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The Changing Image of the Pelvic Science

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Abstract

Pelvic science has made serious progress in single organ studies as exemplified by urological and gynecological studies and consequent successful interventions. Interrelations between pelvic organs are inadequately studied. This evasiveness about the lack of knowledge leads to vitalistic explanations and handling. A series of diseases, like fecal and urine incontinence and low back pain are badly understood. Holistic research is seemingly the only option towards successful clinics, which is clearly missing in pelvic research. The new engineering and/or mathematical techniques like finite element modeling are good options to reach such a functional morphological or holistic pelvic research.

Keywords: Holism; Vitalism; Incontinence; Pelvic muscles; Pelvic history; Finite element; Modeling; Embryology; Anatomy; Ahysiotherapy

Introduction

This short review is by invitation of the editors of the Journal of Yoga and Physical Therapy: I wonder if you could write a short review or a short commentary based on your previous article entitled "Concepts and Approaches in the Study of the Pelvis" for publication in an upcoming issue of "Prenatal yoga". To overcome any misunderstanding chapter 5 (pp 111-141) of our book "The pelvis, structure, gender and society" is indicated.

The heading of this short review is a slight modification of a book entitled "The changing image of the sciences". Its introduction paper ends with "These papers do two things. On the one hand, they provide accounts of the way the sciences are perceived at this time, snapshots of the sciences that are ever changing and interpretations that must change with them. On the other hand, they provide arguments for how we ought to study these changing images and present them to our students and public."

This short review starts with how pelvic science is perceived by the scientist, clinician and the paramedic and consequently will provide arguments and explanations for the changes noted in the pelvic science.

Hypothetic-deductive and holistic reasoning

The hypothetic-deductive method had an enormous influence on research in the beginning of the last century. Key to this was experimentation that should give quantitative data from which hypotheses were constructed that should compete. Any science should start with raw material that consists of observations. The transfer is by language and it is the sentence structure that determines, whether the observations are polluted or not. Therefore sense data was introduced in science, like "red, here, now". In this approach, science had to use restricted communications and observation sentences had to be justified. Evidently, the danger is in the observation sentences, because normally they contain a hypothesis or an assumption. Therefore, the specific observation has to be determined and has to be true, without the observer's subjective view. This rigorous approach at least stresses the real nature of matter [1].

This method resulted in Germany in an experimentalist physiology, which was taken over in biology and later in medicine that in essence "became analytical and reductionist in tone" [1]. In the long run it was applied in all biomedical disciplines, but other types of reasoning stayed present, e.g., functional explanations.

Apart from the analytical methodology, other biomedical scientists persisted in the study of the organism as a whole entity [2-4]. It is called holism. Holism (Greek ὅλος *holos* "whole, entire") says that natural systems (here physical, biological, chemical ones) and their properties should be viewed as whole entities, not as collections of parts. It includes the view that systems function as wholes and that their functioning cannot be fully understood by the study of its separate parts. The holistic approach is a consequence of Aristotle's philosophy. His idea of the living being a real unity of soul (or mind) and body, and the body being carrier of the soul (the flute player without the flute is no flute player anymore) supports holistic methodology but also brings forward vitalism.

The holistic approach has been applied in the work of Claude Bernard on the constancy of the "milieu interieur", as opposed to the "milieu exterieur" given the research on homeostasis. Homeostasis as a system was difficult to study due to its complexity. "As difficult as it was for biologists to find satisfactory means of mapping complex interacting systems, it was becoming clear by the 1920s and 1930s that many biological systems were not reducible only to individual parts, and that studying interactions had to become a core part of the life sciences" [1]. Some who supported the holistic approach, "extended these beyond the empirical and materialistic, often evincing various sorts of vitalistic, "supra-organismic" or other metaphysical views that bordered on the mystical [1].

One should understand that an empirical and materialistic holism does exist that has nothing to do with vitalism, but is directed towards a non-reductive approach of science. "Functional explanations as they are used in biology have neither anthropomorphic nor vitalistic implications. That is, when biologists state that a certain item or activity

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has a function they do not imply that those items or activities result from design by an intellectual being (anthropomorphism) or from the activity of extra-physical, vital forces (vitalism)" [5].

Here we restrict ourselves to two examples from embryology and anatomy: Hans Spemann's embryological research [6,7]. Both researchers knew very well that holism had a questionable reputation: "The holists themselves were to blame for their philosophic ideas not attracting the attention of the scientists by dictums like: "the whole is more than the sum of the parts", without stating where or what this "more" was or indicating a method to find out this "more" [7]. The analytic study of an organ or organ part could only be done in relation to its surrounding structures: studying the jaw of a species necessitates the study of the head the jaw belongs to. In embryology the "spatial coherence" forces the study of the development of an organ or tissue in relation to its surrounding tissues or organs and is strongly related to cell sociology [8]. Without doubt this "true" holistic approach of research has brought progress in morphology and embryology.

It therefore can be said that both the hypothetic-deductive and the holistic method are worthwhile to be present in research and presumably are complementary, but are also in competition with each other. In other words, for a truly empiric science one needs this theoretic pluralism.

Short history of pelvic science

Bladder stones were the consequence of the diet in Europe. In the past, the surgical removal of bladder stones was frequently used, an operation already practiced by the Greeks, Romans, and Hindus before the beginning of our era. The bladder can be approached surgically by three routes. One can reach the bladder over the pubic bones, through the rectum or via the perineum. The preference in days gone by was the perineal route. Bladder stone patients suffered unbearable pain and had trouble urinating, having to deal with "labor-like" bladder pain in between. Therefore, one can understand the willingness of bladder stone sufferers to undergo surgical treatment to remove the stones, whatever the consequences.

The surgical result in most cases was disastrous: wound infection, fistulas, incontinence, and serious hemorrhage were common consequences. One should note that although the bladder stone operation occurred frequently, no lessons were drawn from the negative results, nor did it force the "surgeons" to study the uropoetic system or the pelvis [9]. In those days the surgeon made sure he had left the scene before the results of his interventions became clear to the patient and thus to himself.

During the scientific revolution and the start of the enlightment, the interest in the uropoetic and genital system has remained prominent in comparative anatomy. In human anatomy, Hendrik van Deventer (called Father of the pelvic science, 1651-1724); Govard Bidloo (1649-1713) and Albinus (1697-1770), among others of course, studied the anatomy of the pelvis. The bony pelvis and its organs were consequently described. Van Deventer noticed that midwives lacked professional knowledge (stillbirths occurred at a rate far higher than one in twenty and often the physician had to come to assist the midwife). Van Deventer, Rueff (1500-1558) and Culpepper (1616-1654) all published to increase the midwife's knowledge. "Thus at least three centuries of vernacular publishing and calls by medical doctors and by administrators (e.g. Instructions by the Minister Joseph Raulin (1708-1784) in France) for improvements in the quality of midwifery can be documented but to no avail: stillbirth rates remained high" [9].

Both Van Deventer and Bidloo made mistakes in the description of the bony pelvis and its organs: Van Deventer by depicting a pathological bony pelvis twice. Bidloo missed structures that his medical artist pictured. Albinus recalculated structures to his *homo perfectus*. One must regrettably conclude that, at the end of the seventeenth century, pelvic science made an unhappy start, because it was based on several faulty data [9] for an extended overview.

"In the seventeenth century, the internal pelvic organ descriptions become definitive mainly due to the students and successors of van Horne (1621-1670) at the Leiden University. Drelincourt (1633-1697) studied the changes of the uterus during pregnancy and described fetal development. Nuck (1650-1692) is known for his ligament studies and the cyst of Nuck. Studying the inguinal anatomy, he found cyst formation along the ligamentum teres in the labia majora. Here, we concentrate on the studies of the female pelvic organs, but the same results hold for the male ones. The female internal pelvic organs are described in extenso by Regnoldus de Graaf (1641–1673) and Jan Swammerdam (1637–1680). Ovulum and ovulation of the female were discovered. External and internal sexual organs were depicted and studied. De Graaf examined the clitoris, indicated blood vessels and nerves in relation to the female reproductive organs as Swammerdam did. Ligament connections were given. Although others in the North contributed to the anatomy of the pelvic organs (e.g. Bidloo see above), it is undeniable that de Graaf 's and Swammerdam's work founded the authoritative topography, mesoscopical, and partially the microscopic properties of the female and male reproductive organs" [9].

Thus one should conclude that the sexual pelvic organs were well studied and described. The topographic relations of the bony pelvis, the organs, ligaments and muscles, together with their spatial coherence, have been neglected or wrongly described. We will see that this split in pelvic research remains today and divides clinicians and scientists on the one hand and paramedics on the other hand. Its cause lies in the absence of sound holistic ancient research as historically described above as a snapshot.

Physical therapy and the pelvis

"In essence the passive human spine is an unstable structure and therefore further stabilization is provided by the activity of the trunk muscles. These muscles are often referred to as the "core" muscles, assuming that there is a distinct group, with anatomical and functional characteristics specifically designed to provide for the stability. One of the muscles in this group to have received much focus is the transverse abdominal muscle. It is widely believed that this muscle is the main anterior component of trunk stabilization. It is now accepted that many different muscles of the trunk contribute to stability and that their action may change according to varying tasks" [10]. Low back pain is explained by the instability of the vertebral column that is surmounted by trunk muscle exercises, especially the transverse abdominal muscle. Thus, exercises can strengthen the trunk muscles, and low back pain will be overcome. The consequences are that "a whole industry grew out of these studies with gyms and clinics worldwide teaching the "tummy tuck" and trunk bracing exercise to athletes for prevention of injury and to patients as a cure for lower back pain" [10]. The critical review from which the above citations are taken is destructive for the gym and clinic assumptions to relieve back pain. Moreover, the conclusion for the abdominal muscles is that they contribute less than supposed to spinal stability: "abdominal musculature can demonstrate dramatic physiological changes, such as during pregnancy, postpartum and obesity, with no detriment to spinal stability and health. Damage to abdominal musculature does not seem to be detrimental to spinal

stability or contribute to low back pain" [10,11]. Therefore, publications on abdominal muscles and trunk stability should be read with the utmost care.

Manual therapy started to apply techniques that could strengthen the core abdominal muscles with the consequence that the physiotherapeutic approach of incontinence should be changed or new techniques should be added. "Research has led to an increased understanding of the synergy between the abdominal and pelvic floor muscles and in fact all the muscle groups surrounding the abdominal capsule. The pelvic floor muscles are now considered to have the dual function of providing trunk stability and contributing to continence and elimination of both bladder and bowel" [12].

Trunk stability is now related to abdominal muscles and pelvic floor muscles. After small contractions of the pelvic floor muscles, reactions in the transversus abdominis are noted. Alterations in position and function of abdominal muscles coincide with pelvic floor muscle changes. Intra-abdominal pressure modifications like during laughing, sneezing, and coughing involve both abdominal–pelvic floor muscles and the diaphragm. The new physiotherapeutic/manual therapy approach for stress urine incontinence contains the following: reeducation of diaphragmatic breathing and increase in the tonic activity of the pelvic floor muscles: "Using an independent transverse abdominis contraction to gain a pelvic floor muscle co-contraction helps to ensure the very low-level pelvic floor muscles activation required" [12] and muscle strengthening with retraining of laughing, sneezing, and coughing" [9].

Now one has to consider the criticism: "the control of the trunk (and body) is whole. There is no evidence that there are core muscles that work independently from other trunk muscle during normal functional movement. There is no evidence that individuals can effectively learn to specifically activate one muscle group independently of all other trunk muscles" [10]. At the least, these statements are supported by physiological results that show that the transverse abdominis and the internal oblique muscles cannot function separately and in most cases, the abdominal muscles must act as an entirety [13]. Both muscles have a conjoint tendon with seemingly conjoint receptors for mechanical properties. It therefore seems unwarranted to ask a patient to only activate tonically or strengthen solely one of the abdominal muscles. Please note that the holistic approach overrides the reductive one. However the idea that one muscle, the transversus abdominis, can be held responsible is maintained by manual therapists.

Let's look into the problem of stating that something is a solution (above it was transverse muscle training) for a human pelvic problem (above it concerned incontinence). Now we focus on the sacroiliac joint and low back pain and pelvic pain:

1. The presence of strong movements in the sacroiliac joint during labor is hardly scientifically based. "The amount of displacement, however, is so minimal that it has not been documented radiographically" [14]. Ten patients with sacroiliac joint dysfunction were treated according to the accepted physiotherapeutic methods. X-ray stereophotogrammetric analysis showed that the sacroiliac joint had not altered its position, thus stressing the immobility of the sacroiliac joint [15], and if literature finds movement it is minimal [16,17]. A review and analysis of the papers from the fourth Interdisciplinary World Congress on Lower Back and Pelvic Pain, held in 2001, reveals that most papers do not meet scientific standards concerning pregnant and postpartum women, while even a clear definition of lower back pain versus pelvic pain is lacking [18]. Moreover the question of: "to what purpose the presence of an amphiarthrotic joint at the transition sacrum to ilium?" (The notion "amphiarthrotic joint" is a contradiction in terminis) is seldom posed.

2. Sacroiliac pain is considered a subset of pelvic pain and can be diagnosed in 5–6 % of the cases, depending on one-sided or two-sided symptoms. Nevertheless, most treatments proposed are poorly supported by research, as is the treatment of women in labor by midwives (see comparable criticism on the Wise-Anderson therapy for chronic pelvic pain [9].

3. Most movements in the sacroiliac joint, if present, can be pointed out as being pathologic. One has to be extremely sensible to notice in the normal situation a less than 1 mm displacement of the sacrum to the pelvis through the muscles of the low back as favored during physiotherapy training (for extra arguments for 1, 2 and 3 see [9].

4. Relating sacroiliac pelvic pain to an amphiarthrotic joint without clear pathology is not substantiated. To cite [14] again on the sacroiliac joint and its pain: "Thus we are left with a clinical syndrome of low incidence and no consistent clinical findings, and an invasive test (injection of anesthetics) as the basic gold standard on which to make a diagnosis."

The examples presented on sacroiliac pain and trunk control are hardly based on a reductive or holistic analysis, but rather on a vitalistic and mystic approach, presumably by some mistaken belief that it is beneficial for the pain patient. Let's take sitting during delivery, promoted by midwives, although it is well known that birthing chair delivery is associated with greater blood loss at and after delivery. One should remember that one woman dies every 4 minutes due to postpartum bleeding. Still midwives push chair, ball and bath deliveries, all with an increased risk of postpartum bleeding and its consequent problems. One should note that in all French hospitals intervention teams are available 24 hrs to reduce postpartum bleeding effects [19,20]. Analogous adverse results are noted for trigger-point therapy.

Analytic studies on pelvic floor training in urine incontinence can be summarized as follows: "If one looks for overviews on pelvic floor training, the articles of Kari Bø, a well-known scientist in this field, shows that despite randomized controlled trials "Future studies are needed to assess whether pelvic floor muscle strength training can lift a sagging, stretched and weak pelvic floor into a more optimal position where it can counteract the rise in abdominal pressure" [9]. Several of the studies on pelvic floor muscle training are also considered weak by her. This conclusion has been supported more recently: "There is a need for at least one large, pragmatic, well conducted, and explicitly reported randomized trial, comparing pelvic floor muscle training with a control, to investigate the longer-term clinical effectiveness of pelvic floor muscle training. Also, studies investigating different pelvic floor muscle training regimens are required to establish the optimum method of delivering and undertaking this intervention" [21-23].Thus, it claims that even pelvic floor muscle training is badly supported [9].

The same holds for several alternative vitalist methods: "It has not yet been conclusively demonstrated that abdominal training, the Paula method, Pilates, yoga, Tai Chi, breathing exercises, postural training, or general fitness training is effective for the prevention or treatment of stress urinary incontinence either as an alternative or an adjunct to pelvic floor muscle training. Further development

and testing, ultimately with randomized controlled trials, is needed before these alternative interventions become routine clinical practice" [24].

The opposite is even more true. The reductionist approach brought us the anti-conception pill as a consequence of thorough studies on the female pelvic organs. Manipulation of ovulation and in vitro fertilization became routine techniques, early detection of pelvic carcinomas are now possible, adequate surgical techniques in urology and gynecology are developed and this list can be extended. These are all consequences of the hypothetic-deductive reasoning in the pelvic science. However they mainly concern one researched organ without seeing any relevance in organ interaction.

Perspectives

Diseases and research that concern the interaction of several pelvic organs are hardly solved or studied: urine and fecal incontinence [9], pelvic pain [25], pelvic stability and posture, function of the sacro-iliacal joint, function of racial pelvic differences, the working of neuromodulation in Stoller's Afferent Nerve Stimulation, development of the pelvic peripheral nervous system, the relation bladder muscle function and nervous system [9] and prolaps [26]. And this list can easily also be extended. What one needs is a pelvic holistic approach.

Some examples are given below:

Controller system

Shafik published a lot of articles concerning the pelvic reflexes. Several new reflexes were described from ano-urethral reflex, via recto-urethral reflex, vagino-cavernosus reflex, ano-vesical reflex, utero-cervical reflex, genito-vesical reflex, clitoro-motor reflex, vesico-cavernosus reflex, peno-motor reflex, vagino-levator reflex, levator-urethral reflex, to the vesico-levator reflex [9]. If one knows that any change, or activation modification, of the state of structures involved in the entrances to the pelvic organs will elicit pelvic floor and sphincter contraction, these reflexes must be the expression of one system: the controller action system. This controller system exerts reflex-like activity via the pelvic short neuron system [27] at any disturbance of the steady state of pelvic entrances [9,28]. Here the holistic approach clearly overrides the reductive approach again. (Figure 1 and 2).

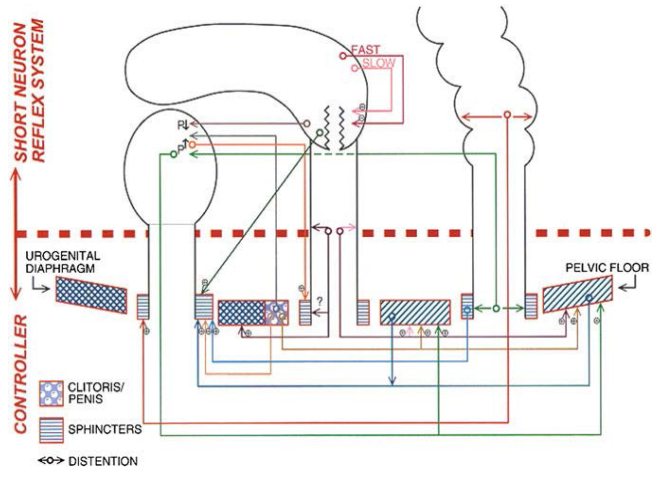

Figure 1: The structures that are guided by the controller action system and by the short neuron reflex system© E.Marani.

Figure 2: Model of the lower body: upper block is the pelvis (as one of its six links), the thighs (two other links), the legs (two links), and both feet (floor and feet are the sixth link) (Reproduced with permission and courtesy from Huson, 1997).

Your freedom of leg movement is restricted if you go from the recumbent to the standing situation. By standing one closes a chain of leg parts and on top of this chain is the pelvis (Figure 2). "The general effect of a closure leads to an increase of its kinematic constraints, in other words it is a reduction of the chain's kinematic degrees of freedom of motion. Said in more general terms, closure leads to a reduction of the chain's mobility or a gain in stability" [29]. The pelvis can be considered a block due to the sacroiliac joint that permits nearly no movement, the fused sacral vertebrae and the tight connection of the pubic bones by the symphysis. By standing on your feet, the kinematic chain of your both legs is closed by the pelvis. Standing consumes hardly any energy, due to the pelvic girdle that acts as a keystone, which closes the kinematic arch. Here, an unexpected, nevertheless important, property of the pelvic girdle is found: the consequences of its rigid joint qualities [9]. One should note that this holistic approach brings unexpected properties of the pelvic girdle forward.

Finite element (FE) modeling

"Finite element modeling is basically a mathematical approach, whereby a structure is divided into small geometrical entities, the elements. For each of these elements there exists an analytical relation between force, deformation, strain and stress, given their geometry, material properties and boundary conditions. Owing to the large number of elements, handling of input and output data and the actual calculation of the stresses and strains are performed using special computer software" [30].

This mathematical technique opens enormous possibilities for pelvic holistic research. It has been used for study of decubitus ulcers of buttocks [31], for the calculation of pelvic cortical shell and core stress that shows the interactions between muscles and bony pelvis [30], for the reconstruction of the pelvic diaphragm showing the muscle forces in the diaphragm [32], which is still thought important for incontinence, for prolaps, ligaments and biomechanical interactions of pelvic organs [33,34], for pelvic mutual organ movement [35] and for the mutual positions of the bladder neck and urethra [36] (Figure 3).

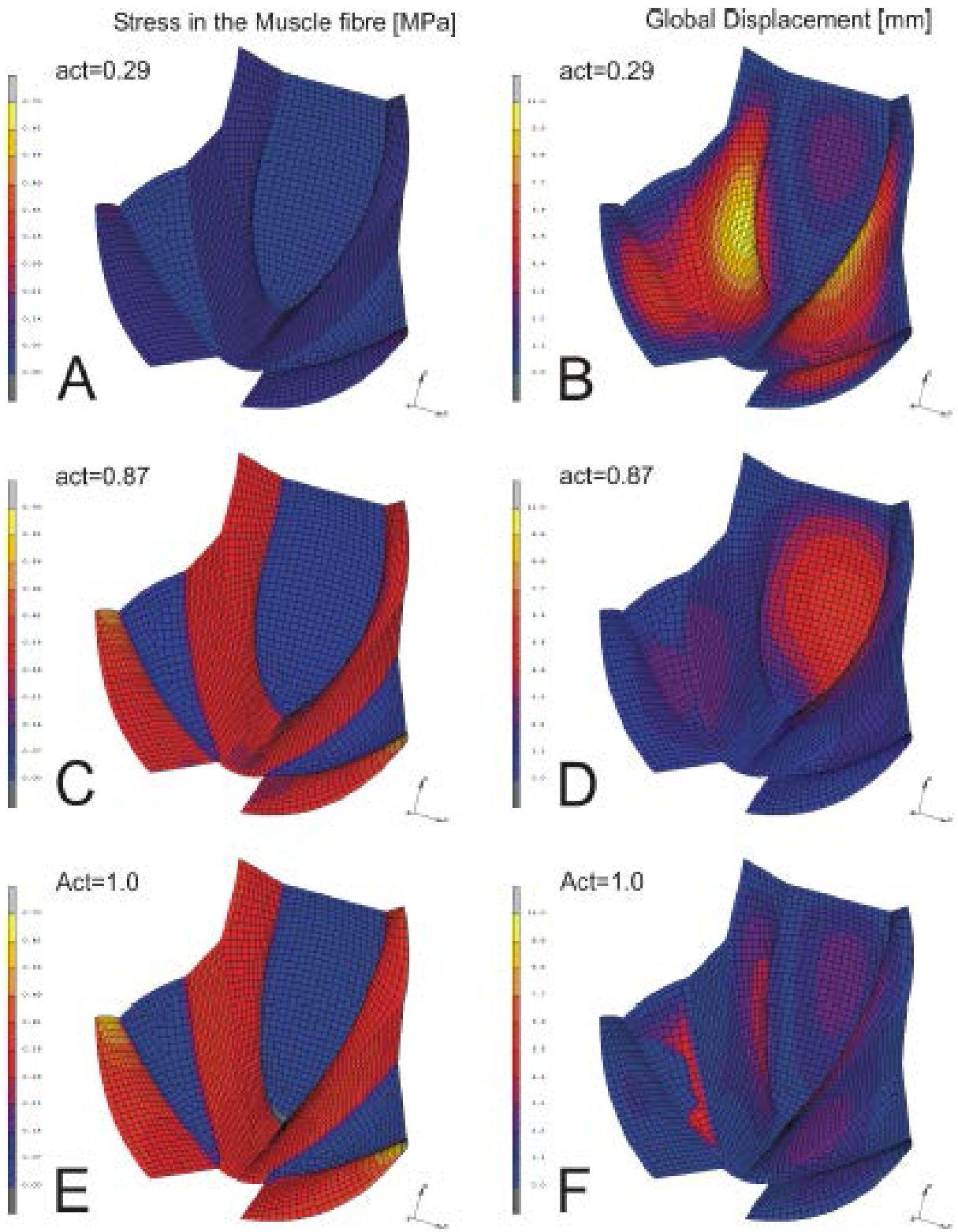

Figure 3: Graphical results of the FE analysis of the pelvic floor muscles. The stress in the muscle fiber direction in MPa is displayed in the left column, displacement in millimeters in the right column. The 'active' stress in the connective tissue is zero in image A, C and E, since it is passive tissue. The same scale is used for all three load-cases. Three particular examples are displayed for three conditions: LC1 (rest): 29% activation, 0.01 kPa load - Images A and B; LC2 (max IAP): 87% activation, 5.4 kPa load - Images C and D; LC3 (max ACT): 100% activation, 1.3 kPa load - Images E and F). (Text and figure with permission from Janda, 2006).

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