PELVIC FLOOR ASSESSMENT

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INTRODUCTION

The topic of pelvic floor assessment is increasingly attracting attention from gynaecologists, colorectal surgeons, urologists and physiotherapists. This is not surprising, many women who have given birth naturally are affected by pelvic floor trauma, and so are their partners. Health professionals deal with the eventual consequences of such trauma, especially pelvic organ prolapse and faecal incontinence.

Until recently ‘pelvic floor trauma’ meant perineal and vaginal tears, and damage to the anal sphincter. In developing countries especially, pelvic floor trauma also includes vesicovaginal, urethrovaginal and rectovaginal fistulae, but these are uncommon in developed countries with good intrapartum care. Anal sphincter trauma has received much attention over the last 20 years and will not be dealt with here.

We now know that ‘pelvic floor trauma’ also affects the levator muscle. In 15–30% of all women who have given birth normally there is serious damage to the puborectalis component of the levator ani muscle.1–3 This is a very recent discovery and has not yet found its way into most textbooks.

The levator ani is a muscular plate surrounding a central v-shaped hiatus, forming the caudal part of the abdominal envelope. As such, it encloses the largest potential hernial portal in the human body, the ‘levator hiatus’, containing the urethra, vagina, and anorectum. Its peculiar shape and function is a compromise between priorities that are virtually impossible to reconcile. On the one hand, abdominal contents have to be secured against gravity, on the other hand solid and liquid wastes have to be evacuated. In addition, and most importantly, there are the requirements of reproduction: intercourse and childbirth. The latter is the most extreme of tasks required of the pelvic floor, in particular in view of the size of the baby’s head. There are other mammalian species in whom giving birth is fraught with danger, but homo sapiens ranks near the top of the list when it comes to the hazards of reproduction.

The levator ani is thought to consist of several major subdivisions, and there is considerable confusion in the literature as regards nomenclature and distinctions between pubococcygeus, pubovaginalis, puboperinealis, puborectalis and iliococcygeus muscles. Since these muscles cannot currently be distinguished easily,
neither clinically nor on ultrasound or magnetic resonance imaging or even cadaver dissection, the author considers only the puborectalis muscle (as the v-shaped muscle originating on the os pubis/the inferior pubic ramus and surrounding the anorectal angle posteriorly) and the pubococcygeus/iliococcygeus muscle. The latter is a sheet of muscle that acts as a continuation of the puborectalis cranially and laterally. While the fibre direction is different from the puborectalis [from ventromedial to dorsolateral rather than almost ventrodorsal as for the puborectalis], on vaginal palpation the pubococcygeus/iliococcygeus is palpable as a continuation of the puborectalis above the inferior pubic ramus in the lateral vagina, extending from the pelvic sidewall to the ischial spine and the coccyx.

Figure 1 shows a fresh cadaver dissection of the levator ani muscle, with the puborectalis forming a V shaped structure about as thick as a 5th finger, anchored to the inferior pubic ramus and the body of the os pubis ventrally. This dissection approach demonstrates the muscle as seen from below or caudally. The left side of the image is the patient’s right side, the symphysis pubis is at the top. Figure 2 demonstrates the appearance of the puborectalis on 3D pelvic floor ultrasound, in a ‘rendered volume’ i.e., a semitransparent representation of volume data. The arrows indicate the gap between muscle insertion and urethra which is important for palpation.

**THE PELVIC FLOOR IN CHILDBIRTH**

The levator ani muscle plays a major role in childbirth. It has to distend enormously, and the degree of required distension varies greatly between individuals, by at least
The appearance of the puborectalis muscle in a rendered volume in the axial plane, using translabial 3D ultrasound with speckle reduction imaging (SRI). The two arrows indicate the gap between urethra and puborectalis insertion that can conveniently be palpated to determine muscle integrity.

Trauma to the puborectalis muscle as a consequence of childbirth was first reported in 1943, only to be forgotten for 60 years. This major form of maternal birth trauma, easily palpable vaginally and occasionally visible in women with large vaginal tears\textsuperscript{8} is missing from our obstetric and midwifery textbooks, and has only recently been rediscovered by imaging specialists using magnetic resonance and 3D/4D ultrasound [see Figure 3]. Most commonly, appearances are those of an ‘avulsion’ that is, a traumatic dislodgment of the muscle from its bony insertion. There are other forms of localized or generalized morphological abnormalities, but they are much less common. Appearances are rarely consistent with pudendal neuropathy which in the past was considered the main aetiological factor in pelvic floor dysfunction.\textsuperscript{9,10}
Figure 3 Right-sided puborectalis avulsion after normal vaginal delivery at term. The left hand image shows appearances immediately postpartum, with the avulsed muscle exposed by a large vaginal tear. The torn muscle is retracted and visible between the gloved fingers at 6–7 o’clock. The middle image shows a rendered volume (axial plane, translabial 3D ultrasound) 3 months postpartum, and the right hand image shows magnetic resonance findings (single slice in the axial plane) at 3.5 months postpartum. With permission, from: Dietz HP et al.  

DIAGNOSIS BY PALPATION

As mentioned, diagnosis of such injuries is possible by palpation, although this requires substantial teaching, and the learning curve seems to be quite long. Until recently, assessment of levator function, if undertaken at all, was limited to grading muscle strength and endurance, using the modified Oxford Grading system first suggested by Laycock (Table 1). Physiotherapists have a long history of using palpation to assess skeletal muscle and some, with appropriate postgraduate training, have extended their skills to include digital assessment of pelvic floor muscle by the vaginal or transanal route. In the physiotherapy literature there are many reports of palpation to assess pelvic floor muscle contraction, and some describe the identification of pain and trigger points, and even evaluation of muscle tone.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Modified Oxford Grading (according to Laycock, L: ‘Assessment and treatment of pelvic floor dysfunction [PhD’]. University of Bradford, 1992)</th>
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<tr>
<td>0:</td>
<td>no contraction</td>
</tr>
<tr>
<td>1:</td>
<td>flicker</td>
</tr>
<tr>
<td>2:</td>
<td>weak</td>
</tr>
<tr>
<td>3:</td>
<td>moderate (with lift)</td>
</tr>
<tr>
<td>4:</td>
<td>good (with lift)</td>
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<tr>
<td>5:</td>
<td>strong (wift)</td>
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However, although clinical anecdote suggests some physiotherapists recognize other characteristics concerning muscle morphology (e.g. holes, gaps, ridges, scarring), it is difficult to find any literature describing the techniques needed to do this or their accuracy or repeatability. Mantle\textsuperscript{17} noted that with training and experience a physiotherapist might be able to discern muscle integrity, scarring, and the width between the medial borders of the pelvic floor muscles by palpation. It is not clear to what extent physiotherapists are able to do this reliably or how such characteristics are to be recorded.

In 1943, an obstetrician from Kansas City published the findings of a palpatory assessment of 1000 women delivered by him personally.\textsuperscript{18} Gainey described trauma to what he called the ‘pubococcygeus’ muscle, and from his description it is quite clear that he did detect avulsion injuries of the puborectalis. In fact, the prevalence of such defects quoted by him [about 20\% in primiparous women] agrees very well with modern work using MR\textsuperscript{19} and Pelvic Floor Ultrasound.\textsuperscript{1,3} Evidently, if it was possible to palpate such trauma in 1943, it should be possible today.

Figures 2 and 4 explain how palpatory assessment of the puborectalis muscle may be undertaken. To assess morphological integrity the palpating finger is placed parallel to the urethra, with the tip of the finger at the bladder neck, and its palmar surface pressed against the posterior/dorsal surface of the symphysis pubis. If the muscle is intact then there will be just enough room to fit the palpating finger between the urethra medially and the insertion of the puborectalis muscle laterally. If there is no muscle palpable on the posterior surface of the os pubis and the inferior pubic ramus immediately lateral to a finger placed parallel to the urethra, and if this finger can be moved over the inferior pubic ramus without encountering any contractile tissue for another 2–3 cm, then this implies an avulsion injury on that side. Assessment is helped by asking the patient to perform a pelvic floor muscle contraction while palpating the area. The extent of avulsion varies enormously and there are several

\begin{figure}
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\includegraphics[width=0.8\textwidth]{figure4.png}
\caption{Digital palpation of the puborectalis muscle insertion. The left image shows a normal muscle, the right an avulsion injury. With permission, from: Dietz HP, Shek KL.\textsuperscript{13}}
\end{figure}
types of incomplete injuries: generalized thinning of the muscle, partial avulsion of the most inferior aspects (with the most cranial aspects of the puborectalis still adhering to the os pubis) and partial avulsion of more cranial aspects, palpable as a hole, slit or gap in the insertion of the superior aspects of the puborectalis, or in the inferior aspects of the pubococcygeus/iliococcygeus muscle. While the importance of such partial trauma is unclear, a complete avulsion detected on palpation is clearly associated with reduced contraction strength of the muscle, as well as with symptoms and signs of prolapse.\textsuperscript{12, 14}

Avulsion often seems to have an impact on adjacent or contralateral intact muscle. After unilateral avulsion, the intact contralateral puborectalis may become spastic and very tender, a hitherto unrecognized cause of chronic pelvic pain and dyspareunia. After bilateral avulsion there is marked hypertrophy of the pubococcygeus/iliococcygeus, resulting in a levator shelf that is almost as strong as the original, just somewhat higher and wider.

Currently the assessment of levator function by physiotherapists, nurse continence advisors, gynaecologists and urologists is (at best) limited to grading “squeeze and lift”. We propose a visual recording system for findings obtained on palpation of the puborectalis muscle [Figure 5]. Such a system should include both some form of strength grading for “squeeze and lift” bilaterally, as well as grading for resting tone (conveniently graded 0–5 to accord with the Oxford system, see Table 2 for a suggested scale).

<table>
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<th>Table 2</th>
<th>A proposed scale for the grading of levator resting tone</th>
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<tr>
<td>0:</td>
<td>muscle not palpable</td>
</tr>
<tr>
<td>1:</td>
<td>muscle palpable but very flaccid, wide hiatus, minimal resistance to distension</td>
</tr>
<tr>
<td>2:</td>
<td>hiatus wide but some resistance to distension</td>
</tr>
<tr>
<td>3:</td>
<td>hiatus fairly narrow, fair resistance to palpation but easily distended</td>
</tr>
<tr>
<td>4:</td>
<td>hiatus narrow, muscle can be distended but high resistance to distension, or pain</td>
</tr>
<tr>
<td>5:</td>
<td>hiatus very narrow, no distension possible, ‘woody’ feel, possibly with pain: ‘vaginismus’</td>
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In addition, one should attempt a morphological assessment of the puborectalis muscle and document findings either as defects or gaps (outlined and shaded area on the muscle diagram) or thinning (outlined and hatched obliquely). While there is currently no data on the relevance of minor abnormalities that fall short of a complete avulsion, the spectrum of traumatic changes to the puborectalis is very wide. It is likely to receive much more attention in the future, and imaging will be essential in determining the functional consequences of minor trauma. The documentation system proposed in Figure 5 could form the basis of teaching efforts to improve on palpatory assessment skills and allow easier communication amongst clinical practitioners and researchers.

Clearly, assessment of the puborectalis muscle by palpation is a skill that requires significant teaching, most conveniently in a unit that allows for instant comparison with findings on imaging. Without additional training, agreement between a clinical assessor and imaging is likely to be poor.\textsuperscript{11–13} However, there is no doubt that
assessment of the puborectalis muscle by palpation is within the capability of any practitioner in the field. The emerging literature on the clinical relevance of levator defects detected on imaging implies that this skill should be well worth acquiring.

**DIAGNOSIS BY ULTRASOUND IMAGING**

It seems that the diagnosis of levator trauma is more repeatable when undertaken by imaging. While magnetic resonance was the first method used to assess the levator ani, it suffers from a number of obvious shortcomings: cost, accessibility, the inability to use MR in women with ferrous implants, issues with claustrophobia in some women, the lack of dynamic imaging and problems with defining correct planes, since very few currently used systems allow true volume imaging. Most of those shortcomings do not apply to ultrasound, especially not to translabial 3D/4D ultrasound. This method uses technology that was developed for fetal imaging and that is now available in virtually all major obstetrics and gynaecology units in the developed world. While transvaginal ultrasound has been used to image the levator ani, this requires side-firing endoprobes which are not in general use and rarely found in obstetrics and gynaecology imaging departments.
Figure 6  Typical right-sided avulsion injury in a rendered volume, axial plane. It is evident that the pelvic sidewall is blank, i.e., that the morphological abnormality documented here is an 'avulsion' of the puborectalis muscle insertion.

The diagnosis of levator trauma by transperineal (or perineal, or introital) ultrasound was first described in 2004\textsuperscript{23} on ‘rendered volumes’, that is, semi-transparent representations of blocks of volume ultrasound data (see Figure 6), using Voluson-type systems and 3D/4D curved array volume transducers that were developed for fetal imaging. This form of 3D ultrasound relies on fast mechanical movement of a curved array within the 3D transducer, acquiring volume data without any need for manual transducer movement or external position sensors. Acceptable quality can be obtained with acquisition angles of up to 85 degrees, encompassing the entire levator hiatus even on maximal Valsalva in a patient with severe prolapse, and at a volume frequency of about 2 Hz. At lower acquisition angles and quality, frequency of up to 20 Hz can be reached. This implies that temporal resolution in any plane is superior to MR, while spatial resolution of structures within the levator hiatus up to about 4 cm depth is comparable to MR.

The diagnosis of avulsion by 3D ultrasound has been shown to be highly reproducible, in particular as compared to palpation.\textsuperscript{3,13} In a further technical innovation, modern 3D ultrasound systems commonly allow tomosgraphic imaging, i.e., serial cross-sections at arbitrarily variable inter-slice intervals and angles. Diagnosis by tomosgraphic ultrasound is probably currently the most repeatable technique.\textsuperscript{24} Figure 7 shows identification of the plane of minimal dimensions as a reference plane, and Figure 8 demonstrates a tomosgraphic representation of the entire puborectalis muscle, based on this reference plane. Tomographic ultrasound is probably best
performed by bracketing the area of interest, with the lowermost slice just below the insertion of the puborectalis muscle\textsuperscript{25} as shown in Figure 8.

Avulsion can be diagnosed with 2D ultrasound, using the simplest and most commonly available abdominal curved array transducers (Figure 9). However, since there is no clearly identifiable point of reference for parasagittal translabial planes, it is more difficult to be certain of a complete avulsion, and, as a result, repeatability is probably inferior.\textsuperscript{26}

Regardless of which imaging method is used, palpation and imaging are best seen as complementary rather than mutually exclusive. Frequently, one method will allow a better appreciation of findings obtained by the other method. The palpating finger provides biomechanical information on tone and contractility that is not currently available on imaging. On the other hand, imaging information is more objective and reproducible, and provides information on deeper structures that are not accessible on palpation.

**RISK FACTORS**

All cases of avulsion documented so far, whether by magnetic resonance imaging, palpation or by ultrasound, were found in women who had delivered vaginally.\textsuperscript{27–29} It is likely that factors such as birthweight, length of second stage, size of the fetal head, and vacuum/forceps delivery increase the probability of avulsion injury,\textsuperscript{1,2,30} but such ‘predictors’ are of very limited use since they are not available prior to the onset of labour.
In order to prevent levator avulsion, we need predictors that can be determined during pregnancy. It is plausible that the risk of trauma to the insertion of the puborectalis muscle, ie, damage to the muscle-bone interface, will depend not just on the required distension, but also on the biomechanical properties of muscle and muscle-bone interface (which are hitherto undefined). It is therefore not surprising that avulsion seems associated with maternal age at first delivery\textsuperscript{1,2,3} – a worrying finding in view of the continuing trend towards delayed childbearing in developed societies. The likelihood of major levator trauma at vaginal delivery more than triples during the reproductive years, from under 15\% at age 20 to over 50\% at 40\textsuperscript{31} (Figure 10). Taken together with the increasing likelihood of caesarean section, it seems that the probability of a successful vaginal delivery without levator trauma decreases from over 80\% at age 20 to less than 30\% at age 40 (unpublished data). Maternal age is the first predictor of trauma that may in future form part of a prelabour predictive model, allowing preventative intervention.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure8.png}
\caption{Assessment of the puborectalis muscle by tomographic or multislice ultrasound. The top left hand image (0) represents a reference image in the coronal plane. Images 1–8 show slices parallel to the plane of minimal hialtal dimensions. Slices 1 and 2 are 5 and 2.5 mm below this plane, slice 3 represents the plane of minimal dimensions, and slices 4–8 are 2.5–12.5 mm above this plane, likely encompassing the entire insertion of the puborectalis. Slice 1 is clearly below the muscle insertion, guaranteeing that the area of interest is imaged in its entirety.}
\end{figure}
Pelvic floor assessment

Figure 9 2D parasagittal oblique views of the puborectalis muscle obtained by translabial ultrasound (A) showing an avulsion in a patient's right, marked by an asterisk (*). Image C shows a tomographic representation of the puborectalis muscle in the same patient, with the avulsion evident in most slices (marked by *).

By a 180° axis muscle on the patient’s left, Image C shows a tomographic representation of the puborectalis muscle in the same patient, with the avulsion evident in most slices (marked by *).
CONSEQUENCES OF LEVATOR TRAUMA

The effect of avulsion on muscle function is substantial. Contraction strength as estimated by Oxford grading and instrumented speculum is reduced by about 1/3, an observation that may help diagnose levator trauma. Avulsion results in a hiatus that is larger (by 20–30%), especially in the coronal plane, more distensible and less contractile. Figure 11 shows the effect of avulsion on hiatal dimensions in a patient after forceps delivery at term.

Prolapse

Levator avulsion is associated with anterior and central compartment prolapse and likely represents the missing link (or a large part of the missing link) between childbirth and prolapse. The larger a defect is, both in width and depth, the more likely are symptoms and/or signs of prolapse. Levator avulsion seems to at least triple the risk of significant anterior and central compartment prolapse (Table 3), with less of an effect on posterior compartment descent. This effect seems largely independent of ballooning (unpublished data), or abnormal distensibility of the levator hiatus, which also is associated with prolapse.
Figure 11 The effect of levator avulsion on hiatal dimensions. Antepartum and postpartum ultrasound images (single slice axial planes in the plane of minimal hiatal dimensions) of a patient with left sided avulsion after forceps delivery. The hiatal area on maximum Valsalva at 38 weeks (on the left, image A) was 15.6 cm². It was measured at 29.3 cm² at 4 months postpartum (image B).

Table 3 Relative risk (95% confidence interval) of each type of prolapse (stage 2 and higher) in women with levator avulsion relative to women with intact levator ani. *Excludes 100 women who had had a hysterectomy (Dietz H, Simpson J33 with permission)

<table>
<thead>
<tr>
<th></th>
<th>Cystocele (n = 781)</th>
<th>Uterine prolapse (m = 681)</th>
<th>Rectocele (n = 781)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unilateral avulsion</td>
<td>2.2 (1.9–2.7)</td>
<td>2.0 (1.0–4.1)</td>
<td>1.2 (0.9–1.7)</td>
</tr>
<tr>
<td>Bilateral avulsion</td>
<td>2.5 (2.1–3.0)</td>
<td>7.1 (4.3–11.6)</td>
<td>1.6 (1.2–2.1)</td>
</tr>
<tr>
<td>Any levator avulsion</td>
<td>2.3 (2.0–2.7)</td>
<td>4.0 (2.5–6.5)</td>
<td>1.4 (1.1–1.7)</td>
</tr>
</tbody>
</table>

It is not clear as to why it often takes decades for symptoms to develop, although DeLancey’s ‘ship in dock’ hypothesis provides a plausible explanation.35 One should also point out that there are many women who present with prolapse without having suffered an avulsion injury. There are other deleterious effects of childbirth on the levator, resulting in traumatic, irreversible overdistension,36 and then there are young nulliparous women who show evidence of abnormal hiatal distensibility and pelvic organ descent that is very likely congenital.37 Our modeling suggests that avulsion in itself is probably only responsible for 30–40% of cases of symptomatic prolapse—but commonly these may well be the most difficult forms of prolapse to treat surgically.
Urinary incontinence

Many laypeople and medical practitioners as well as physiotherapists and continence nurse practitioners assume that urinary incontinence is a sign of a weak pelvic floor. This may not be true. We have recently shown that levator avulsion is negatively associated with stress urinary incontinence (SI) and urodynamic stress incontinence (USI), and this association remained negative even after controlling for eight potential confounders, including all forms of female pelvic organ prolapse [unpublished data]. These findings are highly counterintuitive. Why is it that there should be no major effect of puborectalis muscle trauma on SI or USI, considering that pelvic floor muscle (PFM) training is a recognized and proven therapeutic intervention in women with stress urinary incontinence?38 If the puborectalis muscle is part of the urinary continence mechanism, shouldn’t it matter if one or both insertions of this muscle are disconnected from the inferior pubic ramus, rendering it badly dysfunctional?

Firstly, one should point out that the therapeutic success of PFM training does not prove a role of the puborectalis muscle in stress urinary continence. After all, PFM training affects not just the puborectalis muscle but likely trains all muscular structures innervated by the sacral segments. Secondly, there are several other potential mechanisms by which childbirth might affect urinary continence. Denervation is the most obvious candidate since we have good evidence on the deleterious effect of vaginal birth on the pudendal nerve and its branches.10 Damage to the urethral rhabdosphincter or the longitudinal smooth muscle of the urethra may also be mediated through other factors such as devascularization. There is also the issue of pressure transmission, likely mediated through the pubourethral ligaments and/or suburethral tissues. Clearly, much research will be needed before we can claim to understand the pathophysiological basis for stress urinary incontinence.

Faecal incontinence

The second major clinical symptom that has been attributed to an abnormal puborectalis muscle [via an opening of the anorectal angle] is faecal incontinence. However, we have found no significant association between this symptom and levator trauma [unpublished data]. It therefore appears unlikely that any intervention targeting levator dimensions or function would have a major impact on faecal continence. Any improvement in symptoms is more likely to be due to other associated therapeutic effects.

Sexual function

The puborectalis muscle has been billed as the ‘love muscle’ by sections of the popular press. It is likely that avulsion, especially if bilateral, would have some effect on
sexual function. To date, however, we have only anecdotal information on this issue. Considering the popularity of cosmetic genitoplasty procedures aiming to ‘tighten’ the vagina, this may become an important consideration in the future. In some women the site of the avulsion remains tender, even after decades, and some women and their partners notice a marked difference in sexual relations after the birth of their first child. Other couples however don’t notice any change. For obvious reasons this is not an issue that is easy to investigate.

Clinical repercussions

Major morphological abnormalities of the levator ani probably affect surgical outcomes. A study using MR imaging demonstrated that recurrence after anterior colporrhaphy was much more likely in women with an abnormal pelvic floor. The author’s unit has recently shown that avulsion is associated with prolapse after hysterectomy, anti-incontinence and prolapse operations, especially after anterior repair (unpublished data). In view of the current, often acrimonious discussion regarding the use of mesh implants in reconstructive surgery, this association may turn out to be of major clinical importance. In the opinion of the author it makes little sense to perform a traditional anterior repair in women with bilateral avulsion since such a procedure is very likely to fail.

FUTURE DEVELOPMENTS

Prediction

One approach to reducing the incidence of levator trauma in childbirth would be to target preventative intervention at high risk groups. This will require individual pre-delivery risk assessment. It is currently not clear whether such risk assessment is feasible, but the potential benefits of such an approach should make this a high priority for research. The only currently known pre-labor risk factor is maternal age at first delivery. Others are currently being investigated, such as body mass index, ethnicity and pelvic floor biomechanical properties. It is evident that many women – at least 30–40% of all those delivering vaginally – suffer no appreciable pelvic floor trauma. In view of the necessary distension to allow passage of a term fetal head this is what is truly astounding – not the fact that some births result in trauma. Clearly, we need to investigate what it is that allows so many women to experience a non-traumatic vaginal delivery.

Recently, computer modeling has been used by a number of units to try and investigate pelvic organ support and pelvic floor dysfunction. While computer modeling has enabled important insights into mechanisms of trauma, significant progress is unlikely until input variables are properly defined. There is really no
information on boundary conditions and the material properties of bone, muscle and their interface at present, and any imaging data used for modeling will be just a snapshot of the static anatomical situation in one person. We have recently shown how much static and dynamic dimensions of the levator hiatus can vary between individuals.\textsuperscript{5} On the basis of this information it seems that computer modeling is unlikely to be relevant for clinical practice or even for research until the biomechanical properties of the levator hiatus are better defined. In consequence, modeling is unlikely to play a role in the prediction of trauma for the foreseeable future.

**Prevention**

The ultimate preventative intervention is of course elective caesarean section. In view of the ever-increasing caesarean section rate it is quite possible that pelvic floor trauma will cease to be much of an issue within a generation. However, as mentioned above, many women clearly do not need an operation to deliver their baby and preserve an intact pelvic floor, and it would be an enormous waste of resources to institute a policy of universal caesarean section. Quite apart from resource issues, caesarean section has very substantial disadvantages, both for the mother and her infant, the nature and magnitude of which are beyond the scope of this review. Clearly, caesarean section would only be a potential option in women shown to be at high risk of trauma. Other forms of prevention may potentially be more practicable, such as attempts to change the biomechanical properties of the muscle-bone interface or the muscle and connective tissue of the pelvic floor in general. This may not be as far-fetched as it sounds. There is a commercially available device, the Epi-No\textsuperscript{TM}, that is used to dilate the perineum and vagina in the last few weeks of pregnancy, and this device has been shown to reduce perineal trauma.\textsuperscript{40} The Epi-No is currently under investigation regarding a potential role in pelvic floor protection.

**Treatment**

Is there anything we can do to repair avulsion injury, either immediately after childbirth, or at a later date? From a plastic surgery point of view, surgical failure due to suture dislodgment seems very likely in the postpartum setting, given the quality of the tissues and the fact that there is no opportunity for splinting or immobilisation. I know of four failed attempts at repairing avulsion by direct suturing after childbirth. Direct repair may have to wait several months and may have to utilize autologous fascia or mesh. A first attempt using fascia lata has been reported by Abbas Shobeiri, a Urogynaecologist from Oklahoma City (personal communication). In a different approach, the author has developed a minimally invasive concept that should at least compensate for (if not actually close) an avulsion defect. However, it will very likely
be many years before any reconstructive surgical approach can be regarded as proven and appropriate for general use.

References


