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# Double Dynamic Graciloplasty and Coloperineal Pull-through after Abdominoperineal Resection

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In patients with a very low rectal carcinoma, an abdominoperineal resection with the creation of a permanent colostomy is the surgical treatment of choice. Creation of a colostomy can be avoided without compromise to oncological safety. The distal colon is pulled through to the perineum and both gracilis muscles are used to create a new sphincter and pelvic floor. These muscles are electrically stimulated by an implanted neurostimulator. Contraction is then no longer dependent upon volition and, due to fibre transformation, the muscle will become fatigue-resistant. The outcome in 11 patients was assessed. After a mean follow-up of 1.3 years, continence was achieved in 7 patients, and 2 patients are awaiting completion of the therapy. In 2 patients, necrosis of the distal colon led to failure of the technique. There was no local recurrence, but 2 patients had distant metastasis. Double dynamic graciloplasty after abdominoperineal resection proves to be an oncologically safe procedure with a reasonable chance of continence and a life without a stoma in the majority of patients.

**Key words:** dynamic graciloplasty, coloperineal pull-through, abdominoperineal resection, rectal carcinoma  
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## INTRODUCTION

DURING THE last decade, sphincter saving, reconstructive surgery has developed to such an extent that most patients with a rectal carcinoma can be helped with a colo-anal or colon pouch anastomosis [1–3]. Until recently, the only reliable solution in patients with a very low rectal carcinoma was an abdominoperineal resection with the creation of a permanent colostomy.

The construction of a neorectum and a neosphincter was first performed using the glutei muscles [4]. In 1952, Pickrell started to transpose the gracilis muscle around the anal canal in patients with severe, idiopathic faecal incontinence [5]. Since the contraction of these muscles was dependent upon volition and the muscles are composed of a majority of type II, fatigue-prone, muscle fibres, the results were poor [6]. In 1976, this construction was first used after an abdominoperineal resection [7].

When electrical stimulation of the graciloplasty was introduced, the so-called “dynamic graciloplasty”, results started to improve [8–12]. Contraction of the gracilis muscle is no longer dependent upon volition but contracts in response to the stimulator. A transformation from type II, fatigue-prone, muscle fibre into type I, fatigue-resistant muscle fibre occurs.

The aim of this study was to analyse the outcome of 11 patients with low rectal carcinoma treated with a double dynamic graciloplasty around a colon pull-through after abdominoperineal resection, and to compare different techniques.

## PATIENTS AND METHODS

Between May 1991 and June 1994, 11 patients with a mean age of 55 years (range 28–71) were treated (Table 1). 4 were

Table 1. Patient characteristics

Patient	Age	Stage*	Times of procedure	Configuration group†	Outcome
1. Female	46	B2	Primary	A	Failure
2. Male	56	B2	Secondary	A	Continent
3. Female	53	B1	Primary	A	Continent
4. Female	67	A	Primary	A	Continent
5. Male	52	B1	Primary	A	Failure
6. Female	65	B2	Primary	B	Continent
7. Male	64	A	Primary	B	No implant yet
8. Female	46	B2	Primary	B	Continent
9. Female	28	C2	Secondary	B	Still with stoma
10. Female	71	B2	Primary	B	Continent
11. Male	53	B2	Primary	B	Continent

\*According to the Astler–Coller system; †See text for details.

male and 7 female. All patients had a histologically proven adenocarcinoma of the last 5 cm of the rectum. In none of the pre-operative investigations was there proof of regional spread or signs of distant metastases. All patients were in good general condition, and good function of the gracilis muscles was confirmed by electromyography.

The mean distance from the anal verge to the lowest edge of the tumour was determined before operation on colonoscopy and this was 3.0 cm (range 0–5 cm). The mean tumour diameter was 4.6 cm (range 2–8 cm). Patients were classified according to the modified Astler–Coller system (Table 1). In 9 patients, the abdominoperineal resection, the pull-through and the double dynamic graciloplasty were performed in the same session. 2 patients who were pre-operatively staged as T<sub>3</sub> received pre-operative radiotherapy at a dose of 45 Gy over 5 weeks. In 2

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patients, the pull-through with the graciloplasty was performed at a later date (13 months and 4 years). Both patients had major physical and psychological difficulties with their colostomy.

Before the operation, all patients were well informed about the procedure, the possible complications, the fact that a temporary ileostomy would be created, and the possible advantages and disadvantages compared with other treatment modalities. A training period would require the integration of: (i) the use of the dynamic graciloplasty; (ii) the acquirement of a new defaecation sensation; and (iii) having a normal consistency of faeces.

The procedure was undertaken in two stages.

#### Stage 1

Pre-operatively the patient was prepared with mechanical colon preparation and all patients had systemic antibiotic prophylaxis for 24 h (gentamicin, metronidazole, flucloxacillin). The patient was placed in the lithotomy position with the use of Lloyd–Davies stirrups. The combined abdominoperineal resection, or Miles procedure, was performed and the sigmoid colon, the rectum and the anal canal including the sphincters and pelvic floor were resected. The specimen was sent to the pathology laboratory and after confirmation of removal of the complete tumour with a free lateral margin of at least 1.0 mm [13], the operation was continued. The remaining left colon, the splenic flexure and part of the transverse colon were mobilised paying attention not to damage the arcus of Riolan. When there was adequate blood supply and enough length to reach the perineal skin, the graciloplasties were performed. Both gracilis muscles were identified and mobilised, leaving the proximal neurovascular bundle intact [14]. In the first 5 patients, the double graciloplasty was performed as described by Seccia and associates [15]. One gracilis muscle is transposed behind the neorectum and fixed to the ischial tuberosity, serving as a new puborectal muscle. The other muscle is transposed around the neoanal canal and is fixed to the pubic bone, serving as a neosphincter (group A, Figure 1a). In the last 6 patients, both gracilis muscles without distal tendons were transposed around the distal colon and fixed to each other in order to serve as a new sphincter and neopelvic floor at the same time (group B, Figure 1b). In all patients, a temporary, protecting ileostomy was created.

To ensure that the gracilis muscles remained in good condition, the contractility was evaluated after 4 weeks by transcutaneous electrical stimulation and the sites of lowest threshold were marked. Contractions of the transposed gracilis muscles were tested by anal manometry.

#### Stage 2

After a median of 135 days (range 49–459) after the double graciloplasty, implantation of the stimulator and the leads was performed. An incision was made on the site of lowest threshold and an intramuscular flexible coil wire of platinum iridium was introduced as an anode (SP 5566, Medtronic, Kerkrade, The Netherlands). At the site of the lowest threshold the electrode was pulled crosswise through the muscle and fixed. The length of the bare surface of the electrode could be adjusted to the diameters of the muscle. The same procedure was performed on the other side. Subsequently, the leads were subcutaneously tunnelled to a pocket in the lower abdominal wall contralateral to the protecting ileostomy. There they were connected to an Irel<sup>TM</sup> pulse generator (model 7424, Medtronic, Kerkrade, The Netherlands). Both leads were programmed as cathode while the stimulator functioned as anode.

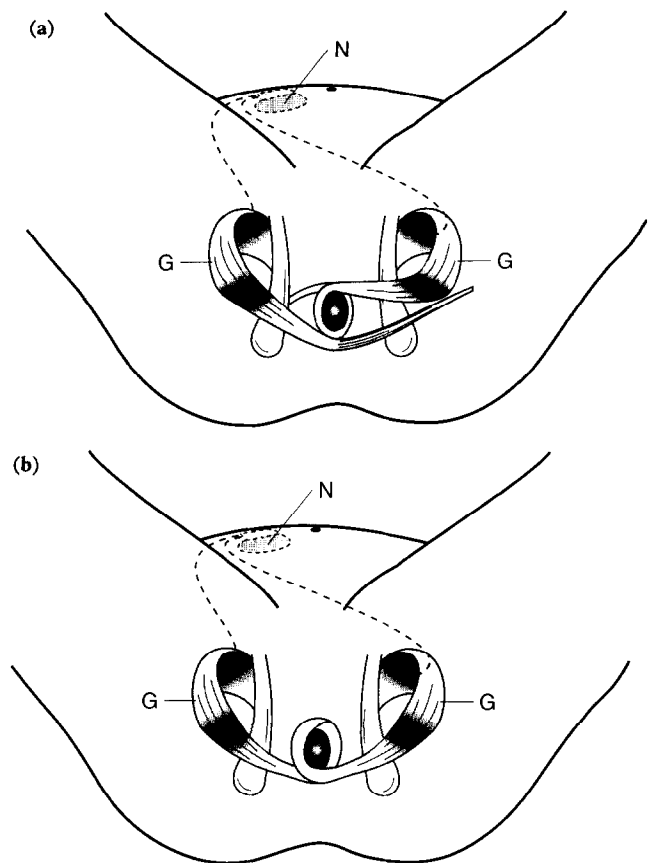


Figure 1. Configuration of the double graciloplasty. G = gracilis muscle, N = neurostimulator and leads (= dotted line). (a) Configuration used in group A. (b) Configuration used in group B.

#### Stimulation of the graciloplasty (anal dynamic graciloplasty)

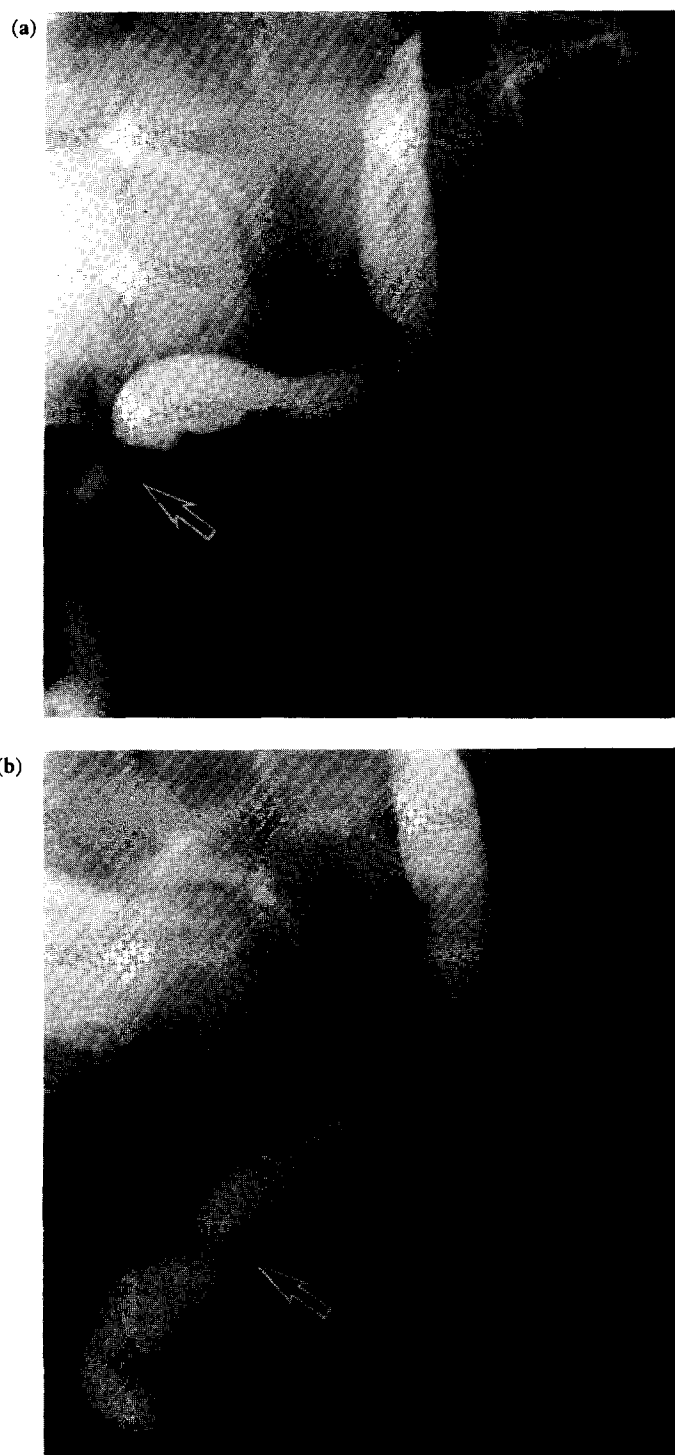
Stimulation was started 3 days after implantation of the pulse generator employing a pulse width of 210 s, a stimulation frequency of 25 pps and a cyclic mode with an "on" time of 0.1 s and an "off" time of 1.2 s, yielding a duty cycle of 8% (the time during which the muscle is actually contracting). Subsequently, telemetrically the duty cycle was increased over the next 6 weeks to 14% (0.2 s "on" and 1.2 s "off") after 2 weeks, 36% (0.4 s "on" and 0.7 s "off") after 4 weeks and 67% (1.0 s "on" and 0.5 s "off") after 6 weeks. At 8 weeks, continuous stimulation was started. An external magnet was given to all patients to turn the mode of operation of the pulse generator "off" to permit defaecation and "on" again after defaecation.

The effect of electrical stimulation on the contractions of the transposed muscle was evaluated by anal manometry. When the rise in anal pressure was less than 20 mm Hg, an adjustment in stimulation voltage was made. The stimulation frequency that produced a fused contraction of the transposed muscle was assessed at the start of the stimulation and 8 weeks later.

When good function was confirmed with a defaecography after 4 weeks of continuous stimulation (Figure 2a and b), the ileostomy was closed.

#### Clinical evaluation

The number and nature of events of incontinence, the frequency of bowel emptying and the time to postpone defaecation were recorded. Continence was classified from I to V according to a standardised scoring method [12]. The treatment was



**Figure 2.** Defaecography, the site of the double graciloplasty is indicated by the arrow. (a) Neurostimulator is switched "on". (b) Evacuation while neurostimulator is switched "off".

regarded as successful if the patient was continent to formed and liquid stools, while occasional soiling was accepted.

Anal manometry was performed using a Konigsberg catheter (Konigsberg Instruments Inc, Pasadena, California, U.S.A.), which was connected to a computer-assisted polygraph (Synectics Medical, Stockholm, Sweden). Highest basal pressure, squeeze pressure and the length of the high pressure zone (HPZ), were measured by means of a standardised stationary

pull-through technique. Defaecography during and without stimulation was performed according to Goei [16].

Patient data are expressed as mean and the range or the standard deviation. The studies were approved by the medical ethical committee of Maastricht University Hospital. Informed consent was obtained from all patients.

## RESULTS

After a mean follow-up of 1.3 years (5 months–3 years) after the implantation of the neurostimulator, continence was achieved in 7 patients (Table 1). All patients had regular follow-up for their carcinoma by colonoscopy and serum carcinoembryonic antigen (CEA) level. In this group of 11 patients, no regional recurrences have been found. Patient 4 developed liver metastases and underwent a hemi-hepatectomy. Patient 9, who had been free of recurrence for 4 years when the dynamic graciloplasty was performed, developed a mediastinal metastasis and is undergoing treatment with radiotherapy. The metastasis was detected after the implant of the stimulator and stoma closure was postponed. In patient 7, implantation of the stimulator was postponed for unrelated medical reasons. The technique failed in 2 patients (group A) due to necrosis of the distal colon stump. The stoma was closed after a mean of 11 weeks (8–21).

After transposition, the overall mean resting pressure was 38 ( $\pm 12.0$ ) mm Hg and the mean squeeze pressure, as measured while pressing the knees against each other, was 141 mm Hg ( $n = 9$ ). At 8 weeks, the overall mean pressure during stimulation was 80.8 mm Hg ( $\pm 26.0$ ). At 16 weeks, this was 90.8 mm Hg ( $\pm 28.1$ ), at 26 weeks 88.7 mm Hg ( $\pm 41.3$ ) and at 52 weeks 91.2 mm Hg ( $\pm 51.9$ ). Data divided for group A and group B are shown in Table 2.

The stimulation voltage needed for a good contraction was 1.2 V ( $\pm 0.4$ ) at 0 weeks and mounted to 1.6 V ( $\pm 0.6$ ) at 8 weeks, 2.7 V ( $\pm 1.2$ ) at 16 weeks, 2.8 V ( $\pm 1.3$ ) at 26 weeks and 4.0 V ( $\pm 1.0$ ) at 52 weeks (Table 2).

At 26 weeks, the mean defaecation frequency was 3 times per day (range 1–5). There was no difference between group A and group B, although 2 of the 3 patients in group A had to use an enema daily for colonic voiding. The mean time to postpone defaecation was 11 min (range 0–30).

## DISCUSSION

Abdominoperineal resection is still the treatment of choice in patients with adenocarcinoma of the lower rectum. In well selected cases, the risk of local recurrence is small. In this series, no local recurrences were seen. The specimens were routinely inked at the outside and during operation the lateral margins were determined [13]. Only when the closest distance of the tumour from the lateral margins was more than 1 mm was the procedure of the coloperineal pull-through with the creation of the neo-anus performed. When the lateral margins are less than 1 mm from the tumour, in our hospital, the patient will be treated with radiotherapy. Postoperative radiotherapy at the site of a neorectum and neo-anus is considered as too great a risk [17] and, therefore, not considered as a reasonable option. In cases of more advanced cancer ( $T_{3-4}$ ), we have used preoperative radiotherapy (45 Gy in 5 weeks) without any significant effect on healing or function of the neo-anus.

The restoration of faecal continence in patients with severe, idiopathic incontinence has improved dramatically by using a pulse generator to improve the function of a graciloplasty. By electrical stimulation of this muscle, many type II, fast twitch, fibres will be transformed into type I, slow twitch, fibres [18].

Table 2. Clinical results expressed in means with standard deviation of the resting pressure ( $P_b$ ), squeeze pressure ( $P_v$ ), pressure during stimulation ( $P_s$ ) and voltage ( $V$ ) at subsequent periods after implantation

		Group A	Group B	Total
$P_b$	(mm Hg)	32.7 (15.6) $n = 3$	41 (10.3) $n = 6$	38 (12.0) $n = 9$
$P_v$	(mm Hg)	109.3 (30.2)	156 (26.5)	141 (34.9)
$P_s$ at 0 weeks	(mm Hg)	58.7 (45.9) $n = 3$	70 (11.0) $n = 5$	66 (26.6) $n = 8$
$V$	(V)	1.4 (0.7)	1.1 (0.3)	1.2 (0.4)
$P_s$ at 8 weeks	(mm Hg)	51.7 (14.3) $n = 3$	98.2 (7.2) $n = 5$	80.8 (26.0) $n = 8$
$V$	(V)	1.8 (0.9)	1.5 (0.5)	1.6 (0.6)
$P_s$ at 16 weeks	(mm Hg)	70.3 (1.7) $n = 3$	103 (27.2) $n = 5$	90.8 (28.1) $n = 8$
$V$	(V)	2.9 (1.5)	2.6 (1.2)	2.7 (1.2)
$P_s$ at 26 weeks	(mm Hg)	67 (41.0) $n = 3$	110.3 (34.3) $n = 3$	88.7 (41.3) $n = 6$
$V$	(V)	3.6 (1.0)	2.0 (1.3)	2.8 (1.3)
$P_s$ at 52 weeks	(mm Hg)	62 (13.2) $n = 3$	135 (63.6) $n = 2$	91.2 (51.9) $n = 5$
$V$	(V)	4.2 (1.0)	3.7 (1.2)	4.0 (1.0)

$n$ , number of evaluable patients.

This will improve the fatigue resistance of the muscle, enabling a prolonged contraction. By using an external magnet, the patient has control over the stimulator but contraction is no longer dependent upon volition.

In this series, we applied the same technique in the construction of a neosphincter in patients after abdominoperineal resection of the rectum. However, the situation is more complex: (i) there is a large defect in the pelvic floor, (ii) all receptors situated in the anal canal, necessary for sensation and discrimination of impending evacuation [19] are removed, and (iii) when a colo-perineal anastomosis is created, the neorectum has limited capacity and has a motility pattern different from the normal rectum.

To reconstruct the pelvic floor, both gracilis muscles were used. In one configuration ( $n = 5$ ), the first muscle replaced the puborectal muscle thereby restoring the anorectal angle. The second muscle was transposed around the neo-anal canal replacing the external sphincter. This neo-anal canal was partly surrounded by the distal gracilis tendon. In 2 patients, this resulted in necrosis of the distal bowel and failure of the technique. In the remaining 3 patients, 2 patients developed constipation making lavage necessary. We, therefore, changed our technique and used both muscles in creating the neosphincter ( $n = 6$ ), which gave less impairment of circulation in the terminal colon. By first transposing the muscles posterior to the bowel, the anorectal angle was restored at the same time (Figure 2a and b). Surrounding the bowel only with muscle tissue resulted in no further failures due to necrosis. Recorded manometrical pressures are higher, without an increased amplitude, but due to small numbers this was not statistically significant. However, there is the impression that functional outcome has also been better, but the numbers are still too low for statistical calculations.

Testing the sensibility of the neo-anal mucosa and submucosa revealed complete sensory loss in a similar group of patients [20]. However, it has been suggested [7] that most patients

develop an alternative form of perception after several months, and this has been confirmed in our group of patients. The type of perception can vary from a periumbilical sensation, a hypogastric murmur, tension on the gracilis muscles to a feeling almost similar to normal perception.

While some patients can have difficulties in voiding, others may experience minor soiling or occasional strong peristalsis. Loss of the rectum can be responsible for this urgency due to a smaller neorectal capacity and the absence of a coordinated activity between the neorectum and the neosphincter [21]. Construction of a pouch increases the distensibility of the neorectum and decreases its propulsive drive [22]. Because of the complexity of the current technique, no pouches have yet been constructed. If autonomic colon contractions prove to be a problem in the long run, construction of a pouch might be considered to overcome this.

In this series, all patients had a protective ileostomy for a few months to allow healing without faecal soiling. Seccia and colleagues [15] showed that a temporary stoma is not always necessary. We implanted the leads and the stimulator in a second procedure in order to prevent serious infection from this foreign material at the time of the greatest risk. Colo-perineal pull-through with double dynamic graciloplasty after abdominoperineal resection is an oncological safe option, it offers patients a reasonable chance of continence and life without a stoma.

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