Osteopathic treatment and stress incontinence, in combination with biofeedback

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1. Abstract

The goal of my work was to determine if a pelvic floor training program, supported by biofeedback and supplemental osteopathic treatments, could lessen the symptoms of stress incontinence.

It was my idea, that the body would be brought into greater balance through the osteopathic treatments, and the functioning of the pelvic floor would thus improve. It was my intention to round out the results using biofeedback-assisted strengthening of the pelvic floor.

My study involved the treatment of 22 women who all suffer with stress incontinence, level I through II. All of the test subjects are post-menopausal and have had at least one child. The women were divided into two groups of 11; i.e. a test group and a control group. Grouping was done randomly.

Both groups participated in seven biofeedback/training sessions. The first six sessions occurred weekly. Following a four week pause, the women took part in the seventh session. During the study period, the women in the test group also received three osteopathic treatments which focused on their specific needs.

Following the study, all participant were asked (two) questions; one regarding the subjective perception of improvement in their condition following treatment, the other in reference to the amount of time spent exercising the pelvic floor independently.

On combining the results from the two groups, I could show a subjective improvement in symptoms. Moreover, it was shown that 71% of the subjects were motivated enough to do additional pelvic floor training independently.

I also observed that there was no significant improvement in symptoms brought about by the osteopathic treatments which took place in the time period of the study.

In order to determine the best possible treatment for such patients, it is without question recommended that this study be repeated sometime in the future using a larger number of subjects.

2. Introduction

Female aconuresis is a frequently occurring disease which significantly limits the quality of life for the women affected.
An epidemiological analyses conducted by *Iosif et al. (1981)* showed a clear connection with ageing: from 15% in the 30 to 40 year age group, increasing to 25% in women aged 40 to 50, and up to 60% in more elderly women.
The psychological burden for these women is without question exceptional, as the problem of aconuresis is seldom discussed openly and thus many women are left feeling isolated.

The use of biofeedback equipment in the treatment of aconuresis has recently been gaining in popularity.
I would like to include this form of treatment in this paper.

In my work as a physiotherapist and osteopath, I frequently encounter patients who suffer from aconuresis. The more I have dealt with this subject, the more important I believe it is to find an optimally effective treatment for these patients.

In this paper, I would like to provide those interested in the topic, those affected by aconuresis, and of course myself and other therapists with a clarification as to the importance of and the need for an effective treatment for aconuresis.

3. The Anatomy of the Pelvic Girdle

Comparisons of the following chapter Meert (2003)

3.1. The Construction and Function of the Pelvis

Our evolution to a more upright posture has not only changed the external form of the pelvis, but the inner structure as well. As bone is a living tissue, its shape is constantly adjusting to the functional demand placed on it. The pelvic girdle functions both statically and dynamically. When one looks more closely at the individual parts of the girdle, one can see how truly amazing this bony structure is.
Wolff believed that the entirety of the construction of a bone is an adaptation to local mechanical conditions, such as compression and contraction. Both the morphogenesis and the form of a bone are products of the demands placed on it. (Richard 1978)

3.1.1. Anthropology

Along with the change to an erect position and bipedalism, the body's center of gravity has shifted. The “center” of our body is a product of this upright posture, and all is supported by the feet. The whole of the hip- and knee-joints have lengthened, which presents a greater challenge to maintaining balance in walking.
On the dorsal side of the pelvis, a bony protrusion has developed: **spina ischiadica**. This feature enables muscles such as the Mm. Obturatorii to function from a position of better leverage. In addition, the Ligg. sacrospinale acquired and enhanced function with the more upright position.
The **iliosacral joints** (ISJ) moved dorsally and inferior in relation to the **coxofemoral joints** (CFJ) and also became closer relatively. Thus, the lever action of the ISJ on the CFJ has changed significantly. This in turn has meant a need for the development of stronger ligaments as well as an adaptation of the cancellous structure of the pelvic bone.

The sacrospinous and sacrotuberous ligaments are essential in slowing down forced anterior moment of the sacrum in relation to the ilium.

Fig. 1: The alteration of the construction and design of the ilium due to a more erect position in human beings, from

Analyses by *Vleeming (1997)* have showed that the dorsal fascia of the M. piriformis radiates into and connects with the Lig. sacrotuberale. Additionally, the fibers of the M. biceps femoris merge partially or sometimes completely into the Lig. sacrotuberale.
While the ilium became shorter and wider, the center of gravity moved lower, and thus improved the mechanical position for the M. gluteus maximus. This muscle limits the torso from tilting forward while walking.
The alae ossis ilii have enlarged and as a result form a kind of “bone bowl” for the inner organs.
The collum femoris has for that reason been extended, thus the M. gluteus minimus and the M. tensor fasciae latae gained a more optimal angle for leverage.
Also the form of the iliosacral joint surfaces has changed in the course of evolution.

Theoretically, it certainly might be possible to diminish further the distance between the ISJ and CFJ, but this would inevitably lead to narrowing the birth canal. The complicated mechanism of birth in human beings results from a compromise between the size of the birth canal and the structural need for the upright posture.

In addition to the adjustments in the pelvis, lordosis of the spine developed, which is at its maximum in the lumbosacral region.

3.2. Ligamentous Connections in the Pelvic Region

As the pelvic region is influenced by many ligaments, I would like to focus here on only the most relevant ones:

3.2.1. Ligg. sacroiliaca

These ligaments are divided into

- Ligg. sacroiliaca anteriora
- Ligg. sacroiliaca interossea
- Ligg. sacroiliaca posteriora

The Ligg. sacroiliaca posteriora run dorsally between sacrum and ilium. The fibers of the top layer are the longest, and are connected to the Ligg. sacrospinale and sacrotuberale.

3.2.2. Lig. sacrotuberale

Another important and interesting connection exists between the Lig. sacrotuberale and the muscle fibers of the M. biceps femoris, M. piriformis and M. gluteus maximus.
Several blood vessels which supply the ISJ run through the Lig. sacrotuberale and the Ligg. sacroiliaca.

Willard (1997) divides the Lig. sacrotuberale into three parts:

- Lateral: It can be found between tuberosity ischiadicum and Spina iliaca posterior inferior and is connected with M. piriformis.

- Medial: Between tuberosity ischiadicum and the lateral sacrum, its fibers run around the Os coccygis. Therefore, the lateral fibers running from the tuberosity are attached to the caudal part of the sacrum and the medial fibers running from the tuberosity are attached to the cranial part of the sacrum.

- Superior: This part contains fibers from M. gluteus maximus and the fascia thoracolumbalis.

Fig. 2: Different parts of the Lig. sacrotuberale, from Willard

3.2.3. Lig. sacrospinale

This ligament is connected to M. levator ani and plays an important role at the coccygodynia.

3.2.4. Lig. iliolumbale

According to *Barral (2004)*, it may also contain contractile fibers, and it is connected with the M. quadratus lumborum.

Willard (1997) claims that there are individual differences in form and size between the ligaments.

Through this ligamentous connection, the movements of the ilium are firmly bound to the movements of the lumbar vertebra (L4 und L5) and of course vice versa.

3.3. The Pelvic Floor

The pelvic floor is divided into two levels. There is diaphragma pelvis (superior level) and the diaphragma urogenitale (inferior level), and both will be discussed in the following sections.

3.3.1. Diaphragma pelvis

The diaphragma pelvis is made up of the M. levator ani and M. coccygeus, as well as by the superior and inferior fascia diaphragmatis of the pelvis.

The ***M. coccygeus*** joins with the Lig. sacrospinale.

The ***M. levator ani*** is divided into the following parts:

- M. puborectalis as the front part: its opposing fibers form a loop around the rectum.
- M. pubococcygeus as the middle part: it can be found on both sides at the Lig. anococcygeum between the anus and the Os coccygis and radiates toward the sacrum.
- M. iliococcygeus as the back part: its fibers are attached directly at the Os coccygis and sacrum.

Fig. 3: Schematic representation of the upper level of the pelvic floor from the ventral cranial perspective.

Between the right and left M. levator ani, there is a cavity: the Hiatus urogenitalis – the ***Levatortor***.

The ***Centrum tendineum perinei*** is formed from the fibers of M. levator ani, M. pubococcygeus, M. transversus perinei profundus and superficialis and of M. sphincter ani externus.

The function of the Diaphragma pelvis:

- Contraction (constriction) of the rectum and the vagina.
- Supportive function for the pelvis and the abdominal contents.
- Constriction of vagina, urethra and rectum when needed; e.g. urination, defecation, coitus and childbirth.
- Elevating the anus.
- Construction of the anorectal angle, which is important in anal continence.

The innervation comes from the Rr. musculares of the N. pudendus (S2 – S4).

3.3.2. Diaphragma urogenitale

The constituents of the Diaphragma urogenitale are the M. transversus perinei profundus, Fascia diaphragmatis urogenitalis superior and inferior, Lig. transversum perinei, and M. sphincter urethrae as well as the M. transversus perinei superficialis.

Fig. 4: Schematic representation of the Diaphragma urogenitale, caudal perspective.

Apart from its supportive function, the Diaphragma urogenitale also functions in the construction of another sphincter with the help from the M. sphincter urethrae.
The innervation is via the Rr. musculares of the N. pudendus

3.3.3. Sphincters in the Female Body:

The sphincters of the female body are the M. sphincter ani internus and externus, Mm. bulbospongiosi, Mm. ischiocavernosi as well as the M. sphincter urethrae, which surrounds the urethra.

3.4. The Bladder

The bladder is a hollow organ made of muscle and connective tissue which stores urine and which, via contraction, moves urine through the urethra.

At a urinary volume of 350ml, the urge to urinate normally appears. The shape of the bladder naturally depends on the volume within.
The bladder is covered with a peritoneum, which also lines the Douglas space. Outside the peritoneum, the bladder is connected to the small intestine, uterus and rectum.
In a woman's body, the inferior part of the bladder is connected to the upper one third of the cervix uteri and also with the vagina.

3.4.1. Turgor Effect

The visceral organs stay in their place largely due to the turgor and interactive pressure in the visceral space.
Each hollow organ has a tendency to expand maximally according to its own elasticity. This phenomenon enables the organs to retain their volume, and at the same time keep their relative position.

3.5. Female Sex Organs

In comparison to the bladder, the internal female sex organs protrude much further into the peritoneal cavity.
Many forces and shifting relationships act on the uterus and its ligaments:
Pregnancy, birth, episiotomies, ventouse or forceps childbirth, sedentary occupation, hormonal disorders, traumas, operations and infections.
The uterus and vagina have a close functional connection with the bladder.
The uterus is supported by numerous ligaments and other connective tissue structures, namely:

- Peritoneum
- Lig. teres uteri
- Lig. latum uteri
- Lig. proprium ovarii
- Tuba uterina
- Parametrium
- Lig. sacrouterinum
- Lamina sacro-recto-genito-vesico-pubicalis
- Pelvic floor

4. Definition of Incontinence

According to the International Continence Society (ICS), aconuresis is a disease which involves involuntary urination and constitutes a social and hygienic problem for patients (Abrams et al., 1998).

The ICS divides incontinence into 4 types:

- Stress incontinence (pressure incontinence)
- Urge incontinence
- Reflex incontinence
- Overflow incontinence

Stress incontinence accounts for approximately 60% of all cases and is thus the most common form of the female incontinence, followed by urge incontinence with approximately 10% of the cases. Mixed forms involving stress and urge incontinence constitute approximately 20% of the cases. Reflex and overflow incontinence occur much more rarely and combined constitute the remaining 10% (Shaw et al., 1992).
I would like to focus on stress incontinence in my study, as it is without doubt the most common form.

Stress incontinence is divided further into three degrees of severity:
Level I: Urine leakage when coughing, sneezing, laughing
Level II: Urine leakage when lifting heavy loads, climbing stairs and running
Level III: Urine leakage when standing, but not when lying

4.1. Reasons for Continence

“How does one become incontinent?”
Before dealing with this question, it is more important to ask:
“What does it mean to be continent?”
To be urine continent, cooperation among several influencing structures and processes must happen in order to create a successful closure.

It is of particular importance that a normal level of intra-abdominal pressure acts on urethra. Additionally, the sphincter must be able to close itself sufficiently, and at the same time the pelvic floor should be simultaneously elastic and tight.
A very important factor is the physiological location of organs one on top of another. Lastly, all tissues in the small pelvis need to be both of normal mobility and have good elasticity.

The pressure lock of the urethra is provided by the periurethral transverse muscles and also the smooth muscles of the urethra (M. sphinkter urethrae), as well as by the mucous membrane and periurethral vascular plexus (McGuire et al., 1976; Blavais et al., 1988).

A proper transfer of pressure to the urethra caused by an increase in abdominal pressure is only possible when the urethra and likewise the bladder are held in correct physiological position by ligaments and muscles.

In addition, a decisive role is played by the M. levator ani. It shares a fascial attachment with the anterior wall of the vagina and with the Arcus tendinosus of the Fascia pelvina (ATFP). The connection of the M. levator ani with the endopelvic fasciae and of the ATFP allows for an active contraction of the pelvic floor musculature, and consequently a raising and support for the anterior wall of the vagina. (DeLancey and Starr, 1990).

On the one hand, the ligamentous attachments and the pelvic floor musculature act as a support for the urethra, on the other hand, the urethra is displaced by the increase in abdominal pressure through reflexive pelvic contractions in the cranio-ventral direction, which in turn causes the urethral pressure differences allowing it to withstand the internal pressure of the bladder and thus, prevent urine leakage (Constantinou and Govan, 1982).
This precise sequence of event involves very accurate timing and adequate strength in pelvic floor contractions, both of which can be detrimentally affect by damage to nerves or muscles (DeLancey and Starr, 1990).

Analyses made by *Bo* and *Stein (1994)* on healthy women who have never given birth nonetheless shows a synergistic contraction of the external urethral sphincters when the pelvic floor is contracted voluntarily.

4.2. Reasons for Incontinence

The reasons for incontinence lie in the disfunction of intrinsic as well as extrinsic continence factors, and also genes.

4.2.1. Malfunction of Intrinsic Continence Factors

One possibility for failure is the atrophy of the mucous membrane and the submucosal vascular plexus. Also, malfunction of continence may occur as a result of surgical scarring and malfunction of the innervation due to neurogenic defects or operations performed in this region.

Such cases are referred to as intrinsic sphincter incompetence. This is characterized primarily by very symptomatic incontinence.

4.2.2. Malfunction of Extrinsic Continence Factors

These factors relate to a loss in effectiveness in extrinsic closure strength, and are primarily caused by an exceptional strain on the pelvic floor such as pregnancy and childbirth, where there is a lacking of sub-urethral support (pelvic floor musculature and connective tissue).

In this context, *Barral (2002)* mentions the occurrence of urethrovesical shift due to change in the function of the pelvic floor.

Urethrovesical Shift:

There are two main reasons for this: first, adynamia and malfunction of the supporting apparatus (probably after ventouse child delivery or due to a major episiotomy), and second the dropping of the abdominal organs (e.g. enteroptosis, Anteversio uteri). Additionally, another reason worth mentioning is a change in the coccyx position and advanced age.

The intra-abdominal pressure affecting the bladder and urethra strengthens the closure mechanism, as long as the urethral sphincter is located properly within abdominal cavity.

Though the proximal urethra may move out from the abdominal cavity inferiorly, the intra-abdominal pressure might not strengthen the sphincter mechanism, rather the pressure on the bladder may increase and thus lead to incontinence. (Huguier et al., 1965)

Fig. 5: Pathophysiology of the bladder

The Relation between Incontinence and Child Birth

Kölbl (2003) found in a survey in which he compared several published studies that not only does pregnancy but also vaginal delivery itself increase the occurrence of stress incontinence as well as damage to pelvic floor.
However, in this context he found there to be few truly objective analyses.

It is important to identify and where possible to reduce the factors involved in child delivery which contribute to the development of the female aconuresis.
In their study, *Beck et al. (1965)* and also *Swash et al. (1985)* state that it is primarily the first vaginal delivery of the child which most injures the pelvic floor. Additionally, the pregnancy itself is a factor.
On the contrary, *Nemir et al.* (1954) and *Wolin (1969)* have demonstrated in their study that 5% of stress incontinence cases occur in young nullipara.

Francis (1960) emphasizes the fact that stress incontinence sometimes occurs before pregnancy in primigravida women, and in 40% of these cases the incontinence worsens during the pregnancy. However, the symptoms seem to disappear after delivery, but appear again and are more severe in succeeding pregnancies.

The main reasons for aconuresis resulting from childbirth:

- Damage to connective tissue structures due to mechanical irritation in the context of vaginal delivery.
- Damage to vessels which supply the pelvic organs due to compression during the passage of the child through the birth canal.
- Damage to nerves and/or musculature during delivery.
- Direct damage to the efferent urinary tract.
- Episiotomy

Peschers et al. *(1997)* has shown that the contractile strength of pelvic floor musculature is reduced for 3-8 days immediately after delivery. After 6 to 10 weeks, a complete degeneration may take place in which the neck of the bladder changes position in a cranial-ventral direction.

Multiparity, forceps delivery, prolonged delivery, third-degree perineal rupture, as well as high birth weight babies are important contributing factors to the damage of Nervus pudendus. (Snooks, 1986; Brown, 1998; Handa, 1996; Moerman, 1982)

Analyses made by *Abitol (1997)* show that reduction in the tone of the pelvic floor via epidural anesthesia makes possible easier delivery of the fetal head through the relaxed passage, which notably accompanies a low incidence of perineal injury.

4.2.3. Aconuresis is Determined Also by Genes

An analysis by *Hannestad (2004)* confirms emphatically the much discussed theory that genetic predisposition also influences the development of aconuresis. His study looked at the risk of incontinence in the daughters, granddaughters and sisters of over 2000 incontinent women. As a control group, 6000 women with asymptomatic relatives were also surveyed. The study comes to the following conclusion: the symptoms of aconuresis likely have varied and complex causes. Well-known risk factors, such as advanced age, pregnancy and child delivery, as well as a high body-mass-index (BMI) additionally increase the risk for women with genetic predispositions. (Hannestad, 2004)

4.3. Classic Methods of Treatment for Stress Incontinence

The classic methods of treatment are pelvic floor training, biofeedback therapy, therapy using vaginal cones or electro-therapy, as well as hormonal therapy using estrogens. Additionally, it is worth mentioning that there is also a possibility for surgical treatment.

4.3.1. Pelvic Floor Training

Training of the pelvic floor is an essential and central therapeutic approach for the conservative treatment of aconuresis, and has good long-term results. Structurally improving the pelvic floor musculature is a means to achieving efficient and well-coordinated cooperation in this diaphragm in relation to intra-abdominal pressure fluctuations. The desired muscle performance is made automatic using many repetitions. According to the training theory, strength, endurance, explosive force, explosive endurance and reactive power are all improved. (Bo et al, 2000)

This long-running success is described in several studies (Klarskov et al, 1991; Hahn et al, 1993; Bo et al, 1995; Cammu et al, 1995).

Furthermore, it has been confirmed in several studies by *Bo et al (1990)*, as well as *Markved et al (2002)* that intensive training of the pelvic floor leads to an increase of the muscle power of this area.

Also, the results are supported in a study by *Bourcier (1994)*, who demonstrates in his work that there is also improvement in urethral occlusion pressure.

Wilson (1987) indicates that classical pelvic floor training done under supervision generates a higher success rate both directly after the completion of the therapy as well as 6 months following, in comparison to at-home therapy.

Several randomized control studies by *Kegel (1948)*, *Lagro-Janssen (1991)*, *Bo et al. (1999)* and *Hofbauer et al. (1990)* demonstrate that the effectiveness of the training of the pelvic floor without requisite biofeedback as part of the treatment of stress incontinence is comparable to no treatment at all.

4.3.2. Biofeedback Therapy

By biofeedback is meant the sensory-motor feedback from muscle tension and movement.

The extent of muscle tension is detected as surface EMG-activity using appropriately place electrodes and converted by a device into an optical or acoustic signal which provides useful information for the patient (Weatherall et al., 2000).

In more recent literature, biofeedback therapy is becoming more and more frequently recommended in the treatment of stress incontinence.
This matches the recommendations of the International Continence Society (ICS), which advocates the integration of treatments which modify behavior as a primary therapy approach.

Morkved et al. (2002) state that biofeedback gives superior motivation to patients than simple gymnastic exercises.

Although such equipment can improve patient compliance, a targeted training of correctly generated contractions of the pelvic floor muscles is necessary, as it has been shown that 30–40% of the patients tense the incorrect muscles without such training or even carry out the Valsalva test at all (Bump et al, 1991).
Shepherd et al. (1983), Castleden et al. (1984), Taylor et al. (1986), Ferguson et al. (1990), Burns et al. (1993), Berghmans et al. (1996) and *Glavind et al. (1996)* also attempt to compare the effect of training pelvic floor in cases of stress incontinence with versus without the support of biofeedback.
All but one showed no improvement in success with the biofeedback groups.
In the study by *Glavind et al. (1996)*, one positive effect was described. The positive result was eventually attributed to the difference in training frequencies for the two groups.

Burns et al. (1993) maintain the opinion that supporting pelvic floor therapy with biofeedback results in an improvement in coordination and also in better control of the pelvic floor musculature in comparison to the group using pelvic floor training alone.
Similarly, they found that there is a significant improvement in the EMG signals produced during rapid and repeated contraction in the biofeedback group. Importantly, there was no difference in relation to incontinence symptoms between the groups.

Berghmans et al. (1996) found that the supporting pelvic floor muscle training with biofeedback is quite effective at the initial part of the treatment. The biofeedback had better results early on, but when again analyzing the overall improvement six weeks after the beginning of treatment, no significant lasting results were evident.

Equally, they analyzed the growth in pelvic floor musculature in the two groups. A significant change in pelvic floor muscle power occurred in one of the groups at measurements after after 3 and 6 months of therapy: the biofeedback group.

Morkved et al. (2002) compare two groups in their study. The first group receive only pelvic floor gymnastics, whereas the second group trained using the same pelvic floor gymnastics and also used biofeedback equipment.

Both groups show a significant reduction in enuresis using the pad-test after six months of training. Nevertheless, there was a statistically significant difference in the effect on the pelvic floor with and without biofeedback.

They also arrive at the conclusion that biofeedback motivates the patients better than pelvic floor gymnastics alone.

4.3.3. Vaginal Cones

Vaginal cones refer to different small, tampon-shaped weights which are placed in the vagina. After some time, the women involved in this treatment learn to hold the weights by tensing the pelvic floor musculature. Over the course of the training, heavier weights can be used.

Deindl et al. (1994) show that with the use of a vaginal cone, the EMG activity of the pelvic floor is significantly increased.

The studies conducted by *Olah et al. (1990), Kato et al. (1992)* and *Kondo et al. (1995)* demonstrate successful use of vaginal cones as a conservative method of therapy.

An overview work by *Bo et al. (1999)* points out the fact that in spite of higher subjective improvements, that is to say the perceived reduction of symptoms, studies prove only a low correlation between the muscle power of the pelvic floor and the weight of the cone which can be held.

Vaginal cones are certainly an inexpensive and efficient means of therapy. The progress of the therapy should be controlled using a precise status indicator as well as close monitoring of the patients. It is possible that some patients may be able to use a heavier vaginal cone due simply to (mis)position in the vagina despite a relatively weak contraction of the pelvic floor.

4.3.4. Electrotherapy

The only parameter for determining the success of electrotherapy in the training of the pelvic floor is the muscle contraction produced. The results of the therapy are indicated in several studies by *Caputo et al. (1993)* and *McIntosh et al. (1993)*, with success rates of up to 70%. Nonetheless other studies by *Fischer-Rasmussen (1990)* and *Luber et al. (1997)* found only a quite weak result with electrotherapy. One positive effect worth noting is the stimulation of sensitive nociceptors, which when occurring in connection with a passive muscle after contraction, help the patients to localize the pelvic floor. It is however essential that a patients attention is directed to the contraction actively, so that in the sense of neuromuscular reeducation, the correct central tracking is initiated.

4.3.5. Estrogen

Eberhard et al. (2000) describe in their study the effect of estrogen deficiency which is primarily a post-menopausal phenomenon. This deficiency leads to atrophy of all urogenital tissue structures; i.e. epithelia, musculature and the connective tissue. Additionally, there is lower water content in the tissues. Likewise, the connection between the pelvic organs weakens. As blood circulation in the tissues declines, the neurogenic and endocrine stimulating mechanism deteriorate, and the vaginal pH value increases. Estrogen substitution causes growth in as well as creation of urogenital tissue and leads rapidly to an improvement of estrogen deficiency related ailments. In the case of urogenital problems, when tolerated, local estrogen treatment should get priority *Geissbühler et al. (1994)*, as the effect is greater and appears more rapidly than a more systemic treatment.

4.3.6. Surgery

It should be noted, according to *Eberhard (2000)*, that all descensus operations which elevate the bladder cause stretching of the urethra and a deterioration in the closing function, and therefore an existing stress incontinence may be worsened or a new stress incontinence can occur. Hence, in unrecognized and in symptomatic stress incontinence, a descensus operation must be combined with an additional incontinence operation.

The recommendation for surgical treatment is usually given after a conservative therapy has been tried, when the aconuresis causes extreme discomfort, the chances for recovery from surgery are good, and of course at the patient's discretion once the chance for success and the risks have been clarified.

As for the specific surgery used in the treatment of stress incontinence, the TVT method is by far the most common (tension-free vaginal tape, as described by Ulmsten).
On the basis of several studies by *Ulmsten et al. (1996, 1998)* and *Fischer et al. (1999)*, a success rate of over 90% has been documented, though this may be due to the relative simplicity of this method (local anesthesia, usually ambulant or only a short hospital stay required), making it more well practiced than other surgical techniques.

5. Osteopathic Treatment

The body is one organically functional unit. A good osteopathic treatment always includes the whole body (structurally, viscerally, and cranially).
The focusing point herein lies at the mechanical, neurological and hormonal level. Additionally, by no means can the psycho-emotional level be forgotten.
Gabriel (2001) has shown positive effect in her osteopathic study on stress incontinence and urine leakage. The patients received three osteopathic treatments and were then tested using the PAD test and a questionnaire.

5.1. Mechanical Level

Comparisons in Barral (2004)

The human body is constantly exposed to various pressures and pulling forces. If a structure loses its elasticity and adaptability, an alteration in the overall balance is the result.
The good function of tissue is based on the coordinated movement of the diaphragm in breathing, the overall body motion, heart activity, the craniosacral rhythm and changes in the peristaltic pressure.
The diaphragm has a strong influence on the organs in the abdomen. However, the organs in the pelvis are not as strongly influenced simply due to the distance. Following x-ray analysis, *Barral (2004)* claims that the bladder can move up to 1.5cm downwards during deep breathing.
The bladder can adhere any tissue, more precisely, to any organ it contacts. Due to such adhesions the position of the bladder is often incorrect, which alters the delicate balance of the area. A fixed organ is inclined to draw another organ to itself.
Inadequate blood circulation in organs makes them vulnerable to infections. Visceral manipulations can improve the circulation of the body fluids, and in this way strengthen the immunological function.

The peritoneum has a strong insertion on the apex of the bladder (Apex vesicae). Peritoneal adhesions (secondary to operations, infections, etc.) can have a negative effect on the mobility of the bladder and the relation to the diaphragm.

Scars or adhesions in the Ligg. umbilikale can additionally impair the mobility of the bladder, since the normal pressure distribution is thus made less than optimal.

Due to its mobility and elasticity, the small intestine and Omentum majus can easily move into the pelvis. A prolapsed, that is, a part of the intestine limited in its mobility, can have a significant effect on the stability and mobility of the bladder.

In addition to “normal” deformations, the uterus may change drastically due to many external influences (e.g. pregnancy, child birth, episiotomy, ventouse and forceps delivery, hormone disorders, traumas, operations, infections, sedentary lifestyle, adiposity, etc.).
These factors can all negatively influence its function.

The pelvic floor has openings for the rectum, vagina, and for larger vessels. At these “weak points”, the pressure is lessened to only a certain extent. To maintain an equal pressure distribution in the pelvis, it is important that the openings are located in the correct position.
When they are displaced caudally, the sphincter tone is no longer strengthened by pressure in the pelvis, that is to say stimulated, and so its function is impaired.

Fig. 6: Meeting of different pressure forces in the small pelvis.

When the center tendineum perinei is too easily moved, it signals a weakness of the pelvic floor. In this area, muscle fibers of the M. levator ani, of the M. transversus perinei superficialis and profundus, as well as of the outer anal sphincter and of the M. bulbocavernosus are all interwoven.
Consequently, the central tendon is a focal point in therapy.

The physiological movements of the bladder, uterus and sacrum should be synchronized: posterior/superior during breathing in and anterior/inferior during breathing out. A false position of the bladder, uterus or sacrum thus has a negative influence on the physiological movement.

The following structures merit examination: the spinal column, the ring of the bony pelvis, including the coccyx as well the hip joints.
The Lig. transversum acetabuli proceeds from the hip joint to the fascia of the M. obturator internus and further on to the bladder. In degenerative hip disease, a negative effect on the bladder may also be observed.
Attention should also be drawn to legs and feet. Restrictions in the lower limbs have an effect on the fascial rings and on the function of the pelvic floor through a decrease in stabilizing ability.
M. obturator internus and its fascia share common fibers with the Ligg. sacrospinale and Ligg. sacrotuberale, from which fibers also go to M. biceps femoris.

Of special importance is symmetry and thus balance between the sacrum and both ilia. Hence, the position of the coccyx is an essential factor. Anterior movement of the Os coccygis causes binding in the local musculature, which in turn leads to a loss in the ability to contract.

Both Foramina obturatoria are closely connected with the bladder. Changes in tension in this region due to fibrosis (e.g. through bacterial inflammations) can be the cause for bladder disorder.

5.2. Neurological Level

Comparison in Meert (2003) and Kahle (2002)

Inappropriate tension of the local connective tissue and peritoneum can contribute to compression of blood vessels and nerves.

5.2.1. N. Pudendus (S2 – S4)

Tensions in the region of the pelvic floor and the Mm. obturatorii can create a compression of the N. pudendus.

The **N. pudendus** (S2 – S4) is divided into 3 branches:

- Nn. rectales inferior, responsible for the motor innervation of the M. sphincter ani externus and the sensory innervation of the anal neck.
- Nn. perineales are responsible for the motor innervation of the pelvic floor musculature.
- N. dorsalis clitoridis is important for the motor innervation of the M. transversus perinei profundus and of the M. sphinkter urethrae.

5.2.2. Sympathetic and Parasympathetic Innervation of the Sex Organs

Efferent **sympathetic** fibers arise from the lateral horn of the spinal cord (T12 to L2) and proceed to the sympathetic chain and from there as Nn. splanchnici thoracici minores and N. splanchnicus thoracicus imus to Plexus hypogastricus superior, and further on to Plexus hypogastricus inferior. From here the sympathetic fibers, along with the A. uterina, reach the uterus and subsequently, Parametrium, where they form the Plexus uterovaginalis.

The efferent **parasympathetic** fibers of spinal cord segments S2 – S4 pass directly to Plexus uterovaginalis.

5.2.3. Sympathetic and Parasympathetic Innervation of the Bladder

There are two paths of **sympathetic** innervation:

Efferent sympathetic fibers pass from the lateral horn of the spinal marrow (L1 – L2) to the sympathetic chain (L1 – L2) and from there as Nn. splanchnici lumbales to Plexus hypogastricus inferior. From here, the nerves pass together with the Aa. vesicales to Plexus vesicalis.

Efferent sympathetic fibers run from the lateral horn of the spinal cord (L1 – L2) to the sympathetic chain (L1 – L2) and from there, further distal to the sympathetic chain ganglia S2 – S3. From here they proceed as Nn. splanchnici sacrales to Plexus hypogastricus inferior and then to Plexus vesicalis.

Impulses of the sympathetic nervous system enable an autonomous tension of the M. sphincter vesicae internus and an autonomous relaxation of the M. detrusor vesicae. This cooperation enables the continence of the bladder. When there is a lesion of the spinal cord segments L1–L2, "spastic bladder" occurs, in which case the influence of the parasympathetic nervous system prevails.

The efferent **parasympathetic** fiber of the Nn. splanchnici pelvici from spinal cord segments S2 – S4 run into the Lamina - SRGVP (Lamina sacro-recto-genito-vesico-pubicalis) to Plexus hypogastricus inferior and from there further to Plexus vesicalis.
An impulse of the parasympathetic nervous system enables autonomous tension of the M. sphincter vesicae internus and as well as the M. detrusor vesicae. This cooperation is illicited by micturition.
With a lesion of the spinal cord at S2–S4, "loose bladder" occurs as the action of the sympathetic nervous system prevails.

5.2.4. Afferent Innervation

Pains and tensions in the pelvic region are transmitted by the parasympathetic Nn. splanchnici pelvici to S2–S4 and from there over ascending pathways cranially via the spinal cord.
Afferent signals are also transmitted over the sympathetic Nn. splanchnici pelvici and Nn. splanchnici lumbales to the lumbar spine at L1–L2.
Afferent signals from the M. sphincter urethrae and the pelvic floor lead from N. pudendus to the sacral region (S2–S4).
Through a strong afferent current, the segments at S2–S4 and L1–L2 can be "facilitated". In cases of facilitated spinal cord segments, the following is understood: according to the Gate-Control-Theory by Melzack and Wall [Pischinger (1998)], there is a control system for the arriving nerve impulses at the posterior horn of the spinal cord. This control system can be inhibited by afferent pain signals, where all signals continue unhampered to the spinal cord. Because of this, the spinal cord segment is at risk for overload. *Korr* (1978)

speaks about facilitated spinal cord segments which can rapidly be surpassed by the level of pain.

As it was already indicated, the segments S2–S4 and L1–L2 can be facilitated by tension and pain. It is possibly that the whole Plexus sacralis is affected. Therefore, it is not surprising that hypertonias occur in the pelvic floor musculature via the N. pudendus, in the M. piriformis via the N. piriformis and in the leg musculature via the N. ischiadicus. These muscular hypertonias can in turn initiate blockages and defective positions in the related segments.

5.3. Hormonal Level

Comparisons in Barral (2004) and Fritsch (2003)

The urogenital system remains under the direct influence of the hypothalamus–pituitary axis. The hypothalamus is the central area for directing vegetative functions and through its connection to the pituitary gland, it is the superior organ of direction in the endocrine system.

Thus the cranium should not be forgotten in the osteopathic treatment.

The ligaments in the pelvis contain contractile fibers. Their strength of contraction depends on the overall tissue tension and the concentration of certain hormones (progesterone, estrogen). An imbalance of the hormone level weakens the tonus of ligaments and the musculature of the perineum and the whole of the pelvis. This hormonal imbalance also explains the tendency for incontinence during menopause.

5.4. Psycho-emotional Level

In his study, *Umphred (2001)* is concerned with the effects of fear, sadness and depression on the body posture. These emotions are also directed from central nervous system and can change the sensory consciousness of the body in general and especially of the pelvic floor. The posture is often bent forward, the balance reactions are hindered and the breathing is shallower. The whole body seems to lack proper tonus.

Special attention in cases anamnesis should be given to the use of antidepressants. Many antidepressants can, according to *Barral (2004)*, affect control over the function of the bladder.

6. Implementation of the Method

The subjects of my study were voluntary, and all suffer from stress incontinence grade I – II. The women are all menopausal and gave birth at least once. No age restriction was applied. The participants were all specially selected for suitability by a gynecologist. Disqualifying criteria are: neurological diseases, total hysterectomy, tumor diseases, chemotherapy, and hormone intake.

The study is concerned with the question as to whether osteopathic treatment has a positive influence on the muscle strength of the pelvic floor in women who also participate in pelvic floor training supported by biofeedback. Additionally, the test subjects are asked in a written form whether they feel a subjective improvement in the difficulties related to their incontinence. Finally, they are interviewed as to whether they have independently continued the training of the pelvic floor during the study.

6.1. Hypothesis

In my opinion, osteopathic treatment improves the tension strength of the pelvic floor, and improves the effect of pelvic floor training supported by means of biofeedback.
By treating restrictions and ptoses in the region of the uterus and bladder, I expect to obtain improvement in the closing function of the sphincter and believe that this affects the subjective well-being of the women.
In my study, I attempt to positively influence the symptoms of incontinence with three osteopathic treatments.

6.2. Pelvic Floor Training with Biofeedback

Both study groups attend seven biofeedback sessions.
The biofeedback program used is called Beboy©, and is a computer-based test and training system especially designed for the pelvic floor musculature. The Beboy© measuring device registers the muscle tension of the pelvic floor via a electromyogram (EMG).

By means of vaginal electrodes, the small electrical impulses which are produced by musculature contraction are measured. From the measuring device, the data is sent on to a computer. The Beboy© program shows the momentary muscle tension on a monitor, calculates it, analyses it and saves it in a database.
Since the biofeedback program has only recently been developed, I will assess the data very critically as it is not yet proven whether the device withstands scientific criteria.

6.3. Test Procedure

The 11 women from the test group all participate in seven sessions of pelvic floor training using the biofeedback mentioned. The training times are fixed at one time per week. After the sixth session, there is a pause of four weeks, and after this time the last biofeedback session is conducted.
Within the first six weeks, the women obtain three osteopathic treatments at intervals of 14 days.

The 11 women from the control group also receive seven biofeedback sessions. The first six sessions occur once per week, and after a four week pause, the seventh session takes place.

Both groups are treated by a physiotherapist for the biofeedback session. The osteopathic treatment is received from me, the duration of which is between 45 and 60 minutes. Following the last session, the participants answer the questions concerning subjective improvement and the perceived results of the pelvic floor training (in written form).

6.4. Osteopathic Result and Treatment of the Test Group

In my study, I attempt to devote my attention to the special needs of the women being tested. In the treatment, I focus on the lesions which are connected with the problem of incontinence.
I begin my examination with a complete medical history, including all diseases, surgeries, accidents and everyday stresses (work, family, etc.). Then, I ask about the specific symptoms of stress incontinence.

After the interview, the test subjects are asked to undress to underwear. A detailed examination in the standing position follows. I observe posture in the standing position and test the mobility of the spinal column.
A “General Listening Test” in the standing position follows (comparisons in *Barral, 2002*) so that I may obtain further clarification as to the main focus of the treatment.
The lesions which are found in the standing position are then confirmed in the lying position. Next, the position of the coccyx is checked.
What follows is a palpation of the Diaphragma pulmonalis, the liver, the Lig. falciforme, the urachus, the small intestine and the sigmoid colon.
In the lying position I check the mobility and motility of the bladder and uterus. Following, I examine the lower extremities including the mobility of the hips and the symmetry of the pelvis.
Especially important for me is the palpation of the Membrana obturatoria. Additionally, I test the tension of the pelvic floor in the prone position, the sacral ligaments and again the mobility of the spinal column.
Afterwards, I examine the cranial system and the rhythmic movement of the sacrum together with the bladder and the uterus.

The primary focus in my treatment is on the regions which, in my opinion, have an influence on the stress incontinence.
I deal with bony lesions in affected areas of the spinal column, the pelvis and legs, hypertonias in the pelvic floor musculature and ligaments as well as in the Membrana obturatoria and in Diaphragma pulmonalis. Moreover, I attend to fixations and ptoses of the bladder, uterus, the small intestine and the liver.
I find it of exceptional importance to deal individually with the wishes of each patient.

In the case of structural lesions, I work using manipulations and Mitchell techniques as well as using the “balanced ligament technique”.
In the visceral area, I use the structural and balanced tissue techniques. The choice of the techniques is specific to the patient (e.g. osteoporosis as a contraindication).
Lesions which, in my opinion, have no negative influence on incontinence are not dealt with.

6.5. Biofeedback Treatment in the Test and the Control Group

This treatment is managed by a physiotherapist and colleague.

The procedure for the biofeedback session is explained in detail to both groups. Afterwards, all participants sign a declaration of consent stating that they agree to the usage of a vaginal probe.

The biofeedback treatment takes place in an quiet therapy room. The sessions are conducted in the sitting position during which time the women are covered with a towel.

Before the recording is started, each participant exercises the pelvic floor contraction using an individual exercise program, that is to say, does preparatory exercises. Then, when the women can activate the pelvic floor without incidental contracion of the lateral, posterior and abdominal musculature, the first session begins.

One session takes place weekly for six weeks. Following, a pause of four weeks is planned. After the four weeks time period, the last session takes place.

6.6. Questionnaire in the Test and the Control Group

After the last biofeedback session, all study participants are asked to answer two questions in written form.

(1) To what extent has your discomfort improved?

☐ A lot ☐ A bit ☐ little ☐ not at all

(2) How often during the interim four week pause have you trained the pelvic floor by yourself?

☐ A lot ☐ A bit ☐ little ☐ not at all

7. Results

7.1. Analysis of a Biofeedback Session

For the analysis of a biofeedback session, I have performed a Multi-variant Multi-factor Variant Analysis (MANOVA). The analysis includes the group variable as well as the point of time variable. Each variable has multiple categories.

The group variable has the categories: test group and control group. The point of time variable has the category: 1^{st} session, 6^{th} session, 7^{th} session.

The group factor has no significant influence on the data (F1= 1.72; p= 0.1946).

The point of time factor has a statistically significant effect on the data (F2= 3.86; p= 0.0264). In order to determine and to clarify the difference, I've used the studies by *Milliken et al. (1992)* and *Searle et al. (1998)* a Post-Hoc-Test (Tukey´s Honestly Significant Difference Test) as a basis.

For the Post-Hoc-Test, the same data will be used wherein the group factor is not allowed. A significant difference between the first and the last session is observable in these results (p= 0.037). However, no significant difference between the second to the last and the last session is shown (p= 0.96).

Fig. 7: Graph
The bars represent the average value of the pelvic floor tension of all tested persons from both groups. The lines going out from the average values set the standard variant of the average value.

6.2. The Analysis of the Written Questions

Question 1: To what extent has your discomfort improved?

	Test group	Control group	total
a lot	3	2	5
a bit	5	3	8
little	3	4	7
not at all	0	2	2

The factor “subjective improvement” is a numbered scale.

The group variable consists of the categories test group and control group. The contingency table analysis showed that no significant increase in the subjective improvement could be determined ($p >= 0.258$).

Furthermore, it has also been shown that no significant difference between the groups could be seen ($p= 1$). The problem of this analysis is the low number of the test subjects.

In order to increase the test clarity, I combined the categories “a lot”, “a bit” and “little” into the following category = “at least some improvement”. Consequently, the subjective improvement factor consists of two categories “not at all” and “at least some improvement”.

	Test group	Control group	total
at least some improvment	11	9	20
Not at all	0	2	2

The contingency table analysis of this modified data similarly shows no significant difference between the test and the control group (p= 0.2966).

At least, 91% of the tested persons (both groups together) showed in this case that the treatment helped them. A significant difference can be found in the group without improvement (p<= 0.01).

Question 2: How often during the interim four week pause have you trained the pelvic floor by yourself?

	Test group	Control group	total
a lot	4	1	5
a bit	5	7	12
little	2	3	5
not al all	0	0	0

The factor “exercising on your own” is thus also numbered scale. The group variable consists of the categories test group and control group.

The contingency table analysis can determine no significant change (p= 1). The group variable shows also no significant difference (p = 1). The problem of this analysis is once again the low number of the women tested.

In order to increase the clarity of the test the categories “a lot”, “a bit” “little” were combined into one category = “at least some exercise”.

Consequently, the factor of exercising on your own consists of the categories “not at all” and “at least some exercise”.

	Test group	Control group	total
at least some exercise	**9**	**8**	**17**
Not at all	**2**	**3**	**5**

The contingency table analysis of this modified data likewise shows no significant difference between the test and the control group (p= 0.6109).

In this case, 77% of the tested persons (both groups together) said that they exercised by themselves. A significant difference between the groups “not at all” and “at least a bit exercised” was found (p= 0,085).

8. Discussion

In my work as a physiotherapist and osteopath, I wondered whether stress incontinence could be positively effected using pelvic floor training supported by biofeedback, as well as using additional osteopathic treatment.

The study showed no significant difference between the test and the control group, I believe due to the low number of tested persons.

In 91% of the women, a subjective improvement can be found between the first and the last biofeedback session when both groups are interviewed. Furthermore, it can be seen that 77% of the tested persons are motivated to improve their pelvic floor function independently when both groups are observed together in the statistics.

The women affected by the disorder are very motivated to improve function of the pelvic floor.

Making the biofeedback treatment problematic is the fact that many women have difficulty contracting their pelvic floor correctly. The instructions had to be presented very clearly by the physiotherapist. It could be observed that the patients were excessively motivated by the display of the power of their pelvic contractions on the screen, causing them to initiate additional contractions of the leg and pelvis musculature as well as holding the breath in order to obtain better results.

Therefore, my co-worker had to be present for the entire duration of the biofeedback session.

The subjective daily conditions of the patients had also an influence on their view of the sessions.

As for the osteopathic treatment, it became clear for me that the focus must be on the region of pelvis and spinal column. Moreover, I always very subjectively balanced the holistic treatment based on patient needs and problems.

In my opinion, in order to achieve the best possible results in the treatment of women with stress incontinence in the future, it is important for every osteopath to strive for an ideal physiological environment so that the pelvis can work effectively. For that reason, it is necessary to support treatment of the pelvis with pelvic floor training in combination with biofeedback.

9. Illustration

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