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## Treatment of Erectile Dysfunction by Perineal Exercise, Electromyographic Biofeedback, and Electrical Stimulation

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# Treatment of Erectile Dysfunction by Perineal Exercise, Electromyographic Biofeedback, and Electrical Stimulation

**Background and Purpose.** Only a few investigators have described the involvement of the perineal muscles in the process of human erection. The aim of this research was to evaluate a re-education program for men with erection problems of different etiologies. **Subjects and Methods.** Fifty-one patients with erectile dysfunction were treated with pelvic-floor exercises, biofeedback, and electrical stimulation. **Results.** The results of the interventions can be summarized as follows: 24 patients (47%) regained a normal erection, 12 patients (24%) improved, and 6 patients (12%) did not make any progress. Nine patients (18%) did not complete the therapy. On the basis of several variables, a prediction equation was generated to determine the factors that would predict the effect of the interventions. The outcome was most favorable in men with venous-occlusive dysfunction. **Discussion and Conclusion.** Comparison of the results of the physical therapy protocol reported here with those obtained for other interventions reported in the literature shows that a pelvic-floor muscle program may be a noninvasive alternative for the treatment of patients with erectile dysfunction caused by venous occlusion. [Van Kampen M, De Weerd W, Claes H, et al. Treatment of erectile dysfunction by perineal exercise, electromyographic biofeedback, and electrical stimulation. *Phys Ther.* 2003;83:536–543.]

**Key Words:** *Electrical stimulation, Erectile dysfunction, Pelvic-floor muscle exercises.*

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**E**rectile dysfunction is defined as the persistent failure to achieve and sustain erections of sufficient rigidity for penetration during sexual intercourse.<sup>1,2</sup> Erectile dysfunction often has multiple causes. Therefore, the diagnostic evaluation for this disability should include an evaluation of the findings of an examination of the patient's psychological, hormonal, neurological, and vascular status.<sup>1</sup> In many cases, a combination of factors is involved.<sup>1</sup> The role of the perineal muscles in the erectile mechanism is still open for debate. Some studies using animal models<sup>3,4</sup> as well as studies of humans<sup>5-8</sup> have demonstrated evidence that there is normally increased ischiocavernosus and bulbocavernosus muscle activity during coitus. This muscle activity contributes to the increase in intracavernosal pressure. During the last 2 decades, research has focused

on the development of diagnostic techniques for male erectile dysfunction in order to provide the most appropriate treatment.<sup>1,9-14</sup>

Different treatment options are available: psychosexual counseling, medication, use of external vacuum devices, intracavernous injection therapy, vascular surgery, and use of a penile prosthesis.<sup>15-22</sup> The etiology of the erectile dysfunction, the acceptability for the patient, and the success rate have been used to determine the choice of intervention.

Physical therapy interventions provide noninvasive methods that are easy to perform, painless, and inexpensive. Studies<sup>23-29</sup> have shown positive results after a pelvic-floor re-education program for men with erectile

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Dr Van Kampen, Dr De Weerd, Dr Claes, and Dr Feys provided concept/idea/research design. Dr Van Kampen and Dr Van Poppel provided writing. Dr Van Kampen, Dr Claes, and Ms De Maeyer provided data collection, and Dr Feys provided data analysis. Dr Van Kampen provided project management. Dr Claes provided subjects. Dr De Weerd, Dr Feys, and Dr Van Poppel provided consultation (including review of manuscript before submission).

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**Table 1.**

Review of the Literature: Results of Pelvic-Floor Muscle Exercises in the Treatment of Erectile Dysfunction

	Mamberti-Dias et al, <sup>24</sup> 1991	Schouman and Lacroix, <sup>25</sup> 1991	Claes and Baert, <sup>26</sup> 1993	Colpi et al, <sup>27</sup> 1994	Claes et al, <sup>23</sup> 1995
N	210	20	78	59	122
Follow-up period (mo)	NI <sup>a</sup>	6	4-12	9	4-12
Complete response	53%	55%	42%-46%	36%	36%-44%
Improved	21%		28%-31%	NI	30%-33%
Failure	26%	45%	12%-13%	20%	14%-19%
Dropout	NI	NI	14%	44%	12%

<sup>a</sup>NI=no information.

**Table 2.**

Review of the Literature: Results of Electrical Stimulation in the Treatment of Erectile Dysfunction

	Stief et al, <sup>28</sup> 1996	Derouet et al, <sup>29</sup> 1998
N	22	48
Follow-up period (mo)	3	3
Complete response	23%	10.4%
Improved	14%	41.6%
Failure	63%	27%
Dropout	NI <sup>a</sup>	21%

<sup>a</sup>NI=no information.

dysfunction. However, different programs were used, and some studies had a small sample size. Data from subjects who did not complete the studies were not included in the analyses, and predictive factors were not investigated (Tabs. 1 and 2).<sup>23-29</sup> The aims of our study were to test an outpatient pelvic-floor re-education program in men with erection problems and to identify factors that could predict therapeutic outcome.

## Method

### Patients

Fifty-one consecutive men with erectile dysfunction who consulted the Department of Urology at University Hospital, Katholieke Universiteit Leuven, Leuven, Belgium, and who consented to take part in a pelvic-floor re-education program were studied. All patients were unable to achieve vaginal penetration because their erections were insufficient in duration or rigidity. The mean age of the patients was 46 years (SD=11, range=25-64). The mean duration of erectile dysfunction was 46 months (SD=66.8 months, range=2 months-30 years). Besides the erectile dysfunction, 7 patients (14%) had lack of libido as determined by

patient report, 3 patients (6%) had decreased orgasm, and 21 patients (41%) experienced ejaculation problems. There were various causes of erectile dysfunction: 20 patients had venous-occlusive dysfunction, 2 patients had arterial dysfunction, and 9 patients had impotence on a pure psychological basis. Nine patients had dysfunction of venous and arterial origin, and 1 patient had venous and hormonal problems. Five patients had venous and psychological impotence. One patient had arterial and psychological problems, and 2 patients were classified with venous, arterial, and psychological disturbances. Two patients could not be classified into any etiologic category.

### Procedure

**Diagnosis.** The protocol for all patients consisted of hormonal (testosterone and prolactin), arterial (Doppler), and pharmacological evaluation (intracavernous injection of 40 mg of papaverine or 30 µg of prostaglandin E<sub>1</sub>). At the start of the study, the vasodilator substance papaverine was injected. Currently, prostaglandin E<sub>1</sub> is used because this drug is associated with a lower risk of priapism and cavernous fibrosis than papaverine.<sup>1</sup> If possible, nocturnal penile tumescence was assessed on 3 consecutive nights.

Before starting the experimental treatment, each patient underwent a urological examination. A psychosocial and sexual history also was obtained. The presence of any risk factors for erectile dysfunction such as alcohol and nicotine abuse, drug use, diabetes mellitus, arteriosclerosis, hypertension, renal failure, and hyperlipemia was documented. A neurological examination also was conducted.

Based on the examinations, the impotence was categorized as arterial insufficiency or venous-occlusive dysfunction, psychogenic, neurogenic, endocrinologic, or a combination of different causes. Patients with erectile problems caused by neurogenic disorders were not included in the study because we did not believe our interventions could improve the problems. Patients with erectile problems caused by hormonal disorders were eliminated from the study because medication was indicated and we did not believe our interventions could improve the problems. Unfortunately, one patient who needed hormonal treatment was erroneously included in the study.

**Treatment.** Each patient attended an individual physical therapy session in an outpatient clinic once a week over a period of 4 months. The treatment was given by a physical therapist (MVK) who specialized in pelvic-floor re-education. No other treatments were applied. Because the physical therapist intervention might have an impact on the psychological and interpersonal relationship of the patient and his partner, the partner was asked to attend at least one treatment session.

During the first session, the physical therapist explained the anatomy of the pelvic floor, the erection process, and the function of the ischiocavernous and the bulbocavernous muscles during an erection. The training program consisted of active exercises, biofeedback, and electrical stimulation of the perineal muscles. The first step in the muscle re-education program was to establish awareness of the function of the muscles. Each patient was taught how to contract the pelvic-floor muscles. He was asked to mimic holding in the flow of urine and to contract the target muscles as hard as possible. The exercises were done in a supine position with the knees flexed. We believe it is easier to feel the pelvic-floor muscles in this position. The therapist performed a digital intra-anal examination to verify if the muscle contraction was correct and selective. The therapist taught the patient how to contract the pelvic-floor muscles by squeezing the therapist's finger. Verbal feedback was used in an effort to obtain accurate performance. The patient was asked to perform short (1 second) and long-lasting (6–10 seconds) contractions of the target muscles. Later, the exercises were done with the patient sitting or standing.

The patient's performance was further enhanced by the use of electromyographic (EMG) biofeedback in order to visualize and quantify the muscle contractions. Electrical stimulation was added to improve awareness of the muscles of the pelvic region and to assist the patient in contracting the ischiocavernous and bulbocavernous muscles. A symmetric biphasic low-frequency current was used with either an anal plug or superficial electrodes on the centrum tendineum. Pulse frequency was 50 Hz, and pulse duration was 200 microseconds. Each burst of electrical stimulation lasted 6 seconds, with a 12-second rest between bursts. The electrical stimulation lasted for 15 minutes. We used an intensity of stimulation that achieved a muscle contraction within the patient's pain limit. As a rule, an anal plug was used for feedback as well as for stimulation. For 2 patients with hemorrhoids, superficial electrodes on the centrum tendineum\* were used. As soon as the patient was able to voluntarily

contract the appropriate muscle, he was asked to repeat the contractions daily. Each patient performed 40 short and 50 long-lasting contractions in a prone, sitting, or standing position. Patients were asked to do 30 contractions in the morning, 30 contractions in the afternoon, and 30 contractions in the evening.

**Assessment.** The physical therapist interviewed each patient every week to establish if there was an improvement in the rigidity or duration of the erection. If possible, the partner was interviewed as well. After 4 months, the urologist (HC) classified the results into 4 categories, based on the information obtained from an interview with the patient:

1. Complete response: the patient reported a return to satisfactory sexual function, with the occurrence of an erection adequate for penetration.
2. Partial response: the patient reported some improvement in the duration or rigidity of erections, but this amelioration was not always sufficient to restore satisfactory sexual intercourse.
3. Failure: the patient reported no noticeable improvement in his erectile function.
4. Dropout: the patient failed to complete the program.

#### **Data Analysis**

Descriptive statistics were used to describe the results of the intervention. The group of patients who continued the physical therapy program were compared with the group of patients who dropped out for 4 characteristics: (1) age, (2) duration of the erectile dysfunction, (3) other sexual problems such low libido, decreased orgasm, and premature ejaculation, and (4) causes of impotence. This comparison was done to determine whether there were underlying reasons that might explain why patients ended the treatment. A *t* test was used to compare groups for age, a Wilcoxon rank sum test was used to compare groups for duration of erectile dysfunction, and a Fisher exact test was used to compare groups for other sexual problems and causes of impotence. Coefficients with a probability value equal to or lower than .05 were considered significant.

Univariate analysis and a logistic regression analysis were used to identify predictive factors for the success of the treatment.<sup>30</sup> To predict the outcome, 3 categories were used: (1) complete response, (2) partial response, and (3) failure. The category of dropouts was omitted. The predictive factors that were selected were age, duration of the erectile dysfunction, and other sexual problems (eg, lack of libido, decreased orgasm, premature ejaculation) and causes of impotence. The causes of impo-

\* Electromyographic biofeedback with 1.5×1.5-cm skin electrodes placed on the centrum tendineum (between the scrotum and anus) or a 6-cm anal plug with ring electrodes.

**Table 3.**  
Results of Physical Therapy Program for Different Causes of Erectile Dysfunction<sup>a</sup>

Results	Causes								Total	
	Ven	Art	Psyc	Ven-Art	Ven-Psyc	Ven-Horm	Art-Psyc	Ven-Art-Psyc		
Complete response	15	1		4	2			1	1	24 (47%)
Partial response	3		2	3	2	1			1	12 (24%)
Failure	1	1	3				1			6 (12%)
Dropout	1		4	2	1			1		9 (18%)

<sup>a</sup>Ven=venous-occlusive dysfunction, art=arterial, psyc=psychological, horm=hormonal.

**Table 4.**  
Frequency and Percentages of Patients With or Without Venous-Occlusive Dysfunction in Relation to the Outcome

Results	Venous-Occlusive Dysfunction	No Venous-Occlusive Dysfunction	Total
Complete response	22 (68.8%)	2 (20%)	24
Partial response	9 (28.1%)	3 (30%)	12
Failure	1 (3.1%)	5 (50%)	6
Total	32	10	42

tence could be arterial insufficiency, venous-occlusive dysfunction, or psychogenic causes. For a univariate analysis, different tests were used depending on the type of variable. An analysis of variance and a Kruskal-Wallis test were used compare age and duration of erectile dysfunction among the 3 outcome groups. The Fisher exact test was used for the other variables (lack of libido, decreased orgasm, premature ejaculation) and causes of erectile dysfunction. A logistic regression analysis was used to explore the relationship between the outcome variables and the prognostic variables.

## Results

When the results of the interviews with the physical therapist and the urologist were compared, only 2 patients gave different answers to the 2 researchers. One patient and his partner told the urologist that he had normal erections, whereas they told the physical therapist that he had only partial erections. Another patient told the urologist that he had partial erections, but he told the physical therapist that he had normal erections.

Following the 4-month training program, 24 patients (47%) had regained a normal erection, 12 patients (24%) had improved, and 6 patients (12%) remained unchanged. Nine patients (18%) failed to complete the program. The characteristics of the group of patients who continued the physical therapy program (n=42) and the group of patients who dropped out of the study (n=9) were compared. More patients with psychological

impotence were found in the group of patients who dropped out of the study as compared with patients who continued the program. No differences were found for any of the other factors such as age, duration of erectile dysfunction, or other sexual problems or other causes of impotence.

All patients who completed all therapy sessions were able to contract their pelvic-floor muscles. The first improvement in rigidity for all subjects occurred between 1 and 6 weeks following the beginning of therapy. The mean time for improvement to be noted was 3.4 weeks (SD=1.1). The first improvement in the duration of the erection occurred between 1 and 12 weeks after the beginning of therapy. The mean time for duration of the erection to be noted was 3.9 weeks (SD=1.9).

Table 3 shows the results of the physical therapy program for the different causes of the erectile dysfunction. Good results were found in the group with venous-occlusive dysfunction. Fifteen out of 20 patients with impotence caused by venous-occlusive dysfunction reported a return of penile erection to allow satisfactory sexual intercourse. Table 4 illustrates the frequency and the percentage of patients with or without venous-occlusive dysfunction in relation to the outcome.

Univariate and logistic regression analyses were used to predict the results of the interventions. The predictive factors that were selected were age, duration of erectile dysfunction, and other sexual problems (eg, lack of libido, decreased orgasm, premature ejaculation) and causes of impotence (arterial insufficiency, venous-occlusive dysfunction, or psychological problems). The univariate and logistic regression analyses indicated the presence of venous-occlusive dysfunction as the only significant factor related to outcome. Age, duration of erectile dysfunction, and other sexual problems or causes of impotence were not found to be predictive of the results of therapy. Thus, the outcome was most favorable in men with venous-occlusive dysfunction.

After termination of the physical therapy intervention, 6 patients continued with other forms of therapy. Two patients with a partial response after physical therapy opted for intracavernous injection therapy. One patient with a partial response after physical therapy underwent vascular surgery, and 1 patient with a partial response after physical therapy had psychosexual counseling. Of the 2 patients who had no improvement after physical therapy, 1 had psychosexual counseling and 1 used medication for hormonal disturbances.

## Discussion

In this study, 47% of the patients regained normal erectile function, and 24% had an improved erection after a pelvic-floor re-education program in combination with EMG biofeedback and electrical stimulation. Six out of 51 patients requested another modality of therapy after cessation of the physical therapist intervention.

The results of our study are in the line with the findings of Mamberti-Dias and Bonierbale-Branchereau<sup>24</sup> and Claes and colleagues.<sup>23,26</sup> The results of Schouman and Lacroix<sup>25</sup> for patients with erectile dysfunction were less favorable, but their sample size was small. Colpi et al<sup>27</sup> reported that only 36% of the patients in their study recovered or improved following pelvic-floor muscle exercises for venogenic impotence. Colpi et al found that age was not a determining factor for the success of physical therapy. The high dropout rate in their study, in which no electrical stimulation was given, is surprising to us. Mamberti-Dias and Bonierbale-Branchereau<sup>24</sup> and Schouman and Lacroix<sup>25</sup> gave no information on the number of dropouts. This makes comparisons difficult and we believe may lead to a positive bias. It is unknown whether exercises, EMG biofeedback, electrical stimulation, or a combination of these interventions is effective for the treatment of erectile dysfunction. Because there was no control group in our study, we cannot rule out a placebo effect, in part, leading to our results.

The success rates in the studies by Stief et al<sup>28</sup> and Derouet et al<sup>29</sup> were 37% and 52%, respectively (Tab. 2). These results were less favorable than ours. Both Stief et al and Derouet et al used only electrical stimulation for treatment of erectile dysfunction. An important finding in the study by Stief et al was that in a comparable control group no improvement was found. In the study by Colpi et al,<sup>27</sup> only exercises were used. They found the highest dropout rate of all studies for which dropout rates were reported. The most favorable results were found in studies in which a combination of exercises, biofeedback, and electrical stimulation was used.<sup>23-26</sup> Further research in controlled studies should provide an answer to the question of which parts of the therapy are necessary. The evaluation of the effect of the treatment was based on interviews with the patients. No methods

are yet available to support these findings. Where possible, the patient's partner was questioned as well. Comparison of the results of the interviews with the physical therapist and the urologist revealed that 2 patients gave different answers on 2 different occasions.

The results of the physical therapist intervention are encouraging, but they are not the same for each group of patients with erectile dysfunction due to the different etiologies. For example, none of the 9 patients with impotence due to a psychological basis fully recovered after the physical therapist intervention. Four of them discontinued the therapy. These findings suggest to us that the interventions we used have a more physiological effect than a psychological effect. The best results we achieved were in the group of patients with impotence due to venous-occlusive dysfunction. Alterations in the flow of blood to and from the penis are thought to be the most frequent causes of erectile dysfunction.<sup>14</sup>

A physiologic explanation for the effect of our interventions is that physical therapy can contribute to the improvement of erectile dysfunction by decreasing venous outflow. Contraction of the pelvic-floor muscles results in a higher pressure at the base of the penis. Age, duration of the erectile dysfunction, and other sexual problems or other causes of erectile dysfunction had no influence on the results of the therapy. We can only compare these findings with those of Colpi et al,<sup>27</sup> who found that age was not a determining factor for success of therapy.

Another issue is the accuracy of our diagnoses. We began our study by taking a careful history, including questions about the patients' medical, sexual, and psychosocial status. This history was complemented by a physical examination.<sup>21</sup> This initial examination, we believe, is the cornerstone for all men with erectile dysfunction. Lack of libido may easily be overlooked in assessing the cause of impotence.<sup>1</sup> It is uncommon to diagnose neurogenic impotence in patients without a known neurological disorder.<sup>1,17</sup> More specific examinations consist of laboratory tests, vascular testing, and nocturnal penile tumescence testing. Laboratory tests for glucose and lipid profile and a morning testosterone assay can exclude risk factors for erectile dysfunction such as diabetes mellitus, hyperlipidemia, or a low positive yield. Several tests are available for evaluating the penile vascular inflow and venous occlusion. Indications for vascular testing are the selection of patients for penile vascular surgery and testing for the proper dose of drugs for injection therapy. Doppler testing is done to confirm the diagnosis of arteriogenic impotence. A good erection within 10 minutes with sustained rigidity for 30 minutes or longer after intracorporal injection of papaverine or prostaglandin suggests normal arterial and

venous circulation to the penis.<sup>1,2</sup> Nocturnal penile tumescence is a method of studying erections during sleep. In men without erectile dysfunction, 3 to 5 erections per night lasting up to 30 minutes may occur during sleep.<sup>12</sup> The Rigiscan system<sup>†</sup> can be used to record penile circumference and rigidity.<sup>1</sup> Nocturnal penile tumescence is a valuable tool differentiating between psychological and organic impotence.<sup>1,12,13</sup> The vast majority of cases of erectile dysfunction are primarily of organic and vascular origin, but psychological factors play an important role in many cases.<sup>14</sup>

The number of men needing treatment for erectile dysfunction is increasing. The treatment options continue to expand, with more attractive alternatives.<sup>22</sup> Jardin et al<sup>1</sup> contend that medical interventions, physical therapist interventions such as those we used, vacuum devices, intracavernous injections of vasoactive agents, venous surgery and implants of penile prostheses, and psychotherapy need to be considered as therapeutic options. The choice of which intervention to use should take into account the patient's acceptance of the treatment modality, cost, and side effects. The best results, in our opinion, appear to occur with medication. Reports of the new orally administered drug, sildenafil, are encouraging. The oral agent is effective and well tolerated in 65% to 85% of men with erectile dysfunction of all causes.

Success rates for penile prostheses vary from 81% to 90%, but the long-term experience has been disappointing.<sup>1</sup> The therapy is costly and can result in complications. Complications are postoperative pain, infection, and erosion, resulting in the need to remove the prosthesis. We contend that use of a penile prosthesis remains the treatment of last resort. Use of vacuum constriction devices is a safe, noninvasive method that is available for almost every patient with impotence. By placing an external cylinder over the penis, the patient can create a vacuum by pumping out the air. A retaining ring fixed around the base of the penis is used to avoid reflux and maintain the erection. This constricting ring cannot be applied for any longer than 30 minutes; otherwise, the penis becomes cold, and the erection becomes painful. Vacuum devices, although not in widespread use, have the advantages that they are reusable and therefore less expensive than penile prostheses. Satisfaction rates vary from 27% to 68% in the short term to 69% in 2-year follow-ups.<sup>1,16,17</sup> The reasons for dissatisfaction are inability to maintain an erection, pain, low penile temperature, and appearance.<sup>1,16,17</sup> In the long term, between 11% and 66% of patients with erectile dysfunction find self-injection unacceptable. More than

80% to 90% of men are satisfied with intracavernous injection therapy, once they have decided to continue this treatment modality.<sup>1,18,19</sup> Vascular surgery is contemplated only for young patients with pelvic trauma.<sup>22</sup> Researchers have compared physical therapist intervention with venous surgery.<sup>26</sup> The initial success rate of both treatments was the same, but the long-term results of physical therapy were more favorable.<sup>26</sup>

Psychotherapy may be the intervention of choice for the patient with primarily nonorganic erectile dysfunction, such as that caused by depression. Psychotherapy can be valuable as an addition to medical or surgical interventions. Unfortunately, there are very few follow-up studies examining the long-term effect of this intervention.<sup>9</sup> Withdrawal from psychotherapy is common. Treatment of erectile dysfunction with interventions used by physical therapists for a well-selected group of patients compares favorably with many other options. The lack of a placebo control group and random allocation of patients to groups in our study and in other trials using these approaches limit the usefulness of the results.<sup>31,32</sup> Stief et al<sup>28</sup> used a control group, but there was no random allocation of patients to groups.

Starting therapy with the least invasive option seems a logical strategy. Pelvic-floor exercises do not involve any risks, and they are painless. The dropout rate is less than for other interventions and treatment modalities. If treatment is successful, the erection is spontaneous, and this in contrast to injection therapy and use of a vacuum pump or penile prosthesis. The cost of the therapy is low, but the patient needs to be motivated to perform the exercises 90 times daily at home for a period of 4 months. We believe our results indicate the need for further investigation. Randomized controlled trials are needed to define the efficacy of physical therapy in the treatment of erectile dysfunction.

## Conclusion

Comparing the results of a protocol that can be administered by a physical therapist reported here with other interventions shows that a pelvic-floor muscle program is a possible noninvasive alternative to treat patients with erectile dysfunction caused by venous occlusion.

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<sup>†</sup> Information on the Rigiscan system is available at: [www.timmmedical.com/Rigiscan](http://www.timmmedical.com/Rigiscan).

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