Chapter 1

The Women's Pelvic Floor Biomechanics

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1. Introduction

The function of the pelvic floor is fundamentally influenced by the behaviour of several organs and the organ-linked processes. The aim of this work is to study the properties and changes of the women's pelvic floor. The motive arises from the fact that pelvic floor dysfunctions badly influence the quality of life. The loss of the proper function in the pelvic floor results in a wide range of problems from asymptomatic and anatomic defects to vaginal eversion. All the aforementioned problems are frequently followed by urinating and defecating difficulties together with sexual dysfunctions.

As the initial symptoms of pelvic floor dysfunctions are very weak, the absence of seeking medical assistance among women is significant at the beginning. However, the fact is that an early and explicit diagnosis is crucial. For example, the prevalence of uterovaginal prolapse is about 50 % among delivering women, but only one half of them search for medical care. These types of health problems occur more frequently as the population is aging.

The basis and origins of pelvic floor dysfunctions have certainly a multifactorial character. The elementary factor is intra-abdominal pressure dynamics and it is usually highlighted by obesity, chronic constipation, physically hard work, coughs and mainly pregnancy, vaginal delivery respectively. The topical application of mechanical stress affects the tissue essentially and can make progress towards the failure of tissue continuity. The only solution is usually surgery that tries to fix found problems, revive functional supports of organs and restore their physiological features. From this point of view, the most important area for research on the pelvic floor is the interaction between individual organs (endopelvic fascia mainly) and rheological description of these interactions.

2. Context and paper targets

In pregnancy, a large number of changes are observed in the female body. The main reason for the changes is to cope with the growing foetus's demands and also to protect the woman's health. The changes are mostly controlled by the endocrine system (hypnosis, adrenal, and thyroid glands, placenta, etc.). The system modifies the production of hormones which influence the whole body. The hormonal activity changes the mechanical properties of tissues and together with anatomical modification (growing) affect body posture. One of the organs that are directly impacted is the pelvic floor.

The women's pelvic floor is traditionally defined as a ligament-muscular apparatus that provides a dynamic support to the urethra, bladder, vagina and rectum. It can be divided into the supporting and suspensory parts.

The supporting part is formed by muscles (m. coccygeus, m. levator ani) that create a thin funnel. The funnel is ended by a hole which establishes a corridor for above mention organs. M. levator ani is directly connected to the vaginal muscle. According to the phylogenetic view, the coccygeus muscle (m. coccygeus) is a skeletal muscle and therefore it is directly connected to the musculoskeletal system.

The suspensory part is a fibrous component that is termed the endopelvic fascia. It is a coherent system that surrounds the vagina and connects to the pelvic walls. The fascia's segments are conservatively named the pubocervical fascia, rectovaginal fascia, cardinal ligaments, and sacrouterine ligaments.

The aforementioned muscles and ligaments guarantee the proper function of the pelvic floor. When the function is unbalanced, it causes a fall and disorganization of organs. These changes strongly affect body posture. While muscular problems are usually solved by suitable physiotherapy treatment, problems of the suspensory apparatus are mostly fixed by surgical approaches when an implant is frequently installed.

This paper discusses the influence of pregnancy on the pelvic floor. In and after pregnancy the pelvic floor is even more loaded and stressed and therefore the eventual dysfunctions multiply related unpleasant effects. The main goal is to discover the structural disorders of suspensory apparatus and rheological expression of endopelvic fascia properties. The outcome of this study helps to design better implants and which mechanical properties are not dangerous due to increasing local mechanical stress.

3. Research

The research in this area has been supported by several grants and it is widely discussed in doctoral and master theses within the department. The experiments are measured in a laboratory that is fully equipped for kinematic and dynamic testing as well as for identifying the rheological properties of soft tissues.

3.1. Changes in body posture

The changes in body posture are observed while walking, standing or performing specific movements (for example landing on the heels after standing on tiptoe). The experiments are conducted on women at different stages of pregnancy. This is very important due to the hormonal changes.

In pregnancy the whole musculoskeletal system is influenced by relaxin, which is produced by the placenta, and corpus luteum. They both control the ligamentary apparatus by inhibiting collagen synthesis that amplifies the activity of collagenase and consequently the ligaments of the pelvic girdle and spine become looser. The loose ligaments and weight of the pregnant uterus increase lumbar lordosis. The whole process results in modifications of movement stereotypes. The modification does not only arise from mechanical principles but in particular form the urgency of seeking a relieving posture. A significant role also played by the fact that m. levatoru ani and the thoracic muscles are functionally engaged in the active muscle chain. In the conducted experiments, the activity of chosen muscles was detected by EMG testing and the performance of movements or the quality of posture was measured by the kinematic-dynamic analysis.

3.1.1. Gait

Nowadays, the topic of normal gait is discussed worldwide by academics (mid gait - Young, 1997). It is an activity which is hardly avoided by pregnant women even in the latter stages of pregnancy. In addition, a unified methodology for evaluating gait has not been invented yet and therefore the published data about gait in pregnancy has varied dramatically.

Atkinson (1999) compared 3D analysis of gait among one pregnant and one non-pregnant woman. The gait was recorded on video. The subjects were labelled with markers on the acromion, the most distal rib, trochanter major, epicondylus lateralis femoris, malleolus laterilis, and the navel. The data were evaluated by using Motion Capture software and Motion analysis. The results showed that there were significant differences neither in the lumbar spine curvature (the maximum difference about 10 °), gait speed nor flexion and extension in the hip joint.

Bird et al (1999) observed gait among 25 pregnant women at the beginning of gravidity. The results showed dilatation of the weight-bearing base in pregnancy.

Butler et al (2006) studied the ability of keeping balance and stability. Moreover, it was tested if falling in pregnancy was related to the decreased postural stability. The reason for that was the fact that almost one quarter of pregnant women suffered a fall. The number is comparable with people who are over 65 years old. Twelve pregnant and non-pregnant women (average age 31) took part in the experiment. At the 11^{th} – 14^{th}, 19^{th} – 22^{nd}, and 36^{th} – 39^{th} week of pregnancy and 6 – 8 weeks after birth the markers were placed on the participants and their gait was recorded by a 3D device. The observed parameters stayed relatively the same within both groups of participants. However, both the extension of the hip joint and the flexion of the knee joint increased at the end of the standing phase (this phenomenon is usually guided by greater extension of the knee joint between the half and the end of standing phase). The results also showed no difference in the width of the base and the position of the thorax during walking cycles. The speed of gait was increasing together with the length of steps from the first to the third trimester ($p < 0.05$). There was found no difference in the postural stability between the groups of the women in the first trimester of pregnancy. Furthermore, the women were also tested standing with closed eyes.

In that case postural stability increased in the group of the pregnant women who were in the second or third trimester and even stayed lower after 6 – 8 weeks after birth. In addition, the difference between the groups was directly proportional to the stage of pregnancy.

Another paper was published by Foti et al (2000). The paper described gait of 15 women in the second half of the third trimester and one year after birth. The chosen gait parameters were obtained by the system for 3D motion analysis and the dynamometric platform. The obtained data were compared by using a paired test. The watched parameters were ranges of the joint motions, moments of inertia, and the width of the weight-bearing base. No difference was measured in the speed of gait, length of steps or gait rhythm. Neither the width of steps nor mobility of the pelvis and the ankle joint was significantly changed ($p > 0.05$). Despite the above mentioned facts, an anterior pelvic angel increased about 4° in pregnancy; however, there were considerable variations between the participants (from – 13° to + 10°). In addition to the results, the flexion and adduction of the hip joint largely increased. Finally it was discovered that the phase of double foot-holding increased and the phase of foot swing was shortened.

Golomer et al. (1991) investigated gait with and without a burden. The group of ten pregnant and 20 non-pregnant women carried the burden. The speed of gait and the characteristics of the foot-ground interaction were monitored. The results presented that the speed of gait of the pregnant women did not depend on carrying the burden. The rhythm of gait was faster for the pregnant woman and the length of steps was shorter during pregnancy. The length of steps stayed about the same with or without the burden.

Lymbery a Gilleard (2005) employed an 8-camera system for 3D motion analysis and also measured the pressure of feet to the ground at the end of pregnancy and after birth. They measured 13 pregnant women at the 38th week of gravidity and 8 weeks after birth. They listed a greater width of the weight-bearing base at the end of pregnancy. The mediolateral reaction force on the ground was increasing in the medial direction. The center of pressure (COP) was moved to the centre and anteriorly.

The paper by Osmana et al (2002) discussed 4 pregnant women at the different stage of gravidity and 4 women after birth. Their walking stereotypes were analysed by using the 3D system Peak Motus 2000 and a video camera that took pictures of reflective markers glued to the body. The activity of paravertebral muscles was measured with EMG in the area of lumbar spine (L4/5). Next, the COP was measured on the dynamometric measuring platform Kistler and the interaction forces between feet and ground were analysed in three directions (vertical, lateral, and anteroposterioric). The data of the groups were compared and results were interpreted. The width of the weight-bearing base was increasing in pregnancy. The mean width of the weight-bearing base increased from 168 mm in the first trimester to 350 mm in the third trimester (increase about 50 %). The mediolateral component of reaction force on the platform increased up to 15 % of the body weight.

The experiment conducted in our laboratory was carried out on six pregnant women who were observed during the full duration of pregnancy. Their gait stereotypes were always analysed at the end of each trimester. The kinematic properties were received thanks to the system Qualisys. The system uses infra-sensitive markers and enables one to observe defined spots in time. The dynamometric measuring platform Kistler read simultaneously reaction force between feet and the platform. The placement of the markers is displayed in figure 1.

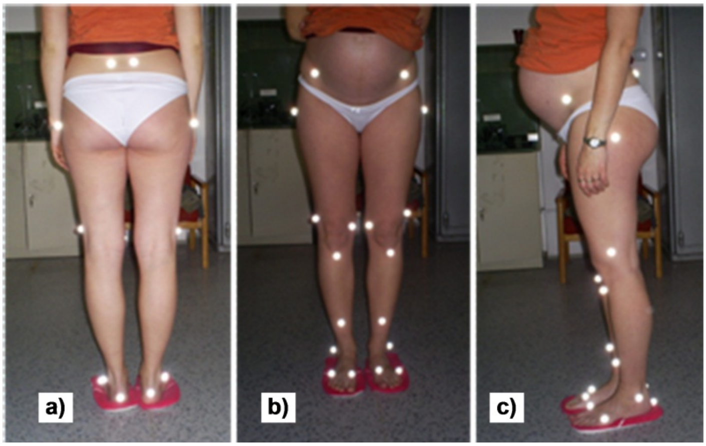

Figure 1. The markers location (a) rear; b) front; c) side.

The observed values were the speed of gait, the weight-bearing base, the time of swing and standing phases, the time of double foot-holding phases, and impulses of the vertical, accelerating, and decelerating forces.

The results are well presented in figure 2. The down-pointed arrow means a decrease in the parameter, the up-pointed arrow means an increase in the parameter and the horizontal arrow symbolizes a steady state. The dash represents no measurement was carried due to birth.

Proband		1	2	3	4	5	6
Gait velocity	1.-2. trimestr	↘	↘	↘	↗	↘	↗
	2.-3. trimestr	↘	↗	↗	↗	↗	-
Supporting base width	1.-2. trimestr	↔	↔	↗	↗	↗	↗
	2.-3. trimestr	↔	↔	↘	↘	↗	-
Swing phase	1.-2. trimestr	↘	↘	↘	↘	↗	↗
	2.-3. trimestr	↗	↗	↘	↘	↘	-
Stand phase	1.-2. trimestr	↗	↗	↗	↗	↘	↘
	2.-3. trimestr	↘	↘	↗	↗	↗	-
Double support phase	1.-2. trimestr	↗	↗	↗	↗	↘	↘
	2.-3. trimestr	↘	↘	↗	↗	↗	-
Vertical force impulse	1.-2. trimestr	↗	↗	↗	↗	↗	↗
	2.-3. trimestr	↗	↗	↗	↗	↗	-
Deceleration force impulse	1.-2. trimestr	↗	↗	↗	↗	↗	↗
	2.-3. trimestr	↗	↗	↗	↗	↗	-
Acceleration force impulse	1.-2. trimestr	↗	↗	↗	↗	↗	↗
	2.-3. trimestr	↗	↗	↗	↗	↗	-

Figure 2. The results of the study.

It is obvious that examined parameters have embodied a high interindividual variability. The variability is strongly related to the current fitness of the women and the foetus position. According to the results only an increase in weight-bearing base has been proven.

3.1.2. Standing

The situation about standing strongly reminds the state of the gait research. The information varies mainly in the area of body posture and the lower back positioning.

Kovalčíková (1990) dealt with curvatures of the spine in sagittal plane and the angle of pelvic among women in the single trimesters of pregnancy, after birth (post partum) and after puerperium (post puerperium). The number of 384 pregnant women was divided into three groups; athletes, women psychosomatically ready to deliver a child, and non-athletes. The depth of neck and lumbar lordosis as well as the angle of the pelvis were examined in standing. The increase of neck and lumbar lordosis was confirmed among all three groups in pregnancy and the state started returning to the normal after birth and after puerperium. The mean angle of the pelvis was decreasing in pregnancy (flexion occurring) and after birth, puerperium the angle was increasing (extension occurring). The most significant changes were listed in the group of non-athletes.

The same results, increasing of lumbar lordosis, were confirmed by Otman et al (1989). In the study, 40 pregnant women were tested. It was written that lumbar lordosis increased significantly in pregnancy. On the other hand it got smaller after birth and it became even smaller at the 6^{th} week after birth but it was still bigger than in the first trimester of pregnancy.

Moore et al (1990) published that the lumbar spine was being flatted and the thoracic spine did not change its shape in pregnancy. For the experiment a special suit was constructed. The suit was covered with ten markers along the thoracic spine between Th1 and L5 and then 25 women were measured form the 16^{th} week of pregnancy to birth and again two months after birth. The side photography was taken of the area of the thorax and the profile of the outer skin was established. The results of that study was that lordosis decreased among 56 % of women at the 16^{th} to 32^{nd} week of pregnancy and after that period lordosis increased among 44 % but it still stayed smaller than the curvatures before pregnancy. Both the kyphotic angle and the position of centre of gravity did not move significantly.

Kušová (2004) conducted a study on 15 women that were examined through the use of Moiré tomography in the second and the ninth month of pregnancy and again at the 7^{th} week after birth. The curvatures in sagittal plane and asymmetries of the trunk were evaluated. The results showed that thoracic kyphosis decreased among four out of six women between the first and third trimester. Lumbar lordosis increased in four women and no change was observed for one participant. There was no change in thoracic kyphosis in two women, in one there was an increase of lumbar lordosis, and in two no change again between the 9^{th} month of gravidity and the 7^{th} week after birth. In the period from the first trimester to the 7^{th} week after birth, thoracic kyphosis increased in two women, decreased in one and did not change in two. Lumbar lordosis increased in two women, decreased in one, and did not change in two participants. The other changes considered as errors were mainly influenced by the variability and instability of standing. The author stated that there was no significant relationship between the changes of the spine shape and pregnancy.

The aim of our study at the field of standing has been focused on finding the objective methodology that scores the changes of mass distribution in the body of pregnant women in comparison with nonpregnant. For this reason side photography segmentation of participants was projected (figure 3).

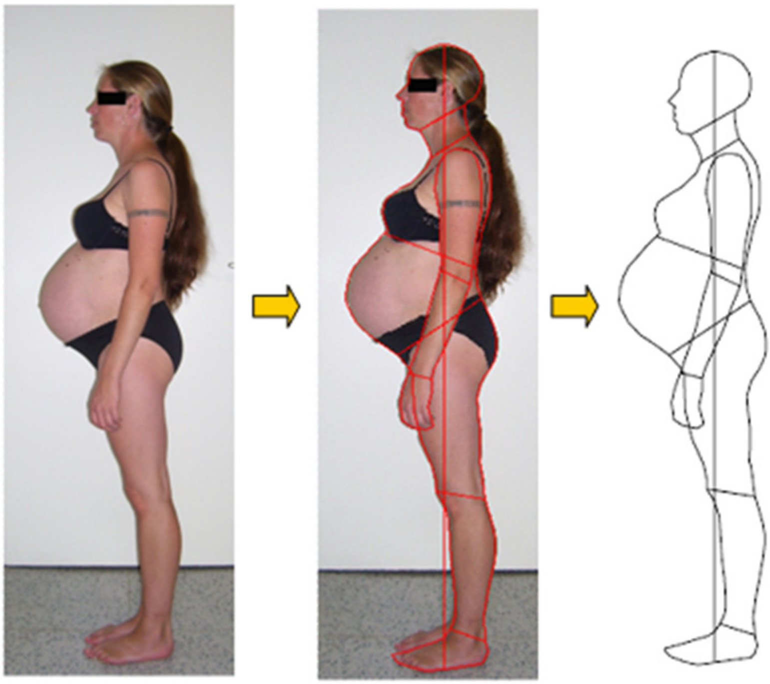

Figure 3. The segmentation process.

The position of the body axis (the line of the centre of gravity), which divides the segments into the front and rear parts, matches the line of action of force of gravity. The force passes through the centre of gravity and it is perpendicular to the ground. Its projection into the ground was established thanks to the dynamometric measuring platform Kistler. The recorded video was used to support the previous experiment. The film showed the marked position of the centre of gravity projection through the use of the dimensions that labelled the relationship between the system of coordinates of the Kistler platform and the participants' ankles (figure 4). The reviewed value in our work was the dimension *c*.

For better orientation, the segmental marking was established topically (figure 5).

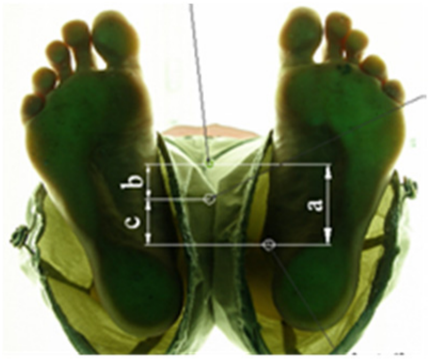

Figure 4. Location of the center of mass projection

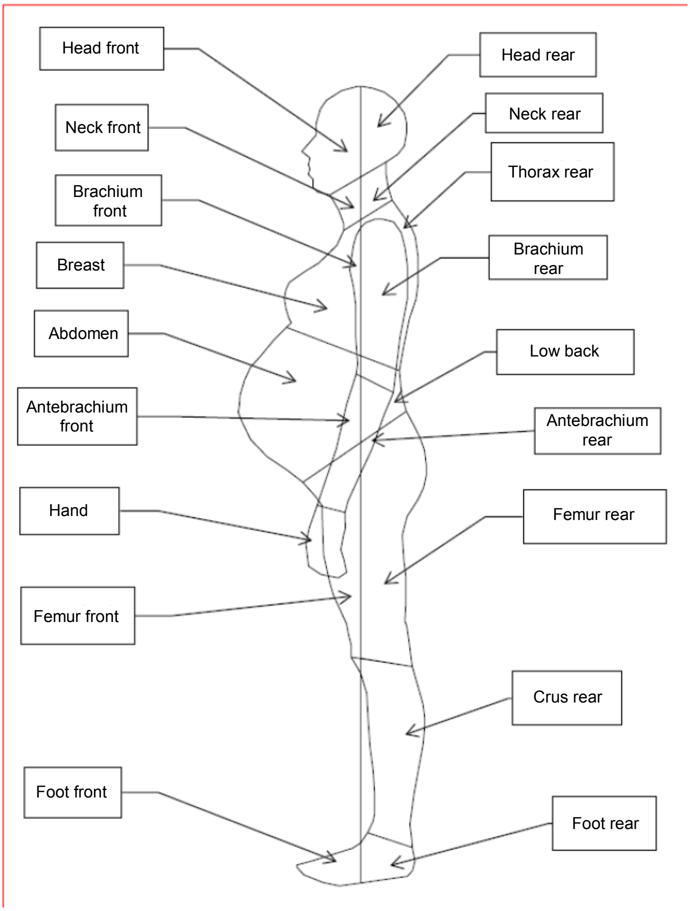

Figure 5. The adopted terminology.

The surface volume of each segment was recounted with the correlation to the weight to avoid data bias.

In the experiment 10 pregnant and 10 non-pregnant women of the same age were tested. The results showed that no significant change in the position of centre of gravity occurred in any direction in pregnancy. The explanation was offered by the analysis of the weights of the body segments. The analysis showed that the progressive state of pregnancy affects growing of the breast, thoracic spine and rear thigh segments up to 4 %. Those changes compensated each other and thus the position of centre of gravity did not differ. According to the analysis of momentum equilibrium it was proved that the momentum impact had forward tendency among the pregnant women. The fact is that the collected data were at the edge of accuracy of the used evaluating methods and therefore it cannot be listed that pregnant women had worse posture stability. The study discovered that pregnancy hardly affects lumbar lordosis and the effect is even smaller among women with a high fitness level.

3.1.3. The dynamic parameters of the gravid abdomen and low back pain

According to the increasing weight of the abdomen in the progressive stages of pregnancy, the inertial effects cannot be neglected or underestimated even during trivial locomotion. The gravid abdomen behaves as an inverted pendulum, which is primarily stabilized by the fibrous suspensory apparatus of the uterus and by the muscles of the abdominal wall. The loading in this area is transferred through the sacrouterinne ligaments to the areas of the low back and lumbosacral junction. This continuous loading consequently leads to overloading of the involved tissue structures which is expressed by pain in the areas mentioned above.

The aim of our research in this field is to establish the influence of changes in dynamic properties of the gravid abdomen and the related force effect on the lumbar region. For changing the aforementioned phenomena, the under mentioned commercially available pregnancy belts were applied in the experiments (figure 6).

(a) (b)

Figure 6. a) pregnancy belt without braces - Cellacare Materna (www.lohmann-rauscher.cz) b) pregnancy belt with braces - Materna (www.ergon.cz)

For the acquisition of the kinematic data, the Qualisys system was used. The force (dynamic) effects were detected by the Kistler equipment. The experiment was conducted on two pregnant women in the third trimester.

In the first phase of the experiment, the normal gait was analyzed. The analysis was focused on the movements of the marker that was placed on the navel in cranio-caudal and latero-lateral direction (figure 7).

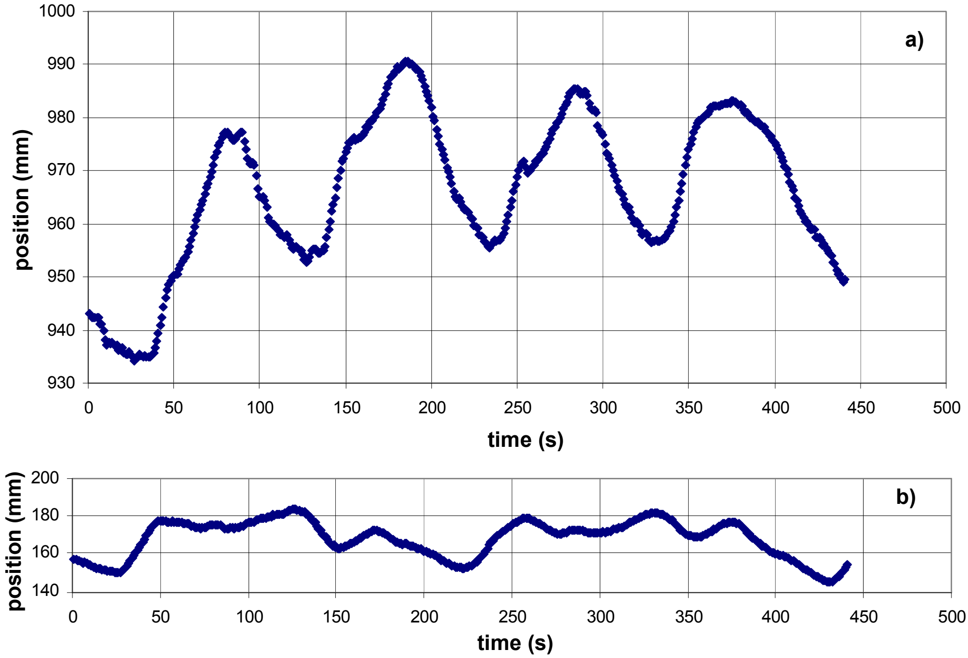

Figure 7. The navel motion (a) caudo-cranial; b) latero-lateral.

The data evaluation was based on mutual comparison of the displayed curves for the measurements without the belt, with the belt and with the belt and braces for both participants. The observed phenomenons were the significant frequencies characterized by the highest amplitudes. The results showed that the belts had a totally negligible effect in this respect, because the change of those frequencies was not found.

In the second stage of the experiment, the vibrations of the participant's gravid abdomen were observed after the fall on heels after standing on tiptoe. The caudo-cranial movement of the navel marker was recorded. The evaluation was performed separately for each direction (figure 8).

The last stage of the experiment contained a questionnaire investigation which was designed to explore the participant's feelings about the belts and the connection between the lumbar pain and wearing the belts. In the final part 11 pregnant women in the third trimester participated. The selected belt type was worn for 14 days except for sleeping.

The obtained results confirmed the reduction of pain in the observed area from 20 up to 76%.

According to the results, the importance of the supporting devices is mainly to decreased loading in the stressed areas and reduce the utilization of the involved tissue structures.

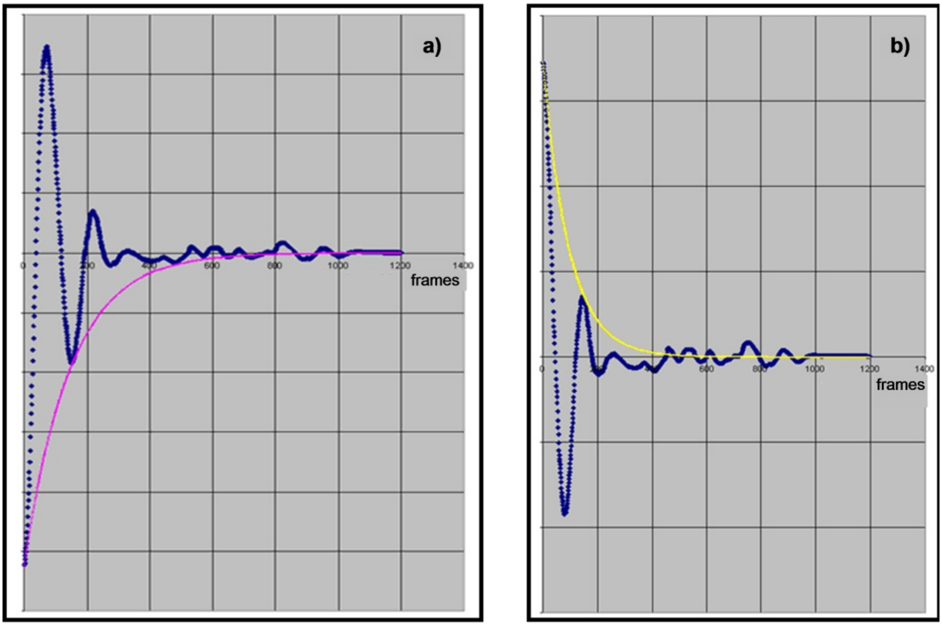

Figure 8. The navel motion suppressing a) downward direction; b) upward direction.

3.2. Endopelvic fascia

The endopelvic fascia is the soft tissue surrounding the vagina. It is attached to the pelvic walls and supports the pelvic viscera - urethra, bladder, cervix, uterus and rectum. Because the fascia is a relatively shape-complicated organ and its various parts are exposed to different mechanical loading, it can be reasonably assumed, that their mechanical properties will vary according to the appropriate field. Regarding the complex structure of the endopelvic fascia, some strength tests through its whole length are difficult to perform. The research is then focused on the areas where the fascia is relatively accessible and where some of its parts can be removed during standard surgeries without causing any inconvenience for patients. The main monitored parameters are elasticity and viscosity, which are represented by the identifiable proteins (e. g. collagen, elastin, etc.) and their mutual arrangement.

Our current work has mainly targeted the issue of long-term postnatal complications in terms of biomechanics, which are largely caused by the processes occurring during birth. The specific goal of the research was the endopelvic fascia and its properties in relation to its intimate relationship to the vaginal mucosa. The changes occurring during birth are also characterized by the greater or minor damaged of tissues. It may also results in a functional failure of the pelvic floor. The damage usually has a multifunctional character and also diverse consequences, however, they are never beneficial for the health of the patient.

The birth is initiated by uterine activity which leads to the gradual extending of the lower uterine segment and cervix. The mechanism of the expansion is allowed by the muscular cell organization. At each contraction the uterus is straightened to the middle line. The uterus is fixed by the suspensory apparatus (especially uteroingvinal chorda) so the fundus is limited in its movement. In the distal direction, the uterus is fixed by sacrouterine ligaments, the muscles and ligaments of the pelvic floor and by its insertion of the vagina. Thanks to the experience that is based on the above mentioned facts, the birth duration and complications, and the other well-known factors it is possible to predict the injury of related tissues and organs. The main recognized causes include injuries such as problematic vaginal birth, chronic increase of the intra-abdominal pressure (obesity, coughs), aging and changed mechanical properties of the suspensory apparatus including the endopelvic fascia.

The mechanical properties of the fascia have been investigated only very marginally and there is still a lack of the valid biomechanical characteristics in world literature. Due to the development of surgical techniques that replace the endopelvic fascia by allogen implants that often result into over rigid spare septa. That is the main reason to increase the knowledge of the mechanical properties of autogenous tissues. From the medical point of view, the biomechanical approach is irreplaceable. Because of the continuing "material disagreement" between the operated tissue and the implant, the foreign material is often refused, which is rather a question of immune response and this can be pharmacologically suppressed. A more serious problem is often the unclear response of the implant to mechanical loading. This is the main factor that influences the success of the surgery, because complicated thermo-visco-plasto-elastic properties of living tissues cannot be substituted by a purely mechanical replacement.

Within the latest phase of our research, 16 samples of vaginal wall with fascia were measured by standardized uni-axial tensile test to determine their "referenced" properties. Next, 6 samples of the implants were measured by the same procedure. The following text presents the proposed and used methods of processing and evaluating of the measured data. At the end, the obtained findings associated with the monitored parameters such as pregnancy, number of completed pregnancies and age of the donor women are listed.

For description of observed materials, we used the linear elastic modulus, which is defined by following formula:

$$F = K \cdot \Delta l, \quad (1)$$

where $\boldsymbol{K}$ is stiffness (rigidity) (N/mm), $\boldsymbol{F}$ force (N) and $\boldsymbol{\Delta l}$ relative extension (mm).

Regarding the real organization of both tissue structures in the samples (figure 9), we created a complete model of the tested samples by parallel junction of two rigidities, which can be described by the following equation of the force balance:

$$F_{FP} = F_P + F_F, \tag{2}$$

where F_{FP} is the force detected by the measuring head of the device, F_P is the reaction force given by properties of the vaginal wall and F_F is the force from endopelvic fascia.

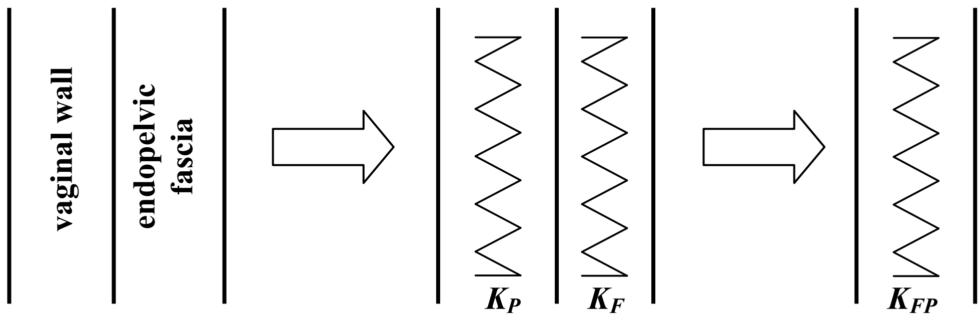

Figure 9. The tissue structure layout chart.

Using the formula (1), the equation (2) can be arranged to the next shape:

$$K_{FP}.\Delta l = K_P.\Delta l + K_F.\Delta l, \tag{3}$$

and after rearrangement, the relation for rigidity of the vaginal wall is obtained:

$$K_p = K_{FP} - K_F \tag{4}$$

Regarding the data obtained from the performed experiments, this relationship can be used to calculate the rigidity of the vaginal wall at the moment of its rupture, when the rigidity of the separated endopelvic fascia is known.

For each dependency between the force and extension (figure 10), several particular magnitudes of the rigidity of the used model were obtained.

The yellow marked area in figure 10a is the record of the cyclic "preload" of the sample in order to stabilize its mechanical properties. The slight vacillations of measured curves (figure 10b, red marked area) showed that the prolongation without the further presumed force increase may be interpreted e.g. as moments, where some minor damages had happened in the tissue without influence on overall stability of tested sample's response. The major breakthrough in the sample response's course was the vaginal wall rupture (figure 10b, yellow marked area). The following graph course (figure 10b, area 8 and 9) was then formed only by the endopelvic fascia response. The moment of the vaginal wall rupture and also endopelvic fascia rupture was well detectable even on the synchronous video recording of the experiment.

The curve (figure 10b) was further divided into the particular sections with a linear character, which were assigned rigidities characterizing the vaginal wall with endopelvic fascia as a whole (figure 10b, areas 1 to 7) and rigidities of the endopelvic fascia separately (figure 10b, areas 8, 9). Applying the above formulas, the rigidity of the vaginal wall can be calculated.

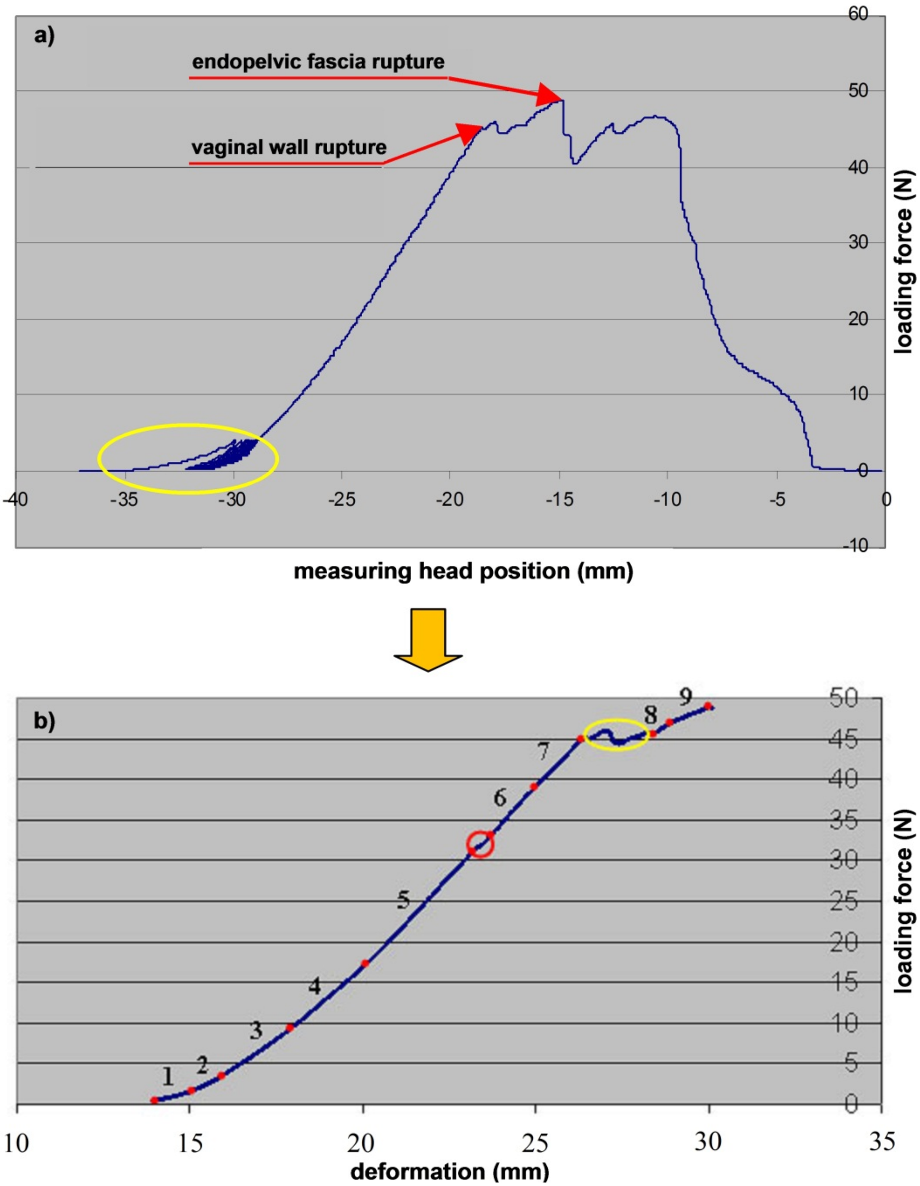

Figure 10. Measurement record (a) and evaluated section (b).

According to the measurement curve analysis and comparison of calculated rigidities the following can be stated:

1. The vaginal wall endures lesser prolongation compared to the endopelvic fascia. This conclusion is valid for all our experiments performed so far, independently on patient anamnesis.
2. Samples rigidity increases with deformation and after reaching maximum decreases while heading for the rupture (figure 11). The curve has a concave characteristic and it is visible on all tested samples.

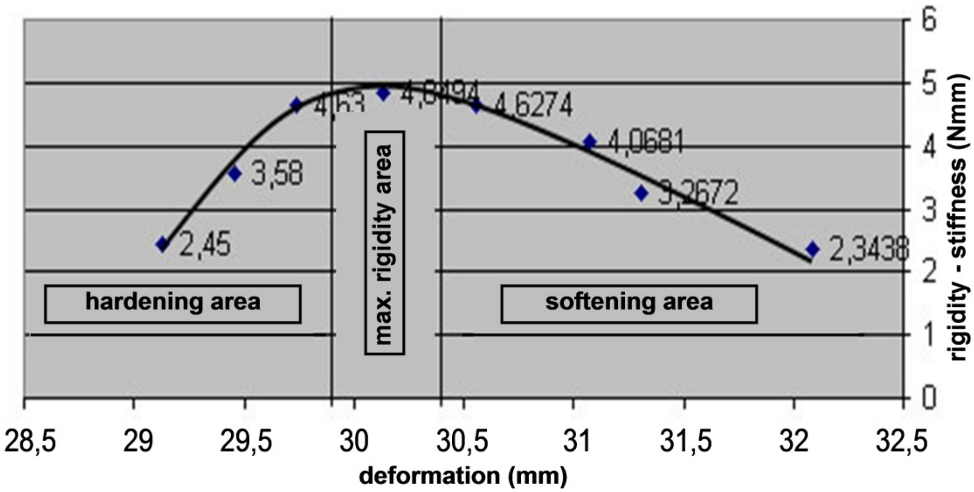

Figure 11. Rigidity – prolongation relation of fascia + vagina complex (an example).

3. After the vaginal wall rupture the rigidity of the endopelvic fascia decreases with increasing deformation. This decrease can be considered linear with satisfying precision.

From the current results it can be concluded that the endopelvic fascia has relatively stable properties that are changed significantly only in pregnancy and stabilized again after it. In terms of long-term changes associated with a decrease of mechanical properties of the fascia the crucial parameter is the age of a woman. The number of completed pregnancies exhibits no significant influence.

The processing and evaluating of the data from the second phase of the experiment corresponded to the methods described above. The data were arranged into graphs (figure 12) and the dependence of rigidity on extension of the samples was evaluated.

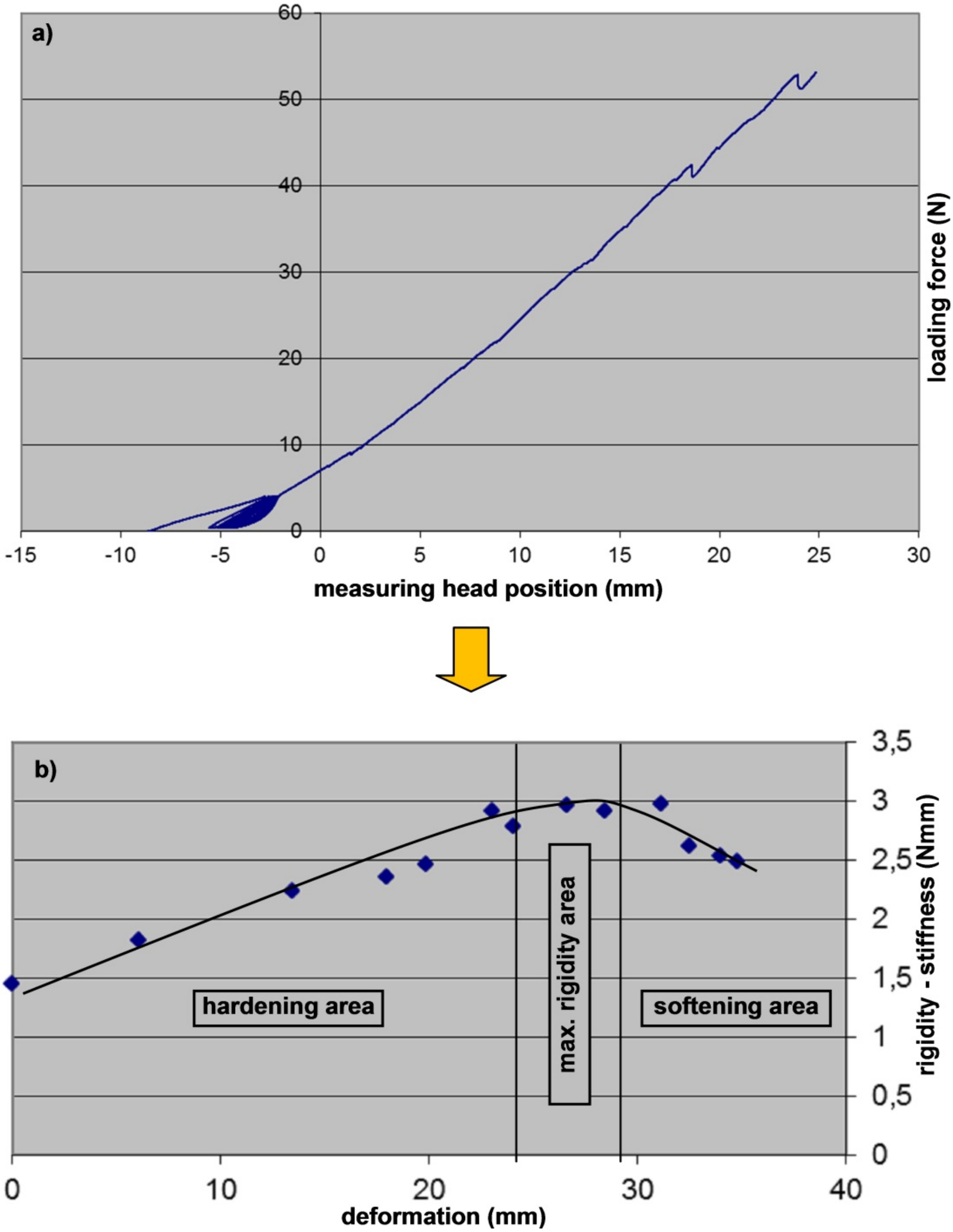

Figure 12. a) Measurement record and rigidity; b) prolongation relation of the implant.

The comparison of the graphs 12a and 12b shows that the response of samples of vaginal wall with the endopelvic fascia and samples of used implants is similar. The question is, whether these values of the implants rigidity are convenient for their purpose. A reliable answer to this question tasks for an extensive study, however, it must be fulfilled that the implant should compensate for the differences between rigidity of the healthy and damaged tissues.

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