THE ROLE OF ELECTRO-DIAGNOSIS AND THERAPY IN MANAGEMENT OF FECAL INCONTINENCE SECONDARY TO ANORECTAL CONGENITAL ANOMALIES

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KEY WORDS: MANAGEMENT OF ANORECTAL CONGENITAL ANOMALIES, ELECTRODIAGNOSIS, ELECTROTHERAPY.

ABSTRACT

Objectives: To assess the diagnostic and prognostic role of electromyography (EMG) of the external anal sphincter and pelvic floor muscles in children born with anorectal anomalies. Also, we tried to assess the role of electric stimulation to the sphincter muscles when applied pre and/or postoperatively in the control of fecal incontinence in those children.

Methods: Eighty children with congenital anorectal anomalies and ten normal children who served as a control group were enrolled to the study. All were subjected to EMG assessment of the puborectalis (PR), external anal sphincter (EAS) & levator ani (LA).

Accordingly patients were divided into: Group I: Patients with normal EMG subjected to surgery, (posterior sagittal anorectoplasty) and EMG assessment after surgery. Group II: Patients with reduced electric activity of EMG. They were subjected to pre and postoperative electric stimulation and EMG before and after electric stimulation with postoperative EMG assessment. Group III: Patients with reduced EMG; they were operated with no electric stimulation with post-op. EMG assessment. Group IV: Patients with post operative fecal incontinence before being included in the study they were subjected to electric stimulation and post electric stimulation EMG assessment.
**Results:** EMG- showed a reduced value of the mean amplitude/turn (M) & number of turns/sec (T) value in the clinically weak muscles. M value was a more sensitive EMG parameter than T value in assessment of sphincter muscle activity. Electrophysiological stimulation showed significant clinical & EMG improvement in the studied groups in the PR, EAS & LA muscles.

**Conclusion:** EMG can be a good diagnostic and prognostic measure in the assessment of EA, PR & LA muscles. Electric stimulation had a valuable role in strengthening the sphincteric muscles before & after correction, especially if combined, and in the conservative management of older incontinent children.

**INTRODUCTION**

Malformations of the anorectum are relatively common congenital anomalies 1 in 3500 – 5000 live births (Grosfeld, 1991). As development of the neuromuscular structures, essential to fecal continence, parallels the embryologic development of the rectum and anus, many patients with congenital anorectal anomalies have problems with continence (Templeton and O’Neill 1986).

There is a great variability in the presence of striated muscle from patient to patient. Some patients have weak musculature, whereas some have nearly normal muscles (Grosfeld, 1991).


<table>
<thead>
<tr>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td></td>
</tr>
<tr>
<td>- Anorectal agenesis</td>
<td>- Anorectal agenesis</td>
</tr>
<tr>
<td>a) with rectovaginal fistula</td>
<td>a) with rectoprostatic urethral</td>
</tr>
<tr>
<td>b) without fistula</td>
<td>fistula</td>
</tr>
<tr>
<td>- Rectal atresia</td>
<td>b) without fistula</td>
</tr>
<tr>
<td><strong>Intermediate</strong></td>
<td></td>
</tr>
<tr>
<td>- Rectovesibular fistula</td>
<td>- Rectobulbar urethral fistula</td>
</tr>
<tr>
<td>- Rectovaginal fistula</td>
<td>- Anal agenesis without fistula</td>
</tr>
<tr>
<td>- Anal agenesis without fistula</td>
<td></td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td></td>
</tr>
<tr>
<td>- Anovesibular fistula.</td>
<td>- Anocutaneous fistula</td>
</tr>
<tr>
<td>- Anocutaneous fistula</td>
<td>- Anal stenosis</td>
</tr>
<tr>
<td>- Anal stenosis</td>
<td></td>
</tr>
<tr>
<td>- Cloacal malformations</td>
<td>- Rare malformations</td>
</tr>
<tr>
<td>Rare malformations</td>
<td>- Rare malformations</td>
</tr>
</tbody>
</table>
In normal individuals, the muscles of the anal canal can be regarded as forming “a tube within a funnel” (McMinn, 1994). The sides of the upper part of the funnel are the levator ani (LA) muscles, and the stem of the funnel is the external anal sphincter (EAS), which is continuous with the levator ani and there is no way to determine the limit between both structures. So, the term “muscle complex” has been used for the intermediate undetermined portion of the muscle between the levator ani and the external sphincter (Pena, 1988a). The tube inside the stem of the funnel is the internal anal sphincter, and internally lays the submucosa and mucous membrane (McMinn, 1994).

In children with anorectal anomalies, the funnel-like striated muscle mechanism is always present and can be identified during an operation. This funnel – muscle structure may show different degrees of development. Sometimes a very prominent musculature is visible and the strength of its contraction when electrically stimulated may be very similar to that seen in normal individuals when surgically explored for other reasons. At other times it may be found as a rather rudimentary structure that shows very weak contractions. Fortunately, it is more frequent to find “good” muscles than “poor” muscles while operating on children with anorectal malformations.

The importance of electromyography (EMG) in the physiological assessment of patients with anorectal anomalies has been stressed by many authors (Taylor et al., 1973). EMG sphincter muscle mapping can accurately determine the site and activity of the external anal sphincter muscle and locate the central muscle complex to house the anoplasty (Schouten & Gordon, 1992).

On muscle contraction, the force developed by the muscle is graduated on the one hand by the firing rate and, on the other, by the number of recruited motor units (Ludin, 1980). So, on voluntary or reflex contraction of the sphincter muscles, there is increased rate of firing of the basal tonic low-threshold motor units followed by recruitment of phasic high-threshold motor units of much larger amplitude up to 2 mv. So, on maximal voluntary contraction of the sphincter muscles the amplitude of the interference pattern (IP) is much increased because of superimposition of the motor unit action potentials (MUAPs) and recruitment of high-threshold motor units of large amplitude (Fowler, 1991).

Different techniques for automatic electromyographic analysis are available. One method for the quantitation of the IP was published by Wilson (1964) and Rose and Williston (1967). They measured the number of turns (Potential changes of more than 100 microvolt and of opposite sign) per second of the signal (T) and the total amplitude per second (A).
This technique was modified by Stalberg and Antoni (1981) where another parameter, which designated the mean amplitude per turn (M), was derived. The values of T and M depend on the force at which IP signals are recorded (Nandedkar et al., 1991). There is a positive correlation between T and M, but at higher degrees of muscle activity, the M usually tends to increase relatively more than the T (Stalberg et al., 1983). The T and M recorded in a given site increase linearly with effort up to 30-50% of maximum force and with greater effort the T remains unaltered or decreases while the mean amplitude continues to rise (Fuglsang-Frederiksen & Manson, 1975). T and M correlate well with force and with each other when the force is controlled in one individual.

Since the early 60s electrical stimulation of the pelvic floor has been used as a treatment for various types of urinary incontinence (Zollener-Nielsen & Samuelsson, 1992) and for fecal incontinence (Binnie et al., 1990).

Transanal electrostimulation is accepted by the patient and is followed by positive emotional response and improvement in the striated sphincter function. Interferential therapy has been used extensively in the treatment of stress incontinence by placing the electrodes on the lower abdomen and inner thigh to produce a good strong contraction of the pelvic floor (Forster & Palastanga, 1988 and Pescatori et al., 1991). Muscle stimulation can be done using either low-frequency or medium-frequency electrical currents.

Low-frequency electrical currents are interrupted (intermittent) direct currents of different durations and frequencies. A considerable range of such currents is available and the duration of the current used ranges from 0.01 milliseconds to 3 seconds.

Medium-frequency electrical currents: The most frequently used form of medium-frequency currents is the interferential therapy. In this form of therapy, two medium-frequency currents of different frequencies are applied so as to cross in the patient’s tissues. Where the two currents cross, an interferential effect of a frequency equal to the difference in frequency between the two currents is produced.

**Aim of Work:**

So, the aim of this work was to assess the diagnostic and prognostic role of EMG of the external anal sphincter and pelvic floor muscles in children born with anorectal anomalies. Also, to assess the role of electrical stimulation to the sphincter muscles when applied pre and/or post-operatively in the control of fecal incontinence in those children.
MATERIAL AND METHODS

This study included 80 patients selected from the Rheumatology & Rehabilitation and Pediatric Surgery Departments at Ain Shams University Hospitals. All patients were children born with congenital anorectal anomalies.

Ten age and sex matched healthy children with no congenital anomaly, normal external anal sphincter (EAS), puborectalis (PR) and levator ani (LA) muscle, served as a control group. Standards for EMG values of EAS, PR and LA muscles were obtained by studying this control group.

On their first visit, all patients were subjected to thorough clinical assessment followed by EMG assessment of the EAS, PR and LA muscles. According to the clinical evaluation and EMG assessment the patients were divided into 4 groups:

Group I: Included 20 children with uncorrected congenital anorectal anomalies with normal EMG assessment of EAS, PR and LA muscles. This group was subjected to surgical correction in the form of posterior sagittal anorectoplasty (PSARP) operation. After surgery another clinical and EMG assessment was performed. Children who showed clinical weakness and/or reduced electrical activity of one or more of the three examined muscles were subjected to a post operative (Post-op) course of electrical stimulation (ES). Final clinical and EMG assessment were done after the ES.

Group II: Included another 20 children with uncorrected congenital anorectal anomalies who had reduced electrical activity of the EAS, PR and/or LA muscles on their 1st EMG assessment. They were subjected to a pre and post-op. ES with pre, post-op. and post ES clinical & EMG assessment.

Group III: Included another 20 children with uncorrected congenital anorectal anomalies who had reduced electrical activity of the EAS, PR and/or LA muscles on their 1st EMG assessment. They were operated upon without prior ES. They were subjected to post-op and post ES clinical & EMG assessment.

Group IV: Included 20 children who had undergone surgical correction before being included in this study and presented with post-op. fecal incontinence, they were subjected to ES with Post-ES clinical & EMG assessment.

Clinical assessment of the patients included full history taking with particular emphasis on the type of incontinence (gas, liquid stool, or solid
The criteria used for grading of continence were modified from Kiesewetter (Smith et al., 1978). Grading of continence could not be done before 3 years so it was done only in old children of group IV who had undergone surgical correction in the past.

**Good:** Soiling is absent or very rare (i.e. no soiling with solid stool or soiling with liquid stool once per day).

**Fair:** Soiling is occasional to frequent particularly with liquid stool i.e., soiling with solid stool 1-2 times/day or with liquid stool 2-3 times / day.

**Poor:** Constant soiling (i.e., soiling with solid stool 3 times or more/day or soiling with liquid stool 4 times or more/day).

Perianal inspection to obtain a clinical evidence of the type of the anomaly. Digital rectal examination (in reconstructed anus) to assess the resting tone and the maximum voluntary contraction that can be achieved in the sphincteric muscles. This rectal examination could only be done postoperatively after surgical reconstruction of the anus; the muscle power was graded on 0-3 scale: 1) Normal power, 2) Mild weakness, 3) Moderate weakness 4) Severe weakness.

EMG assessment of the EAS, PR and LA muscle was done using a Dantic key point™ made by Dantec of Denmark, using autoclavable concentric needle electrodes. A large ribbon-like surface electrode wrapped around the thigh was used as a grounding one. A filtering bond width of 20 Hz to 10 KHz was used. The sensitivity gain was 200 μv and the analysis time was 200 ms.

**Technique:**

The patient was placed in the left lateral position and the recording needle electrode was inserted into the muscle as follows:

**a- External anal sphincter:** The needle was inserted approximately 0.5 cm lateral to the anal orifice and about 0.5-1 cm deep (if the anus was present). The position of the needle was adjusted according to the amplitude of the response obtained and the audio output of the EMG machine (Fowler, 1991). If the anus was absent or in abnormal site, the position of the EAS was determined by using electric stimulation using a low-frequency current applied through a pencil electrode to induce visible or palpable contraction (Grosfeld, 1991).

**b- Puborectalis:** The needle was either inserted posterior to the anal verge and advanced paralleled to the anal canal [with the position of the tip of the needle controlled with a finger hooked into the rectum if possible (Snooks et al., 1985) until its tip was about 2.5-3 cm deep to the skin. Motor
unit activity was recorded during needle advancement but there was a silent area before the tip entered a second active striated muscle, puborectalis (Bartolo et al., 1983). If the anus was absent or in abnormal position, the needle was inserted posterior to the site of the EAS (as determined by electrical stimulation) and at an angle of 45° and advanced until its tip is about 2.5-3.5 cm from the skin (Schouten & Gordon, 1992).

c- Levator ani: The needle is inserted about 1.5-2.5 cm lateral to the anal orifice and about 3-6 cm deep. The position of the needle was adjusted according to the amplitude of the response obtained and the audio output of the EMG machine.

In each muscle, the number of turns per second ($T$) and mean amplitude per turn ($M$) of the interference pattern was recorded. The mean of the $T$ and $M$ values recorded during ten trials of maximal voluntary contraction of that muscle (Stalbeg et al., 1983).

Electrical Stimulation Of The EAS, PR And LA Muscles:

The electrical stimulation (ES) was done by using both of low-frequency and medium-frequency electrical stimulation.

Both low-frequency and medium-frequency ES was done in the same session. The duration of each session was 20 minutes with each type of ES applied for ten minutes. Three sessions were done weekly for four weeks (Zollener Nielsen & Samuelsson, 1992).

Low-Frequency Electrical Stimulation Technique:

This ES was done using Dynatron 438 apparatus. The patient was placed in the left lateral position with the left lower limb extended and the right lower limb semiflexed. The area of stimulation was washed with warm saline and any abrasions were protected by a little jelly covered with a small piece of non-absorbent cotton wool (Forster & Palastanga, 1988). The active pencil electrode was slightly introduced inside the anus (if present) or applied to the site of the EAS muscle which was determined by observing and/or palpating its contraction. The indifferent rubber electrode was applied to the inner aspect of the upper part of the left thigh.

ES was done using rectangular impulses of 0.2 ms duration. The highest possible current strength (just bearable) was used with the impulse frequency of 10 Hz (Williams et al., 1991).

Medium-Frequency Electrical Stimulation (Interferential Therapy) Technique:

The apparatus used was an Endomed 433. The patient was placed in the supine position. The area of stimulation was washed with warm saline
and any abrasions were protected as in low-frequency electrical stimulation. The four electrodes were applied over the lower abdomen and inner thighs (*posterior to the anus site as much as possible*). The two electrodes of each circuit were placed diagonally opposite one another in such a way that the interference effect is produced about the anus (*Forster and Palastanga, 1988*).

The two circuits were adjusted to obtain a low-frequency effect (*AMF*) of 20 Hz. The base frequency of the first circuit was 4000 Hz with the frequency of the second circuit was 4020 Hz. A spectrum of 30 Hz used. So, the apparatus was adjusted to provide a low-frequency effect with a frequency ranging to and fro 20 and 50 Hz (*Basford, 1990*).

**RESULTS**

Eighty patients were included in this study 42 (52.5%) were males and 38 (47.5%) were females. Their age ranged from 0.4- 11.8 y (*mean 2.3±3.0*) years. The anomaly was low in 25%, intermediate in 56% and high in 19%. The control group was matched in age and sex. A non-significant difference was found in the EMG findings of males and females.

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Mean of T ± SD/ μV</th>
<th>Mean of M ± SD/ μV</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAS</td>
<td>227±28.4</td>
<td>438.7±56.6</td>
</tr>
<tr>
<td>PR</td>
<td>307.4±45.7</td>
<td>458.1±56.5</td>
</tr>
<tr>
<td>LA</td>
<td>303.6±28.3</td>
<td>457.8±48.3</td>
</tr>
</tbody>
</table>

**Group (I):** Included 20 children with uncorrected congenital anorectal anomalies. They were 12 (60%) males and eight (40%) females, their age ranged from 0.4- 1.3 years. All had low anorectal anomalies. There were non significant difference between EMG finding of group I & control group preoperatively. After operation 10 children showed normal EAS, PR & LA muscles clinically and EMG finding. A non significant difference of their EMG finding and control group. 10 children showed clinical weakness and/or reduced electrical activity of T and/or M values of one or more of the 3 examined muscles. Comparison between 1st and post-op. EMG showed that T values showed non significant decrease (*p > 0.05*) in the 3 muscles, while M values showed significant decrease in EAS and PR muscles (*p < 0.05*).

All were subjected to electrical stimulation, eight out of ten weak EAS muscle (80%), six out of eight weak PR muscles (75%) and four out of six weak LA muscles (67%) showed improvement to good contraction.
Clinical improvement was accompanied by T & M value significant increase ($p < 0.05$) in the three muscles.

Table (3): Comparison between postoperative EMG and Post-electric stimulation EMG of group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Muscle</th>
<th>Postoperative EMG (mean ±SD/μV)</th>
<th>Postelectric stimulation EMG (mean ±SD/μV)</th>
<th>t</th>
<th>p</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>EAS</td>
<td>248.2±30</td>
<td>262.8±30</td>
<td>2.86</td>
<td>&lt;0.05</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>280.0±75.6</td>
<td>293.5±56.6</td>
<td>1.23</td>
<td>&gt;0.05</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>281.8±615</td>
<td>327.3±37.3</td>
<td>4.49</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td>M</td>
<td>EAS</td>
<td>315.3±34.3</td>
<td>364.5±49.0</td>
<td>6.47</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>334.2±51.2</td>
<td>394.6±59.0</td>
<td>11.11</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>335.0±58.7</td>
<td>410.9±70.6</td>
<td>10.29</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
</tbody>
</table>

Group (II): They were nine (45%) males & eleven females (55%), their age ranged from 0.5-1.8 years (mean 0.9±0.5), 16 children (80%) had intermediate anorectal anomalies without sacral agenesis and four (20%) had high anomalies with sacral agenesis. There were non-significant differences between EMG of those patients with high and intermediate anomalies.

All patients received electrical stimulation preoperatively. After surgery, all children had clinical weakness and reduced electrical activity of the EAS muscles. PR showed weakness and reduced activity in 90%. LA showed clinical weakness in all patients and reduced activity in 90%

Table (4): Compression between the 1st, 2nd post electrical stimulation EMG finding and 3rd postoperative EMG finding of group II.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Muscle</th>
<th>1st EMG (mean±SD) μV</th>
<th>2nd EMG (mean±SD) μV</th>
<th>p</th>
<th>Sig.</th>
<th>3rd EMG (mean±SD) μV</th>
<th>p</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>EAS</td>
<td>217.3±52.5</td>
<td>220.9±27.7</td>
<td>&lt;0.05</td>
<td>S</td>
<td>217.1±57.9</td>
<td>&gt;0.05</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>213.4±32.4</td>
<td>220.9±31.9</td>
<td>&gt;0.05</td>
<td>NS</td>
<td>208.2±44.4</td>
<td>&gt;0.05</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>212.2±55.5</td>
<td>238.5±61.8</td>
<td>&lt;0.001</td>
<td>HS</td>
<td>202.3±55.6</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td>M</td>
<td>EAS</td>
<td>235.0±88.0</td>
<td>269.5±70.7</td>
<td>&lt;0.001</td>
<td>HS</td>
<td>227.0±72.9</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>280.4±90.9</td>
<td>328.5±77.9</td>
<td>&lt;0.001</td>
<td>HS</td>
<td>284.1±82.7</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>247.9±84.2</td>
<td>329.2±81.1</td>
<td>&lt;0.001</td>
<td>HS</td>
<td>272.5±91.7</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
</tbody>
</table>
After surgery all patients in group II received a course of ES for four weeks. There was improvement in the power of EAS (80%), LA (70%) and PR (67%) following the post-operative course of ES.

Table (5): Comparison between the 3rd pre-electric stimulation and 4th post-electric stimulation EMG findings of group II.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Muscle</th>
<th>3rd EMG (mean±SD) μV</th>
<th>4th EMG (mean±SD) μV</th>
<th>p</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>EAS</td>
<td>217.1±57.9</td>
<td>231.2±38.4</td>
<td>&gt;0.05</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>208.2±44.4</td>
<td>224.6±34.0</td>
<td>&lt;0.05</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>202.3±55.6</td>
<td>232.1±41.9</td>
<td>&lt;0.05</td>
<td>S</td>
</tr>
<tr>
<td>M</td>
<td>EAS</td>
<td>227.0±72.9</td>
<td>285.8±66.8</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>284.1±82.7</td>
<td>345.4±94.7</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>272.5±91.7</td>
<td>339.3±97.1</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
</tbody>
</table>

**Group (III):** There were nine males (45%) and 11 females (55%). Their age ranged from 0.4 to 2 years. Sixteen children had intermediate anomalies (80%) and four children (20%) had high anomalies. Two of the children who had high anomalies, had sacral agenesis. Comparison between EMG findings of patients with intermediate anomalies and those with high anomalies showed non-significant differences (p>0.05) as regard the T value of the three muscles and M values of the EAS and LA muscles. On the other hand, for the M value of EAS muscles there was a significant increase (p<0.05) in patients who had intermediate anomalies.

Table (6): Comparison between 1st preoperative, 2nd postoperative and between 3rd post electric stimulation EMG finding of group III.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Muscle</th>
<th>1st EMG (mean±SD) μV</th>
<th>2nd EMG (mean±SD) μV</th>
<th>p</th>
<th>Sig.</th>
<th>3rd EMG (mean±SD) μV</th>
<th>p</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>EAS</td>
<td>225.0±48.4</td>
<td>201.3±50.6</td>
<td>&lt;0.001</td>
<td>HS</td>
<td>249.0±51.3</td>
<td>&lt;0.05</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>215.5±42.4</td>
<td>213.6±33.2</td>
<td>&gt;0.05</td>
<td>NS</td>
<td>221.2±35.6</td>
<td>&lt;0.05</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>222.3±48.0</td>
<td>192.5±55.0</td>
<td>&lt;0.05</td>
<td>S</td>
<td>243.4±65.4</td>
<td>&lt;0.05</td>
<td>S</td>
</tr>
<tr>
<td>M</td>
<td>EAS</td>
<td>223.7±82.8</td>
<td>182.1±62.1</td>
<td>&lt;0.001</td>
<td>HS</td>
<td>240.2±59.9</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>255.9±85.7</td>
<td>220.1±72.9</td>
<td>&lt;0.001</td>
<td>HS</td>
<td>267.9±66.9</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>273.3±92.9</td>
<td>223.9±76.0</td>
<td>&lt;0.001</td>
<td>HS</td>
<td>279.7±70.1</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
</tbody>
</table>

All patients had clinical weakness and reduced electrical activity of EAS, PR and LA muscles after surgery. All patients of group III received a
course of ES for four weeks period after that PR examination showed significant improvement in the three muscles.

Comparison between the clinically improved and unimproved patients as regards the post EST value showed a non-significant difference in the three muscles ($p > 0.05$) while the M value showed significant increase in the EAS.

Comparison between the EMG of group II with pre-op. ES & group III without pre-op. ES showed non significant difference in the T value in the 3 muscles ($p < 0.05$) while the M value showed significant increase in the three muscles of group II (table 7).

Table (7): Comparison between EMG of groups II and III.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Muscle</th>
<th>Group II (mean±SD) μV</th>
<th>Group III (mean±SD) μV</th>
<th>p</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>EAS</td>
<td>231.2±38.4</td>
<td>249.0±51.3</td>
<td>&gt;0.05</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>224.6±34.0</td>
<td>221.2±35.6</td>
<td>&gt;0.05</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>232.1±41.9</td>
<td>243.4±65.4</td>
<td>&gt;0.05</td>
<td>NS</td>
</tr>
<tr>
<td>M</td>
<td>EAS</td>
<td>285.8±66.8</td>
<td>240.2±59.6</td>
<td>&gt;0.05</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>345.9±94.7</td>
<td>267.9±66.9</td>
<td>&gt;0.05</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>339.3±97.1</td>
<td>279.7±70.1</td>
<td>&lt;0.05</td>
<td>S</td>
</tr>
</tbody>
</table>

**Group (IV):** They were twelve (60%) males and eight (40%) females. Their age ranged from 0.7 to 11.8 years. Thirteen (65%) had intermediate anomalies and seven (35%) had high anomalies. Five of them had sacral agenesis as well. Eight children had fair continence, ten showed poor continence and two were less than three years.

Table (8): Comparison between the 1st and 2nd post-electric stimulation EMG findings of group IV.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Muscle</th>
<th>1st EMG (mean±SD) μV</th>
<th>2nd EMG (mean±SD) μV</th>
<th>p</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>EAS</td>
<td>217.9±47.6</td>
<td>235.8±75.6</td>
<td>&gt;0.05</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>238.7±59.6</td>
<td>248.3±73.3</td>
<td>&lt;0.05</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>197.8±55.3</td>
<td>246.5±68.3</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td>M</td>
<td>EAS</td>
<td>175.8±81.2</td>
<td>227.8±91.0</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>204.4±68.8</td>
<td>262.1±85.7</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>195.5±79.0</td>
<td>244.4±80.6</td>
<td>&lt;0.001</td>
<td>HS</td>
</tr>
</tbody>
</table>
A non-significant difference \((p>0.05)\) was found in the T value between patients with high and those with intermediate anomalies and in patients with and without sacral agenesis both in pre- and post- ES EMG. The M value showed a significant increase \((p<0.05)\) in the three muscles of patients with intermediate anomalies and patients without sacral agenesis in the pre ES EMG. The three muscles showed significant \((p<0.05)\) clinical improvement in the grade of continence and a highly significant improvement in P/R examination in the three muscles \((p<0.001)\) after ES.

**DISCUSSION**

Many patients with congenital anal malformation have problems with continence. The posterior sagittal anorectoplasty (PSARP) is the most popular operation employed for surgical management of all these anomalies (Grosfeld, 1991 and Skandelakis et al., 1994). Since the clinical assessment of the sphincter muscles by P/R examination cannot be done in these children before surgical repair of the congenital anomaly because of the absence of normal anus, many authors have stressed the importance of EMG in the physiological assessment of their sphincter muscles. EMG can determine the site and activity of the sphincter muscle to locate the site of anoplasty and can be done as a prognostic indicator of potential sphincter function.

Many investigators have studied the role of electric stimulation in the control of fecal incontinence. So, the aim of our study was to assess the diagnostic and prognostic role of EMG in the assessment of sphincter muscles and to assess the effect of electric stimulation on sphincter muscle as well as to assess if it is better to electrically stimulate the muscle both pre and post operatively or that postoperative ES alone is enough.

Eighty patients born with congenital anorectal anomalies were included in this study besides ten age and sex matched controls.

**Group (I):** After operation, the T value of the EAS, PR and LA muscles showed a non-significant decrease \((p<0.05)\) while the M value showed a significant decrease in EAS & PR muscles \((p<0.05)\). This result is in agreement with that of Neill et al. (1981) who stressed the importance of electrophysiological tests in recognizing the activity of the sphincter musculature in most patients with fecal incontinence. Also, Pena (1988 b) stated that EMG is an objective method of estimating the sphincter function. Again, the nature and extent of incontinence can be assessed by sphincter EMG (Williams et al., 1991).

Post ES EMG showed a highly significant increase \((p<0.001)\) in the M value of the three muscles. So, this may imply that the better the preoperative muscle activity, the better the postoperative & post EA results,
which imply that EMG can be done as a prognostic indicator of potential sphincter function. This in agreement with Grosfeld (1991).

The valuable role of EMG in the assessment of function of the sphincter can be explained by its validity in the estimation of the number of functioning MUAPs in the muscle during its contraction (Wiechers & Johson, 1990). The force developed by a muscle is graduated on the one hand by firing the rate and on the other hand by the number of recruited motor units (Ludin, 1980). So, on voluntary contraction of the sphincter muscle there is an increased rate of firing of the basal tonic low threshold motor units followed by recruitment of phasic high threshold motor units of much larger amplitude (Fowler, 1991). So when examining the EMG pattern at maximal voluntary contraction, the relation between the recorded electrical activity and strength can be assessed (Ludin, 1980).

Our results showed that the M value was a more sensitive EMG parameter than the T value in the assessment of the activity of the examined muscles. There is general agreement that the T & M values increase linearly with effort up to 30-50 of the maximum force. Meanwhile with greater effort, the T value remains unaltered or decreased while the M value continues to rise (Fuglsang-Frederiksen Masson, 1975 and Stalberg et al., 1983). This explains and agrees with our result that the M value is more sensitive than T value in assessment of muscle activity.

In our study we used a postoperative course of electrical stimulation for duration of four weeks and we tried to assess the effect of this ES on the sphincter as a valuable way of overcoming the problem of postoperative weakness. The clinical and EMG assessment showed improvement in the power of contraction in 80% of EAS, 75% in PR and 67% in LA muscles.

Comparison between the clinically improved and unimproved patients regarding the post-ES change in T and M values showed a significant increase in the T and/or M values (p<0.05) in the clinically improved patients. The clinical improvement of the three muscles was associated with improvement in their electrical activity T and/or M values, in agreement with Farouk et al. (1992).

This can indicate that EMG can be done as a prognostic indicator of the potential sphincter function, and that the better preoperative assessment of the sphincters and levator muscle is vitally important for future continence. This is in agreement with Smith et al. (1978) and Grosfeld, 1991).

Electric stimulation has good effects on the pelvic floor muscles. This improvement in the function of the sphincter muscles may be attributed to improvement of muscle blood circulation and improvement of muscle
tone as a toning effect. It can also be attributed to restoration of the
sensations of muscle tension and activation of the proprioceptive receptors,
which activate the local spinal reflex arc and help tightening of the
puborectalis portion of the pelvic floor to persist following a PSARP (Binnie
et al., 1990 and Williams et al., 1990). Again it might also increase muscle
strength which can be explained by several theories:

a) Electric stimulation improves muscle strength in the same
mechanism as active exercise by increasing the muscle functional load
(Delitto & Snyder-Mackler, 1990).

b) Electrical stimulation of the partially developed muscle results in
hypertrophy of the remaining innervated muscle fibers giving the muscle an
enhanced activity and thus perhaps making the patients more aware of its
contraction (Binnie et al., 1990 and Abdel Moty, et al., 1994).

c) Electric stimulation changes the contractile properties of
denervated muscles which are claimed to have abnormal contractile
properties and impaired excitation contraction coupling (Milner- Brown &
Miller 1989 and Abdel Moty et al., 1994).

d) Electric stimulation promotes a change in muscle fiber
composition. During normal muscle contractions low twitch motor units
(Type I skeletal muscle fibers) are recruited first followed by the fast-twitch
motor units (with type II skeletal muscle fibers) as the force demand
increases (Sinacore et al., 1990). Muscle denervation may lead to atrophy of
type I population (Herbinson et al., 1981) and conversion to a type II
population (Edstrom & Grimby, 1986). The preferential activation of type II
muscle fibers and their possible transformation to type I could be a potential
explanation for the strengthening effect of electrical stimulation (Abdel
Moty et al., 1994).

e) Electrical stimulation allows the muscle to over-ride the reflex
inhibition caused by painful conditions (Abdel Moty et al., 1994).

f) Reinnervation of denervated muscle fibers (Binnie et al., 1990).

In our study, we used both low and medium frequency electric
currents for the ES This combination may have the advantage that low
frequency current can stimulate the voluntary muscle while the medium
frequency current can stimulate both voluntary and smooth muscle fibers. In
addition medium frequency current cause little sensory irritation of the skin,
so high current intensity can be used to maximally stimulate the deeply
placed muscle with little discomfort for young children (Forster &
Palastanga, 1988).

**Group (II):** There was a significant increase in the electrical activity
of the three muscles after each of the pre and postoperative course of ES.
This improvement in electrical activity was associated with significant clinical improvement in the three muscles.

There was a significant positive to a highly significant improvement in the EMG findings before and after each of the pre and postoperative courses of ES specially in the M value. Results of group II showed that the combined pre and postoperative ES had a good effect on the three examined muscles but less in EAS. The pre operative ES improves the muscles that eventually improve the postoperative as well as the final results following the postoperative course of ES.

**Group (III):** To ascertain the role of preoperative ES, we examined another matched group of patients who were operated upon without pre-operative ES. All patients had postoperative weakness and reduced electric activity of the three muscles, after operation. ES was done and comparison between groups II and III was done to determine whether combined pre and postoperative ES has better effect than the postoperative ES alone. Group II showed significantly better preoperative and postoperative EMG results than patient of group III in the M value ($p<0.05$). These results might be due to preoperative ES improvement of muscle activity in group II before being operated upon. This may imply that combined pre and postoperative ES has a better result than the postoperative alone.

**Group (IV):** we studied this group to ascertain the role of ES as a conservative line of treatment of incontinence after surgical correction as many children who had undergone surgical correction of anorectal anomalies in the past still complained of fecal incontinence and have weak sphincter muscle. This study showed that there was a significant clinical and EMG improvement after ES It emphasizes the results of the previous three groups.

**Conclusions:**

Our study showed that the M value was a more sensitive EMG parameter than the T value in the assessment of sphincter muscles activity. EMG can be a good diagnostic and prognostic measure in the assessment of the EAS, PR and LA muscles in the children born with congenital anorectal anomalies. Also ES had a valuable role in strengthening the sphincter muscles of those children before and after operative correction and in conservative management of older incontinent children where no operative measure can help. Also, combined pre and post operative ES is recommended than the postoperative ES alone.
REFERENCES


دور التشخيص والعلاج الكهربائي في علاج السلس الشريحي الناتج من التشوهات الخلقية في القناة الشرجية المستقيم

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الهدف من البحث: هو تقييم الدور التشخيصي لرسم عضلات القناة الشرجية بين تشوهات خلقية في الأطفال المولودين بشروط خلقية في القناة الشرجية والمستقيم. هذا بالإضافة إلى تقييم دور التنوب الكهربائي سواء كان قبل وبعد العملية في السيطرة على عدم التحكم في البراز في هؤلاء الأطفال.

الطريقة: أجريت الدراسة على 80 طفل مصاب بهذه التشوهات وعمرهم من الأصحاء ثم فحصهم إلكترئيكياً مع عمل رسم عضلات القناة الشرجية وقياس العضلات قاع الحوض وقياس عضلات القاع الحوض.

المجموعة الأولى: أجريت على عشرين طفل كان لديهم قياس طبيبة لرسم العضلات ثم تم عمل جراحة لهم كما تم تقييمهم إلكترئيكياً مع رسم العضلات بعد ذلك.

المجموعة الثانية: عشرين طفل كان لهم النشاط الكهربائي للعضلات منخفضاً وقد تم عمل تنوب كهربائي لعضلاتهم قبل وبعد الجراحة.

المجموعة الثالثة: عشرين طفل كان لهم رسم عضلات منخفض وقد تم إجراء الجراحة.

المجموعة الرابعة: عشرين طفل كان قد تم إجراء العملية الجراحية التقويمية لهم منذ فترة.

وبعدين من سلس غان طرف وقد تم عمل تنوب كهربائي لهم ثم إعادة التقييم لهم.

وقد أُجريت النتائج اختبار قياس قياس عضلات الضعيفة إلكترئيكياً مع وجود أن قيمة (M) أكثر دلالة من قيمة (TH) في تقييم نشاط عضلات القناة الشرجية دون التنوب الكهربائي كما أُجريت التحصينات إلكترئيكياً وقياساً اً قياس مرات العضلات بعد الجراحة.

الاستخلاص: يمكن أن نستخلص من البحث أن رسم عضلات القناة الشرجية وقياس قياس على قياس عضلات القناة الشرجية قبل وبعد العملية الجراحية. كما أن لوجود التنوب الكهربائي للحفاظة للأطفال المصابين بسلس قاع الحوض.