Protocols

Female Urinary Stress Incontinence Protocol

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Using the NeuroTrac 5™ EMG Biofeedback for the treatment of pelvic floor dysfunction in women with urinary stress incontinence.

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Background information

Urinary incontinence is defined by the International Continence Society (ICS) as a 'condition in which involuntary loss of urine is a social or hygienic problem and is objectively demonstrable' (Abrams et al. 1988). It is often a devastating condition severely affecting the quality of life for sufferers.

The most common form of urinary incontinence (affecting approximately 45% of incontinent people), is stress incontinence, described as a leakage of urine associated with an increase in intra-abdominal pressure for example during a cough sneeze, laugh or physical exertion. If the client is investigated using subtracted cystometry (urodynamics) where the behaviour of the Detrusor muscle can be observed, then a diagnosis of genuine stress incontinence (GSI), may be made. This is in accordance with the ICS definition of genuine stress incontinence (Abrams 1988),

> *' GSI is the involuntary loss of urine occurring when in the absence of detrusor contraction, the intravesical pressure exceeds the intraurethal pressure.'*

Acknowledging the role of the change in intra-abdominal pressure, Abrams (1999) suggests that this definition should be modified to read : -

> *The involuntary loss of urine occurring when due to raised intra-abdominal pressure, the intravesical pressure exceeds the intraurethral pressure.*

The Pelvic Floor Muscles

The term 'Pelvic Floor' is often used when referring to this structure, which is actually a complex structure of muscle and fascia. It can broadly be divided into three sections : -

i. Endopelvic Fascia
ii. Levator Ani Muscles
iii. Superficial perineal muscles / external anal sphincter

The pelvic floor muscles and the perineal membrane act together as the pelvic diaphragm. The perineal membrane attaches the lateral walls of the vagina and perineal body to the ischiopubic rami.

Endopelvic fascia

The endopelvic fascia has an important role as it gives attachment to and also envelops the pelvic floor muscles and pelvic organs. The vagina and urethra pass through the fascia and pelvic floor musculature. The fascia is composed of smooth muscle, elastin, collagen and blood vessels. There is bladder neck support from the pubocervical fascia. The cardinal and utero-sacral ligaments are orientated vertically aiding suspension of the pelvic organs.

Levator Ani

The deeper layer of muscles are known collectively as the Levator Ani. They lie superior to the superficial muscles and are thought to have the more important role in the maintenance of urinary continence and the prevention of uro-genital prolapse.

The **pubococcygeus** arise anteriorly on either side of the pubic symphysis and pass posteriorly on either side of the urethra, vagina and anus to insert into the coccyx. There are some loops of muscle fibres that pass posteriorly in a loop behind the urethra, some loop behind the vagina and some behind the anus. These muscle fibres are known respectively as **pubourethralis, pubovaginalis and puborectalis**, however, some authors dispute the presence of pubourethralis in all subjects.

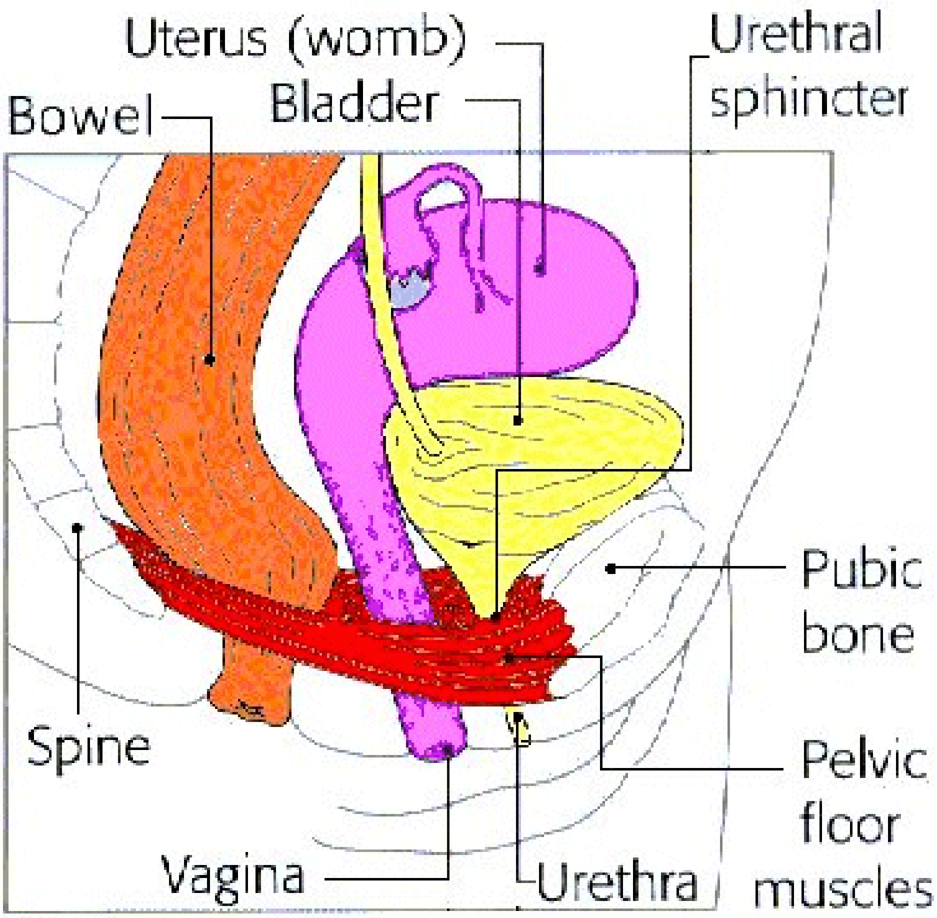


Fig A

Superficial Pelvic Floor muscles

The superficial muscles consist of symmetrical bands of muscle either side of the vagina. They have an important role in sexual activity.

The **transverse perinei** attach to the ischial tuberosities and insert and meet with each other at the perineal body.

The **bulbospongiosus** attaches to the anterior perineal body and passes via the lateral aspects of the vagina and urethra to insert into the corpus of the clitoris. Both the transverses and the bulbospongiosus may be damaged when an episiotomy is performed.

The **external anal sphincter** encircles the anus, inserting anteriorly into the perineal body and posteriorly into the coccyx.

The position of the perineal body is determined by the muscles inserted into it. It has been suggested that the distance between the posterior margin of the vaginal introitus and the anterior margin of the anal sphincter is significant in the predisposition to incontinence i.e. the shorter the distance the greater the risk.

Innervation

The innervation of the pelvic floor muscles is somatic and originates in the **pudendal** nerve from the same segment of the spinal cord which gives the lower urinary tract the autonomic pelvic innervation, S2 - S4.

Fibre Types

The striated muscles of the pelvic floor are composed of both slow (Type I) and fast (Type II) fibres. Some authors have described further subdivisions of fast fibres into those with properties of purely power and speed and those with both endurance and power. [Fast glycolytic, Fast oxidative glycolitic (FOG)]
The pelvic floor muscles main function is to act as a postural, supportive structure, consequently the predominant fibre type is Type I (slow twitch) fibres, which are capable sustained activity. However, in order to respond to sudden changes in intra-abdominal pressure the pelvic floor muscles also contain Type II (fast twitch) fibres which can work strongly for short bursts of activity. Various authors (Gilpin,[1989], Koebl [1989],Fischer [1992])describe the ratio of fibre types as between 60 - 70% slow and 30 - 40% fast, with a variation in fibre type distribution in different areas of the pelvic floor.

Role of the Pelvic Floor Muscles in Genuine Stress Incontinence.

During times of raised intra abdominal pressure the muscle fibres of the pelvic floor normally act to maintain closure of the urethra and prevent urine leakage. There are three basic theories as to how the pelvic floor muscles achieve this. Firstly, it acts as a type of platform or hammock as described by DeLancey (1994). The hammock of muscles under the vagina and urethra allow the raised intra-abdominal pressure to compress the urethra against this resistance and thus prevent urine leakage. Secondly the postural tone of the pelvic floor enables it to act as a supportive structure maintaining the position of the bladder and proximal urethra within the intra-abdominal cavity. Rises of intra-abdominal pressure are transmitted to the proximal urethra which helps the external urethral sphincter and PFM's to counteract the effect of this pressure squeezing on the contents of the bladder.

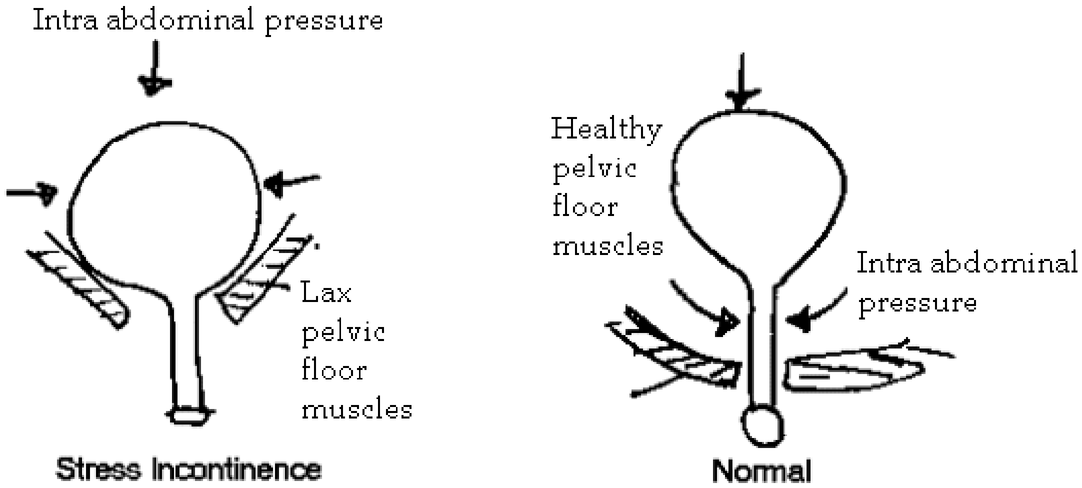
See Fig B enclosed

Thirdly, Ulmsten and Petros (1993,1995) proposed the 'integral hypothesis' based on the view that the pelvic floor is a single functional unit. If a part of the structure is weakened, for example the pubo-urethral ligament, this means that the hammock has lost some of its original function. The integral theory also suggests that obstruction of the urethra is caused by both sphincter activity and a fracture of the urethra with the aid of a contraction of the pelvic floor muscles.

To prevent stress leakage, the pelvic floor muscles need to be able to respond quickly and with **power** to a sudden rise in pressure, but they also require the ability to maintain the postural tone and therefore require **endurance**.

Miller (1998), describes a study working with older women (mean age 68) who had symptoms of mild - to - moderate stress incontinence. The intervention group were taught the technique of intentionally contracting the pelvic floor muscles before and during a cough, this skill was termed 'The Knack'. The results showed a considerable reduction in urine loss when the women used the 'Knack' compared to just coughing without a pre-contraction of the pelvic floor.

Fig B



Biofeedback

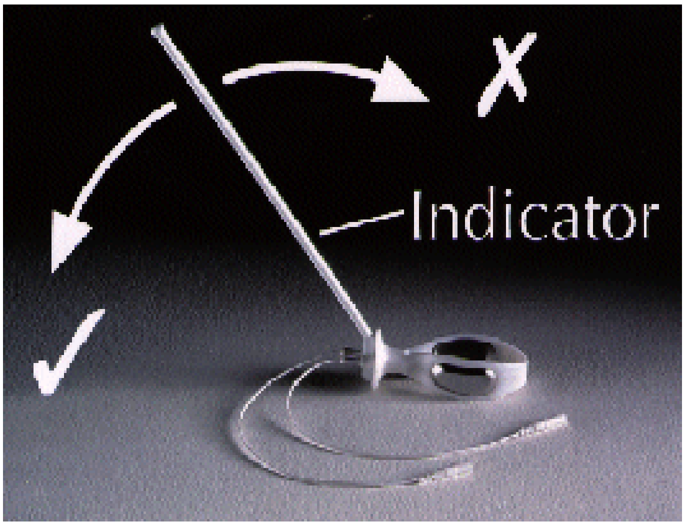
Biofeedback, is in simple terms, a means of attaching a device whether it have sound, lights or a picture, to show the patient how they are performing. It can be as simple as touching a muscle with ones fingers to feel when it contracts. It has been defined as : -

'… the detection of a physiological process (either directly or indirectly) and the presentation of this information to a patient who is then able, with training, to use the information to gain control over the process.'

Biofeedback and the Pelvic Floor Muscles

The earliest recorded work using Biofeedback for the treatment of pelvic floor dysfunction comes from Kegel (1948), he is often referred to as 'the grand - daddy of pelvic floor exercises'. Kegel described enhancing the effect of pelvic floor muscle exercises (still called Kegel exercises in some parts of the world), using a perineometer. This was a vaginal probe capable of measuring a PFM contraction using manometric pressure. Developments in this area of work have seen the introduction in the 1980's, of the Bourne perineometer, which was then followed in the 1990's by the Peritron giving the sophistication of a microchip and digital recordings. In the United Kingdom further developments during the 1990's, with computerisation of the biofeedback information, have lead to an increase in the use of surface electromyographic (sEMG) biofeedback.

Simple pelvic floor muscle biofeedback.



Using the Periform electrode if the pelvic floor is contracting correctly and with elevation the indicator stick will move in a downwards direction during a contraction. If the patient is bearing down or pushing the indicator stick will move upwards. Without the use of EMG recording this can be a useful form of biofeedback, however because of it's light weight and the ability for it to be retained in the vagina when sitting, standing or moving, the Periform lends itself well to dynamic rehabilitation of the pelvic floor using EMG.

Surface EMG Biofeedback

'EMG is the study of muscle function through the enquiry of the electrical signal the muscle emanates', Basmajian & De Luca (1995); or more simply it is 'the recording of muscle bio-electrical activity - a practical indicator of it's contractility.', Vodusek (1994)

The technique of using EMG in the therapeutic setting should be distinguished from that used in research and muscle physiology testing where a single needle EMG recording is usually used, which although this gives a much more accurate reading is not practical in the clinical setting. The clinical application of pelvic floor EMG uses skin electrodes; this may confuse some therapists as these devices may be placed inside the vagina or anal canal, however they are still recording the EMG output through the skin. These surface electrodes detect the electrical signal when the nerve impulse reaches the neuromuscular junction causing a depolarisation of muscle fibre membrane.

Choice of electrodes

When recording sEMG the equipment requires the detection of three signals. One referred to usually as the body reference detects information on the background bio-electrical activity of the subject. The other two will detect the electrical activity within the pelvic floor muscle.

Skin Electrodes

Two self adhesive skin electrodes may be placed either side of the perineal body, just posterior to the vaginal introitus. A third body reference electrode should be placed over a bony point close to the pelvic floor muscle (the anterior superior iliac spine [ASIS] , or ischial tuberosity are useful points). It is important that the skin is clean and dry before attachment of the electrodes.

Vaginal Electrodes

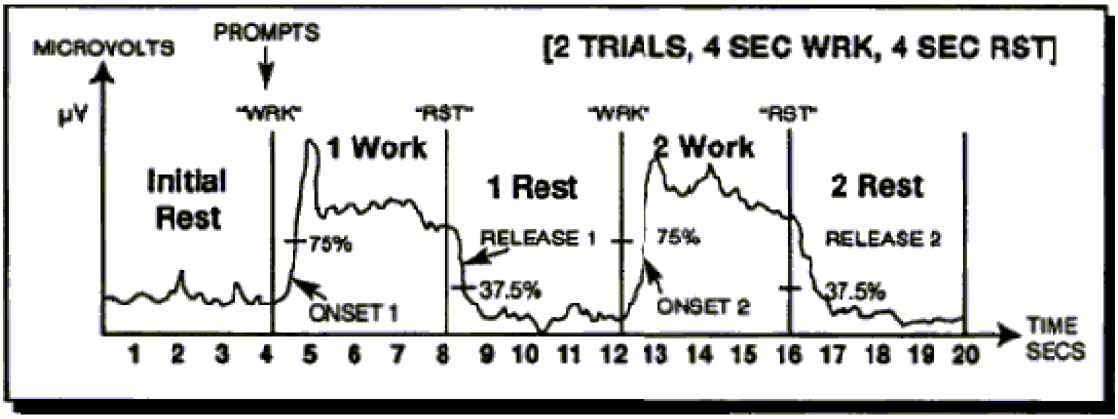
Usually the electrode of choice for female stress incontinence will be vaginal and one that is lightweight so that it can be retained and still allow the patient to re-educate the pelvic floor in dynamic positions. A good example of this is the Periform electrode seen earlier. There are a wide range of vaginal electrodes available with different designs and numbers of electrical contacts. Any internal electrode with two contacts will require the attachment of a body reference electrode. An electrode with an odd number of contacts will have an inbuilt body reference contact.

Clinical use of EMG Biofeedback
Assessment

sEMG can be used to assess the 'health' of the pelvic floor muscles with particular reference to the function of both slow and fast fibres.
Using Work / Rest Assessment mode the Neurotrac 5 is able to record the following parameters: -

Onset Time.

This is calculated as the average time taken after each work prompt for the EMG signal to reach 75% of the average microvolt output for the 2nd or 3rd second of that particular segment of activity (work). The expected normal value for onset is <1 second, in the condition of stress incontinence this is frequently much longer due to the loss of power and coordination of the fast twitch muscle fibres.



Work Average.

This records the average value in microvolts of all the work segments (excluding the first second of each work segment).
It must be remembered that this reading is subject to a number of variables such as type of electrode used, timing of examination in menstrual cycle, activity levels, time of day, pH of vagina etc.

Rest Average.

This records the average value in microvolts of all the rest segments (excluding the first second of each rest segment).
A well functioning pelvic floor muscle should rest at below 10% of the work average. Readings higher than this indicate a failure to relax and could contribute to fatigue of the pelvic floor muscles and an inability to contract on command during episodes of raised intra-abdominal pressure.

Release Time.

This records the average time taken after the 'rest' prompt to reach 37.5% of the previous 2nd or 3rd second of work.
Similar to the onset time a well coordinated pelvic floor muscle should have an average release time of <1 second.

Work / Rest Peak.

This records the highest microvolt reading of all the work segments. It is important to monitor activity during the recording session as this value can be affected by artifacts giving momentary high readings.

Work / Rest Average Deviation.

This records the variation in microvolts during a work phase or rest phase. The measurement is taken after the first second in each work or rest segment has elapsed. Sample readings are taken every quarter of a second and are measured against the work or rest average for that second. The percentage of deviation (%) can be calculated by dividing the deviation by the average work value.

$$\text{Work deviation \%} = \frac{\text{Work average deviation}}{\text{Work average}} \times 100\%$$

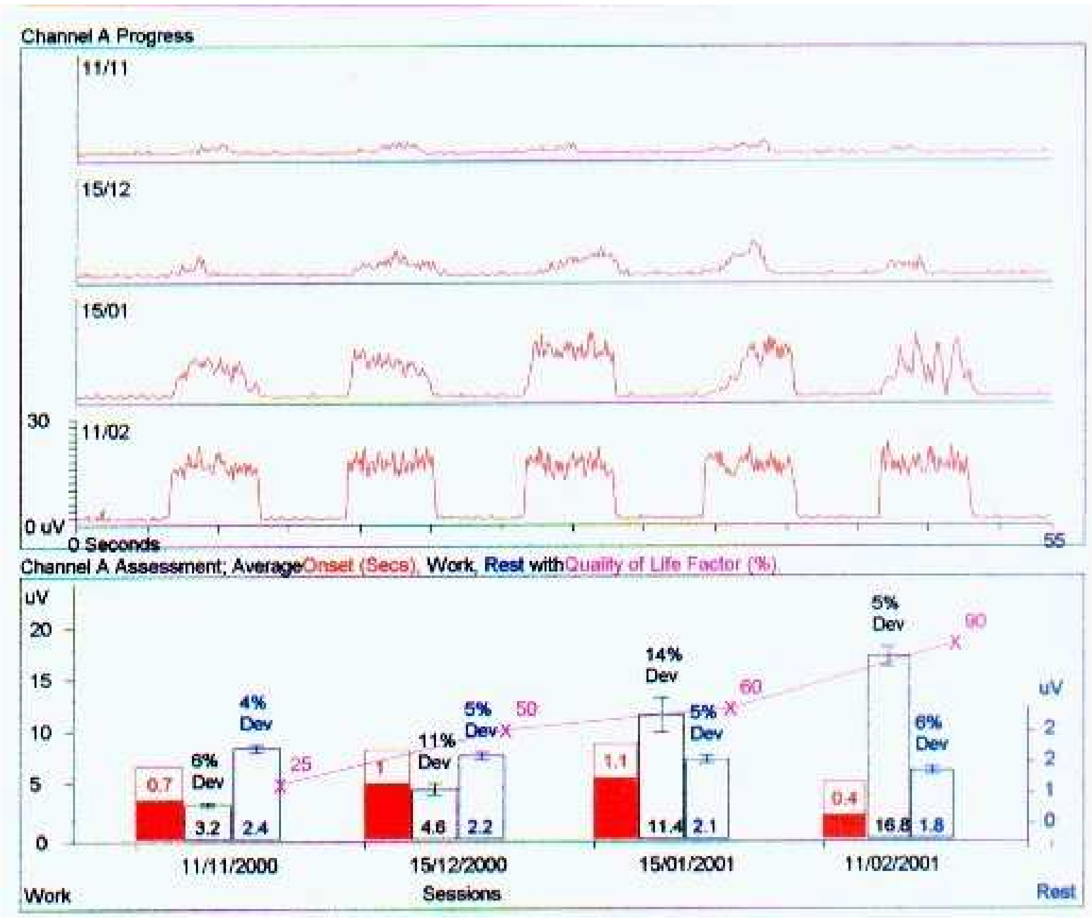
The percentage is called the coefficient of variability. Deviations of over 20% normally indicate lack of muscle control and stability

In clinical practice patients with a pelvic floor muscle dysfunction will have an increased average deviation at work, which can be seen to reduce as the pelvic floor muscle regains it's fitness.

Work / Rest Assessment Reports

The Neurotrac 5 has the ability to store and compile a report of successive assessment sessions. The work/rest assessment parameters must be the same for each session. The work and rest time should be set between 2 and 10 seconds, the number of trials for the assessment is default set to 5. The Neurotrac 5 records the various parameters for each session saved , and stores them in the patient file. By selecting these graphs from the patient file it is possible to compile a report comparing muscle function at the start of treatment and at stages during a course of treatment.

Work / Rest Assessment Progress Report



This is a typical progress report of a patient with stress incontinence. The first assessment shows a combined problem of loss of power, endurance and co-ordination. Over a treatment period of 16 weeks the graphs show the gradual improvement in power, followed by endurance and finally the last trace shows the desired ability for the pelvic floor muscles to work effectively to protect against stress leakage, i.e.

To contract in less than 1 second (onset 0.4 secs),

To hold the contraction with 5% deviation at work for 5 seconds,

To release the contraction cleanly (<1sec)

Normal average resting microvolt reading (1 .8m v).

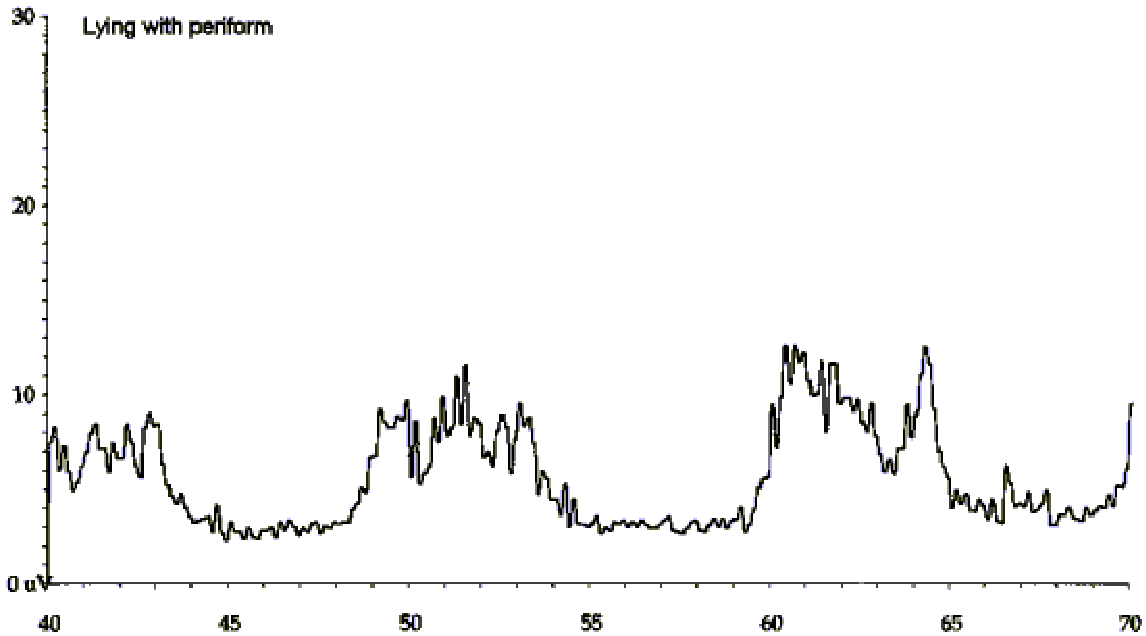
Case Example

Female. Age 28, stress incontinence following delivery of first baby.

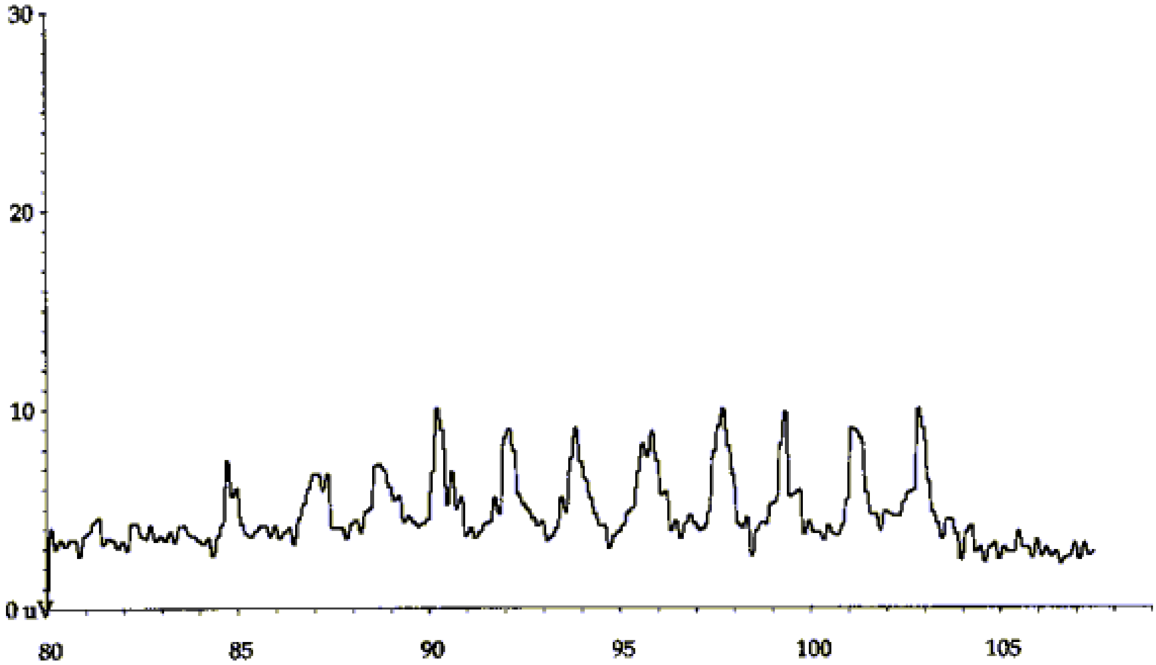
Initial assessment performed at 8 weeks post delivery.

Following initial verbal assessment and digital pelvic floor muscle assessment (Modified Oxford Grade 2/5/3//10), an EMG recording was taken with the patient in a supported supine (crook - knees flexed) position. The electrode used was the Periform with a body reference electrode attached to the right anterior superior iliac spine (ASIS).

These graphs clearly show a loss of muscle co-ordination combined with loss of both power and endurance.



II: Fast twitch fibres



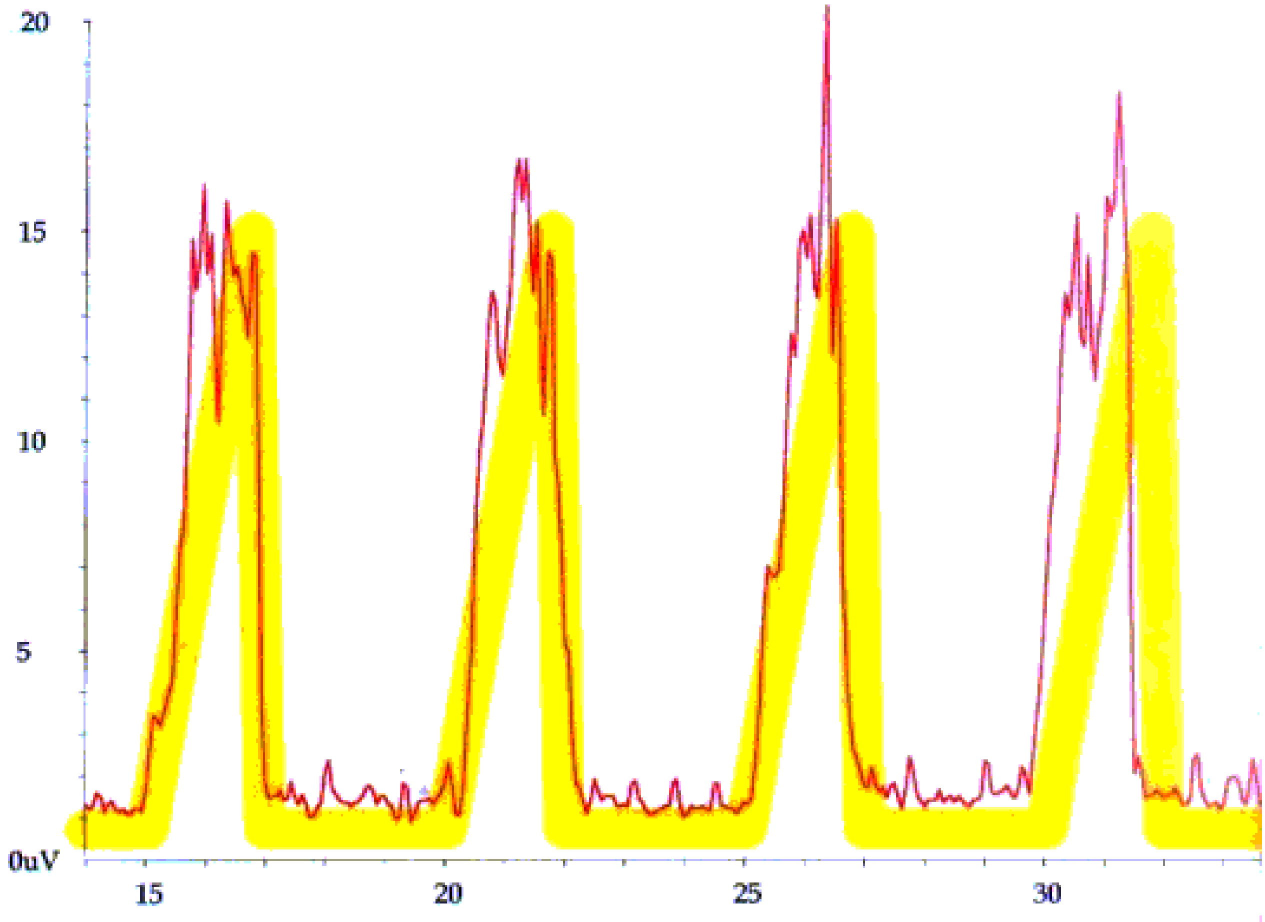
The patient was instructed in the use of a Neurotrac 2 unit for home EMG Biofeedback using a programme of 5 trials (repetitions), 5 seconds work, 5 seconds rest, which was used x1 per day. This is based on the Muscle function as assessed by modified Oxford Grade and EMG assessment.

The patient also performed pelvic floor muscle exercises x3 per day consisting of 5 contractions holding 5 seconds and 10 short (1 second) maximal contractions. These were performed in a variety of functional positions throughout the day.

The patient attended clinic weekly and used template training to practice the skills of coordinating the contraction with maximal power.

Template Training

Templates can be used to train either slow muscle fibres to improve endurance or fast muscle fibres to improve power and co-ordination. For the client with stress incontinence it is useful to create templates taking the muscle to its maximal power in less than 1 second. - see graph below

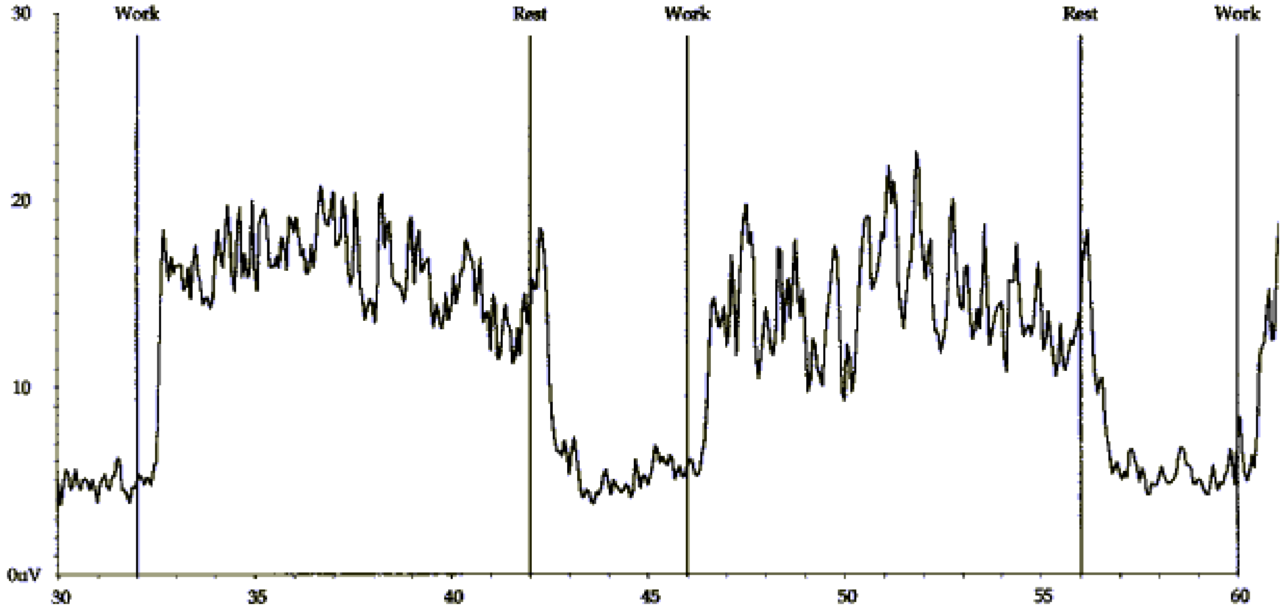


Progression

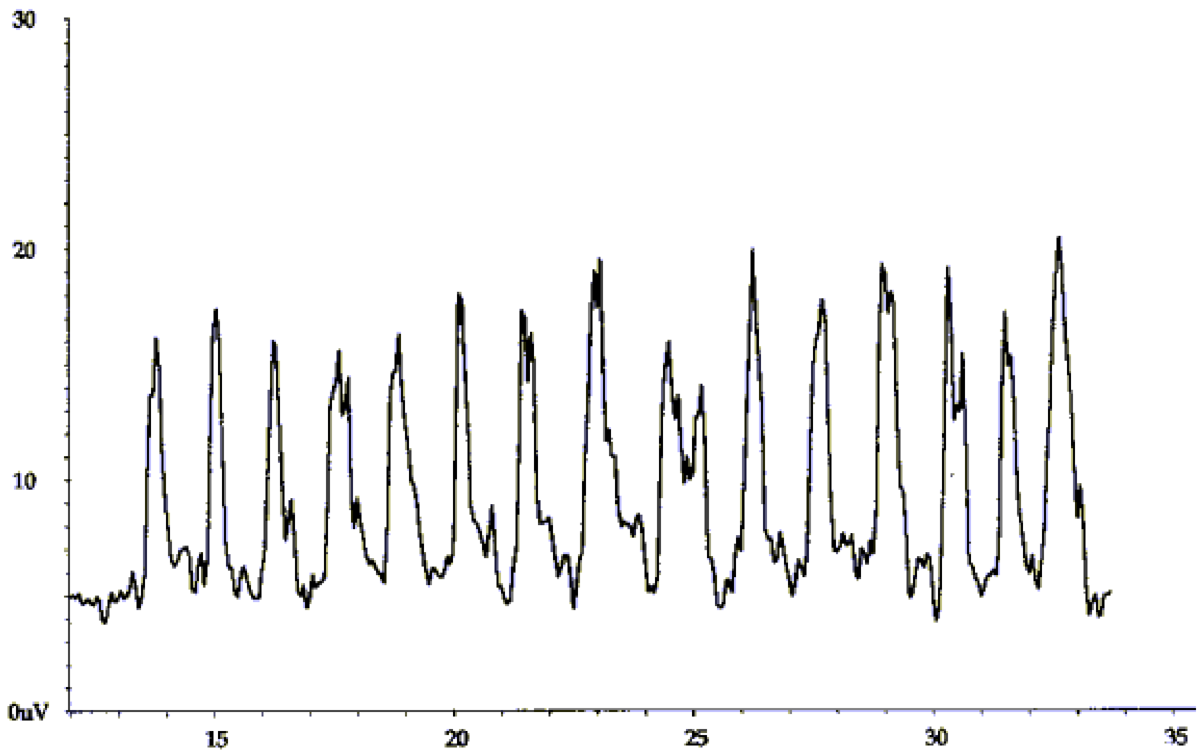
As the patients muscle endurance and power improves the sessions can be progressed gradually increasing the work/rest rate and number of trials. The patient is taught to 'brace' or contract the pelvic floor prior to any stress event such as sneezing or coughing, also during activities of daily living such as lifting. Progress can be monitored using the work/rest assessment programme.

Post Treatment.

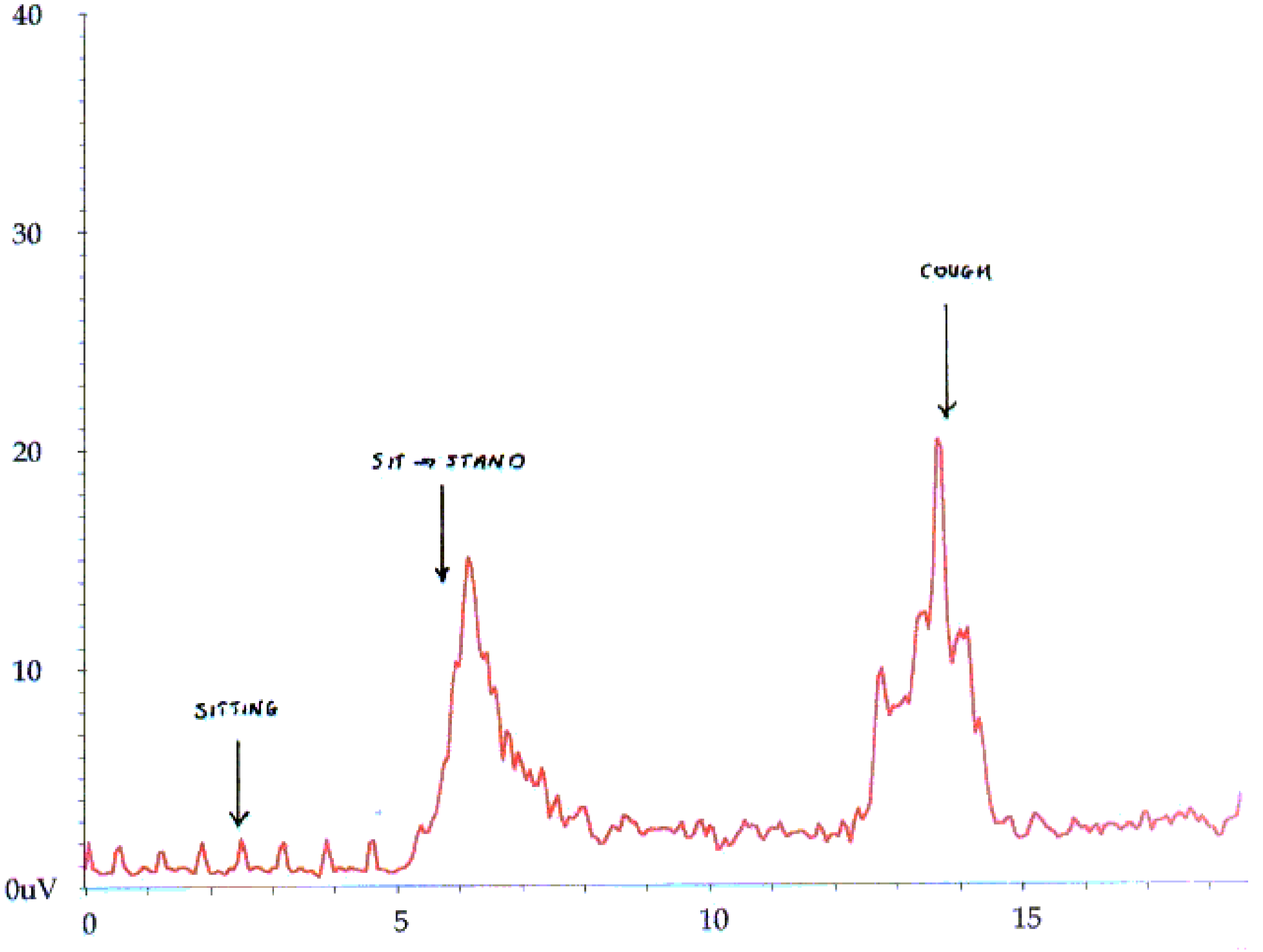
I Endurance



II Fast twitch fibres



The final Pelvic Floor Muscle EMG graphs were taken at the end of treatment with the patient using the Periform electrode in the upright position. The patient is now able to hold the contraction for 10 seconds with reduced average deviation at work and with an onset less than 1 second. The patient is able to hold against sneezing and coughing and no longer experiences stress incontinence.
It is also possible using an assessment screen (Open Display), to look at the function of the pelvic floor muscles during stress events.



This graph shows the function of the pelvic floor muscles to resist the increased intra-abdominal pressure when moving from sitting to standing and also the activity required prior to coughing.

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