps which gave more chance for satisfactory calibration of the resting anal canal pressure without much tension on either the flap or its neurovascular pedicle so that achieving better function.

This was also noticed by certain authors when they tried a unilateral distally based gluteoplasty and shifted to bilateral gluteoplasty technique.⁽¹⁾

Defecation problems in the form of fecal impaction, as well as sensation of incomplete evacuation were experienced in 40% & 10% in patients in group I and II respectively which might be duo to partial mechanical tightening of the muscle sling that increase the anorectal angle to one side during attempt keeping continence.

The overall complication rate experienced in this study as well as in other studies are relatively low when compared to restoration of continence.^(1,7,16)

On the other hand, 60% & 80% of patients in group I and II have achieved clinical improvement whether with complete or incomplete satisfaction at the end of biofeedback retraining which was confirmed by physiological and radiological studies. These results seem satisfactory with several other authors who reported a success rate ranging between 60% to 71% although they used different techniques of bilateral gluteoplasty.

The anal manometric parameters in our patients showed significant increase in both resting and squeeze anal pressure after the proximally based procedure whereas in distally based flap, there was more significant increase in squeeze anal pressure that was maintained throughout the whole follow up period. Interestingly, all improved patients regained their rectal sensation which might be explained to be as a result of encirclement of the anal canal which in turn allows rectal distension with the fecal matter so that, helps in perceiving rectal sensation. These findings cope with Pear et al., 1991 who pointed to the efficiency of the procedure in resuming anal pressures to near normal values.⁽¹⁾

In the present series there was significant improvement in all items of quality of life scale according to rockwood et al., 2000⁽¹⁶⁾ (life style, coping & behavior, depression & self perception, and embarrassment) for six months postoperatively and at different periods of follow up. In reviewing the literature, Sprangers et al., (1995)⁽¹⁸⁾ and Grumann et al., (2001)⁽¹⁹⁾ showed that non stoma patients scored significantly higher on a broad range of measures,

including fewer bowel-related problems, improved psychological functioning (including lower rates of depression suicidal ideation and loneliness), improved social functioning (for example, 83% returning to work compared with 40% of stoma patients), and lower rates of sexual dysfunction, at least amongst men.

Results of gluteus maximus muscle dissection and mobilization obtained in the present study show that proximally based flaps were longer than distally based flaps and that transposition and wrapping around the anus with proximally based flaps were always easily performed without tension resulting in successful improvement of incontinence and anorectal physiologic parameters in patients with irreversible damage of anal sphincter as it acts as a functioning neosphincter that provides variable but satisfactory degrees of continence in most patients with less incidence of morbidity related to tension on the muscle or its neurovascular bundle.

In conclusions adynamic unilateral gluteoplasty is considered one of the options for managing patients with end-stage faecal incontinence in whom every other therapy has failed although it is associated with a high morbidity rate.

The patients must be selected critically and be informed extensively preoperatively about potential problems in order to achieve satisfactory results.

On the other hand, we recommend the proximally based gluteoplasty rather than the distally based type as it seems to be a simple, easy to carry out as the neurovascular bundle is far from the dissection of the flap from its insertion at the iliotibial tract and that leading to adequate length of the muscle flap without tension for wrapping around the anal canal.

REFERENCES

- Pearl RK, Prasad ML, Nelson RL, Orsay CP, Abcarian H. Bilateral gluteus maximus transposition for anal incontinence. *Dis Colon Rectum*. 1991;34:478-481.
- Chetwood CH. Plastic operation for restoration of the sphincter ani, with report of a case. *Med Rec*. 1902;61:529.
- Stone HB. Plastic operation for anal incontinence. *Arch Surg*. 1929;18:845.
- Bistrom O. Sphincter ani. *Acta Chir Scand*. 1944;90:431.
- Pak-art R, Silapunt P, Bunaprasert T, Tansatit T, Vajrabukka T. Prospective, randomized, controlled trial of proximally based vs. distally based gluteus maximus flap for anal incontinence in cadavers. *Dis Colon Rectum*. 2002;45:1100-1103.
- Farid M, Farag A. The use of unilateral gluteus maximus muscle for the management of fecal incontinence following anorectal surgery. *Tech Coloproctol*. 2000;4:7-12.
- Devesa JM, Madrid JM, Gallego BR, Vincente E, Nuno J, Enriquez JM. Bilateral gluteoplasty for fecal incontinence. *Dis Colon Rectum*. 1997;40:883-8.
- Hentz VR. Construction of a rectal sphincter using the origin of the gluteus maximus muscle. *Plast Reconstr Surg*. 1982;70:82-5.
- Madoff RD, Rosen HR, Baeten CG. Safety and efficacy of dynamic muscle plasty for anal incontinence: lessons from a prospective, multicenter trial. *Gastroenterology*. 1999;116:549-56.
- Meehan JJ, Hardin WD, Georgeson KE. Gluteus maximus augmentation for the treatment of fecal incontinence. *J Pediatr Surg*. 1997;32:1045-8.
- Christensen J, Hansen CR, Rasmussen O. Bilateral gluteus maximus transposition for anal incontinence. *Br J Surg*. 1995;82:903-5.
- Bruining HA, Bos KE, Colthoff EG, Tolhurst DE. Creation of an anal sphincter mechanism by bilateral proximally based gluteal muscle transposition. *Plast Reconstr Surg*. 1981;67:70-2.
- Guelinckx PJ, Sinsel NK, Gruwez JA. Anal sphincter reconstruction with the gluteus maximus muscle: anatomic and physiologic considerations concerning conventional and dynamic gluteoplasty. *Plast Reconstr Surg*. 1996;98:293-302.
- Orgel MG, Kucan JO. A double-split gluteus maximus muscle flap for reconstruction of the rectal sphincter. *Plast Reconstr Surg*. 1985;75:62-6.
- Pescatori M, Anastasio G, Bottini C, Mentasti A. New grading and scoring for anal incontinence. Evaluation of 335 patients. *Dis Colon Rectum*. 1992;35:482-7.
- Rockwood TH, Church JM, Fleshman JW. Fecal incontinence quality of life scale: quality of life instrument for patients with fecal incontinence. *Dis Colon Rectum*. 2000;43:9-16.
- Farid M, Moneim HA, Mahdy T, Omar W. Augmented unilateral gluteoplasty with fascia lata graft in fecal incontinence. *Tech Coloproctol*. 2003;7:23-28.
- Sprangers MA, Taal BG, Aaronson NK, Ate Velde M. Quality of life in colorectal cancer patients: stoma vs. non stoma patients. *Dis colon Rectum*. 1995;38:361-9.
- Grumann MM, Noack EM, Hoffman LA, Schlang PM. Comparison of quality of life in patients undergoing abdomino-perineal extirpation or anterior resection for rectal cancer. *Ann Surg*. 2001;233:149-56.