Prospective ultrasonographic follow-up of synthetic mesh in cohort of patients after vaginal repair of cystocele

Suivi échographique prospectif des prothèses synthétiques dans une cohorte de patientes opérées d’une cure de cystocèle par voie vaginale

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Summary

Objective. — We sought to validate a sequence of ultrasonographic mesh measurements to determine the relevant time points in the postoperative monitoring of mesh size.

Methods. — Mesh was measured preoperatively ex vivo, prior to insertion, in 25 patients scheduled to undergo vaginal repair of cystocele involving insertion of a Ugytex™ transobturating polypropylene mesh. A 2D/3D perineal ultrasound scan was performed at the end of the surgical procedure (D0), then on third day after surgery (D3) and 6 weeks (W6) after the operation. Medio-sagittal view was used to measure mesh total length and the sagittal arc (length between the most distant points of the mesh).

Results. — Time-course changes in sagittal arc were marked by a 8% increase on D3 (with respect to D0) and a 20% decrease at W6 (with respect to D3). Mesh total length at W6 on average corresponded to 74% (±20) of mesh total length measured on D3.

Conclusion. — This study showed the changes in the mesh ultrasonographic measurements following vaginal placement by vaginal route. The D3 ultrasound scan should appear to be suitable as a reference for subsequent ultrasonographic monitoring.

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Level of evidence: 4.
Introduction

Surgery for genital prolapse is one of the most frequent procedures conducted in post-menopausal women. Prevalence of genital prolapse in women aged more than 70 years is about 70% [1]. Prolapse is generally accompanied by urinary, bowel and sexual symptoms [2] that impact on patient quality of life [3].

The conventional management of cystocele by vaginal surgery consisted in performing an anterior colporrhaphy. But postoperative cystocele recurrence was frequent about 41% 3 years after surgery given the natural weakness of the tissues [4]. Polypropylene vaginal meshes have been developed over the last 10 years to improve the results achieved with cystocele repair. These techniques most often use tension-free meshes where the arms of the mesh are placed across the obturator foramen, and they reduced the risk of short-term anatomical recurrence [5]. However, cystocele recurrence continued to be seen in 4.7 to 8.8% of cases following insertion of an anterior mesh [5,6]. These new techniques are also associated with a risk of vaginal mesh exposure (prevalence between 5% and 10%) [7].

Mesh integration into native tissue appeared to be accompanied by mesh size variation [8] and this could cause postoperative pain and dyspareunia [9]. Another point was that the magnitude of the shrinkage may appear to be predictive of the risk of future recurrence [10].

Pelvic ultrasonography has proved to be an excellent tool for mesh visualization [11] and was first used to visualize tension-free vaginal tape (TVT) and establish a correlation between tape position and clinical symptoms [12]. The polypropylene vaginal meshes used in cystocele repair could be visualized in the form of a hyperechogenic line, and this made possible their study by 2D or 3D pelvic ultrasonography [10,13,14].

Few prospective studies were done to prospectively assess the synthetic mesh size evolution. "Mesh shrinkage" was so difficult to analyze with clinical examination. It could be tied to dyspareunia or chronic pain. Prospective follow-up of synthetic mesh in a cohort of female patients after vaginal repair of cystocele could be done by ultrasonography. We sought to validate a sequence of ultrasonographic mesh measurements to determine the relevant time points in the postoperative follow-up of mesh size.

Materials and methods

This was a prospective, observational study conducted at the University Hospital Center and received a favorable opinion from a medical ethics committee (CEROG-20-09-007).

Patients presenting with symptomatic cystocele (POP Q [15] ≥ stage 2) and undergoing surgery in our department with insertion of a Ugytex™ synthetic mesh (Sofradim-Covidien, Trévoux, France) were included in the study. Based on literature data, our aim was to include 25 patients [13]. Ugytex™ is a collagen-coated, monofilament polypropylene mesh with weight of 38 g/m² and 89% of porosity with pore size exceeding 1.5 mm.

All the patients were operated on using the same surgical technique. The patient was placed in the gynecological position under strictly aseptic conditions. A vertical colpotomy was made. Dissection then continued laterally to the sciatic spine. The mesh, prepared under aseptic conditions, was measured before insertion and a real-size drawing of the mesh was also made (Fig. 1).

The mesh was then positioned using ancillary procedures with the four arms placed across the obturator foramen [16,17]. The anterior colpotomy was then closed by means of an absorbable 3/0 continuous suture.

A Foley urinary catheter was installed at the start of the procedure and was kept in place for 48 h thereafter. Intravaginal pack was inserted at the end of the procedure for 24 h.

No colpectomy was performed conjointly with mesh insertion. Also none of the patients underwent bladder pllication in combination with mesh insertion.

Different procedures, depending on patient symptoms, were performed in association with cystocele repair, for instance use of TVT for stress urinary incontinence.
Patient functional disability and impact on quality of life were assessed preoperatively and at the postoperative consultation after 6 weeks. The ICS POP Q [15] prolapse quantification system was used for a classification at the same time points, i.e. preoperatively and 6 weeks after surgery (Fig. 2).

Transvaginal and transperineal ultrasound scans (in 2D and 3D) were obtained by two trained operators on a Voluson E™ or Voluson 730™ ultrasound system (GE Healthcare, Milwaukee, WI, USA) using a 5 to 9 MHz vaginal probe. This ultrasonography was performed in accordance with literature data [18]. Medio-sagittal and transversal views were obtained of the vagina. The mesh was visualized in the form of a hyperechogenic line and the medio-sagittal view was used to measure mesh total length (B) and the sagittal arc (C) (Fig. 1). This arc was defined as the length between the most distant points on the mesh. In the transversal view, the width of the mesh and the corresponding arcs were measured at the two ends of the mesh. Proximal width at the bladder neck was defined as vulva width (E) and distal width below uterine cervix was defined as fundal width (D) (Fig. 1). In order to identify folds, a folding coefficient was defined, corresponding to the ratio of sagittal arc (C) to mesh total length (B). The thickness of the mesh (mesh hyperechogenicity in the middle of mesh on mediosagittal view), and its position with respect to the bladder neck (A), were also recorded (Fig. 1).

An initial ultrasound scan (day 0 = D0) was obtained in the operating room at the end of the surgical procedure. The patient was placed in the gynecological position and the D0 ultrasound scan obtained under strictly aseptic conditions after suturing the colpotomy, but before the vaginal pack was inserted. Two further follow-up scans were also obtained: one on the third day (D3) after surgery, before the patient left the hospital, after removal of the vaginal gauze and urinary catheter, and another 6 weeks postoperatively (W6) during the postoperative consultation (Fig. 2).

Patient and mesh characteristics were expressed by means and standard deviations (SD) for continuous variables and by number and percentage for qualitative variables.

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**Figure 1.** Mesh measurements prior to insertion and during ultrasonographic follow-up.

**Figure 2.** Clinical follow-up of patients and mesh. *:* ultrasonography on D0 at the end of the surgical procedure, after suturing the colpotomy, but before vaginal pack was inserted. Op: operative; D0: operative day; D3: third day after surgery; W6: 6 weeks after surgery; US: ultrasound.
Interobserver reproducibility (Table 1) for ultrasonographic measurements was previously assessed by calculating the intraclass correlation coefficient and using the Bland-Altman method [19] for agreement, which consisted in studying differences between a series of measurements and their mean.

Mesh size assessed on D0, D3 and after 6 weeks were compared between these three groups. The mesh size reduction was compared on D3 and after 6 weeks by Student’s t test or Wilcoxon’s test. The correlation between the mesh size and folding coefficient was quantified using Spearman’s correlation coefficient with a 95% confidence interval. Statistical significance was set at 5%.

The statistical analysis was performed using SAS version 9.1 (SAS Institute, Cary, North Carolina).

Results

In all, 25 patients were included over a regular period with recruitment depending primarily on sonographer availability and that of the ultrasonograph in the operating room. Mean patient age was 68 years (±9 years). Patient parity was a mean of 2.75 (±1.7) for a mean birth weight of 3534 g (±419 g).

Six patients had undergone previous surgery for prolapse (four sub-vesical plications, two rectocele repairs by plication) and four had undergone surgery for urinary incontinence (two Burch, one TVT, one Bologna).

Eleven patients had during surgery a concomitant procedure for urinary incontinence (TOT).

No immediate postoperative complications were observed. One explantation was required on D20 following a periprosthesis hematoma with scar dehiscence. No other complications, particularly mesh infection, were observed during the follow-up period.

The mesh was visible at each ultrasound examination (Fig. 3) and was visualized in the form of a hyperechogenic line under the bladder. The arms of the mesh were also visible but could not be studied along their entire length because of bone interposition.

Mesh dimensions prior to insertion and ultrasonographic measurements made on D0, D3 and 6 weeks postoperatively are reported in Tables 2A and 2B. Mesh total length (B) remained stable between the preoperative measurement [65 mm (±4)] and the ultrasonographic measurements on D0 and D3. Only arc length changed over this period (Table 2A). D0 sagittal arc (C) corresponded to 57% of preoperative mesh length. Mesh total length (B) 6 weeks after surgery [40 mm (±9)] corresponded to only 61% of initial preoperative mesh length (Table 2B). The W6 sagittal arc (C) [32 mm (±8)] corresponded to only 49% of the preoperative initial length (Table 2A).

When we compared evolution of mesh size between the different ultrasound scans (D0, D3, and W6), we noted that the sagittal arc (C) and the fundal arc increased by 8 to

### Table 1

<table>
<thead>
<tr>
<th>Intraobserver: D3 mesh total vaginal length</th>
<th>Interoobserver: D3 mesh total vaginal length</th>
<th>ICC</th>
<th>CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.87</td>
<td>0.76</td>
<td>0.77–0.92</td>
<td>&lt; 0.0001</td>
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</tr>
<tr>
<td>0.76</td>
<td>0.59–0.86</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ICC: intraclass correlation; CI: confidence interval; D3: third day after surgery.

### Table 2A

<table>
<thead>
<tr>
<th>Preoperative ex vivo mm (±SD)</th>
<th>Measurements</th>
<th>D0 mm (±SD)</th>
<th>D3 mm (±SD)</th>
<th>W6 mm (±SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 (±4)</td>
<td>Sagittal arc (C)</td>
<td>37 (±5)</td>
<td>40 (±8)</td>
<td>32 (±8)</td>
</tr>
<tr>
<td>73 (±7)</td>
<td>Fundal arc</td>
<td>42.5 (±6)</td>
<td>47.5 (±7)</td>
<td>38 (±6)</td>
</tr>
<tr>
<td>49 (±4)</td>
<td>Vulva arc</td>
<td>40 (±9)</td>
<td>39 (±9)</td>
<td>31 (±8)</td>
</tr>
</tbody>
</table>

n = 25 for preoperative measurements and ultrasound on D0 and D3; n = 24 for ultrasound at W6. SD: standard deviation; D0: operative day; D3: third day after surgery; W6: 6 weeks after surgery.

### Table 2B

<table>
<thead>
<tr>
<th>Measurements</th>
<th>W6 mm (±SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total length (B)</td>
<td>40 (±9)</td>
</tr>
<tr>
<td>Fundal Width (D)</td>
<td>47 (±9)</td>
</tr>
<tr>
<td>Vulva Width (E)</td>
<td>38 (±12)</td>
</tr>
</tbody>
</table>

SD: standard deviation; W6: 6 weeks after surgery.
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Figure 3. Perineal ultrasonography of polypropylene meshes. The mesh was visualized in the form of a hyperechogenic line. A. Measurement of the sagittal arc (C) on the sagittal view of the mesh. B. Visualization by the sagittal view of a hematoma in contact with the mesh. C. Measurement of fundal width (D) (on the transversal view). D. Presence of major mesh folding.

11% between the ultrasonographic measurements on D0 and D3. These arcs then decreased by about 20% in 6 weeks (W6 – D3/D3) (Table 3A). Mesh total length (B) at W6 on average corresponded to 74% (±20) of mesh total length measured on D3 (Table 3B).

Time-course changes in mesh total length (B) and sagittal arc (C) are shown on Fig. 4.

These successive ultrasound scans also served to study mesh location with regard to the bladder neck (A). Six weeks after surgery, the lower edge of the mesh was seen to have risen toward the vaginal fundus by about 6 mm with respect to the bladder neck. As none of the patients had cystocele recurrence after 6 weeks it was impossible to establish any correlation between this elevation and a risk of prolapse recurrence.

Mesh thickness measured by ultrasonography on D3 and at W6 did not vary significantly (1.8 mm ± 0.7 vs.

<table>
<thead>
<tr>
<th>Ratio</th>
<th>D3–D0/D0</th>
<th>W6–D3/D3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagittal arc (C)</td>
<td>±8</td>
<td>−20</td>
</tr>
<tr>
<td>Fundal arc</td>
<td>±11</td>
<td>−20</td>
</tr>
<tr>
<td>Vulva arc</td>
<td>−2</td>
<td>−20</td>
</tr>
</tbody>
</table>

SD: standard deviation; D0: operative day; D3: third day after surgery; W6: 6 weeks after surgery.
Vaginal mesh ultrasound

<table>
<thead>
<tr>
<th>Table 3B</th>
<th>Mean and SD of the ratio between total mesh length (B) or fundal and vulva width on D3 and the corresponding measurements at W6 (in %).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>W6/D3 % (±SD)</td>
</tr>
<tr>
<td>Total length (B)</td>
<td>74 (±20)</td>
</tr>
<tr>
<td>Fundal width (D)</td>
<td>81 (±22)</td>
</tr>
<tr>
<td>Vulval width (E)</td>
<td>79 (±11)</td>
</tr>
<tr>
<td>SD: standard deviation; D3: third day after surgery; W6: 6 weeks after surgery.</td>
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</table>

1.7 mm ± 0.7, P > 0.05. As no vaginal mesh exposure was noted in our cohort it was impossible to establish any correlation between mesh thickness and the onset of erosion.

The ultrasonography on D3 showed the presence of a hematoma around the mesh in seven patients (30%) (Fig. 3B). Suture rupture in one of these seven patients on D20 required mesh explantation.

The ultrasound scans obtained postoperatively on D0 and D3 showed marked folding or waving of the mesh (Fig. 3D). These folds were noted in 23 patients (92%) by the ultrasonography on D3.

In order to better identify these folds we devised a folding coefficient that corresponds to the ratio of sagittal arc (C) to mesh total length (B). The folding coefficients on D3 (0.76 ± 0.11) and at W6 (0.80 ± 0.11) showed a statistically significant correlation, with a correlation coefficient of 0.49. This indicates that folding on D3 corresponded to that noted by ultrasonography at W6.

**Discussion**

We used successive pelvic and perineal ultrasound examinations for the prospective follow-up of synthetic meshes in a cohort of female patients after vaginal repair of cystocele.

In all cases the polypropylene mesh was visible by pelvic ultrasonography in the form of a hyperechogenic line. Whether the mesh was smoothly spread or showed folds was easily evaluable in all the ultrasound scans, consistent with literature data [14].

Our ultrasonographic measurements consisted of mesh total length (B), which therefore included mesh folds, and that of what we called the “arc”. This corresponded to a direct measurement of the distance between the ends of the mesh in the sagittal or transversal view. We considered this measurement as particularly useful as it should correspond to the effective size of the mesh supporting the bladder [13].

Our successive ultrasonographic measurements showed that arc distance decreased substantially between the preoperative measurement and that taken on D0. The surgical procedure itself and mesh insertion may in part explain this change. Also, the change in mesh measurement technique certainly played a role in this decrease given that preoperative measurements were made directly on the mesh whereas the others were obtained by ultrasonography.

The sagittal (C) and fundal arc measurements then increased by 8 to 11% between the D0 and D3 ultrasound examinations. The insertion of vaginal pack at the end of the surgical procedure, but after the D0 ultrasound measurement, may explain this increase given that the compression exerted by the vaginal pack for 24 h would help the mesh spread and started to integrate native tissues. As folding coefficient (sagittal arc/mesh total length) at the D3 ultrasound examination was closely correlated with that observed at W6, it may be assumed that the folding which took place by D3 was permanent.

The D3 ultrasound scan would therefore appear to be suitable as a reference for future ultrasonographic monitoring. Subsequent scans may therefore be compared with the D3 scan, not the preoperative measurement.

Mesh total length (B) 6 weeks after surgery corresponded to only 61% of preoperative mesh length and the sagittal arc (C) corresponded to only 49% of this length (Tables 2A and 2B). Mesh size had therefore decreased by about 40%. The length supporting the bladder, i.e. the sagittal arc, therefore corresponded to only about half the length of the mesh when inserted. This decrease in size could correspond to shrinking of the mesh. These results were consistent with those of Tunn et al. who noted that mesh proximal-distal distance after 6 weeks corresponded to 43.2% of initial length [13]. But a comparison between the D3 and W6 ultrasonographic results appeared to closer reflect reality than a comparison with the preoperative value since the D3 ultrasound scan took account of the impact of the surgical procedure and any folds in the mesh. In this case, we observed that mesh total length (B) decreased by 26% between D3 and W6, and the sagittal arc (C) decreased by 20% (Tables 3A and 3B).

Velemir et al. demonstrated a relationship between mesh shrinkage and an increase in its thickness, as visualized by ultrasonography [10]. In our study, the D3 ultrasound

![Figure 4](image_url)  
**Figure 4.** Graphic representation of changes in mean of total length (B) and sagittal arc (C) over time [preoperative and ultrasound scan at D0 (operative day); D3 (third day after surgery); W6 (6 weeks after surgery)]. Mean were express in millimeter. Preop: preoperative; D0: operative day; D3: third day after surgery; W6: 6 weeks after surgery.
scan showed evidence of periprosthetic hematomas and marked mesh folding, both causing major inflammation which may explain more marked shrinkage or postoperative complications. The D3 ultrasound scan showed evidence of a hematoma in a patient who required mesh explantation on D20 due to rupture of the suture.

Pelvic ultrasonography could also be used to study mesh position and visualize the location of any recurrent prolapse with respect to the mesh [10,14]. Two recurrence mechanisms have been described using this technique. Prolapse recurrence may occur due to the mesh incompletely covering the lower part of the vagina [10]. Our data showed that the mesh gradually rose over 6 weeks toward the vaginal fundus. The way used to fix the mesh could influence the clinical recurrence through the decrease of vagina area covered by the mesh [20]. Other recurrences may occur due to defective anchoring of the mesh arms, leading to a fundal recurrence. In these cases 3D ultrasonography showed that the mesh changed orientation during the Valsalva manoeuvre [14].

The postoperative follow-up period in our study that stopped at 6 weeks, was insufficient for us to establish any correlation between ultrasonographic data and clinical recurrence rate. Neither were we able to establish a correlation between the presence of hematomas, mesh folds, location with respect to bladder neck, and the risk of mesh exposure or prolapse recurrence.

Such correlations could only be detected by more long-term patient follow-up conducted to note prolapse recurrences and determine etiology (poor cover of the lower part of the vagina) [10] and problems with the anchoring of mesh posterior arms [14]. Finally, our findings should be confirmed by studies involving other types of mesh kits (different materials and type of fixation), thus assessing the impact of surgical technique.

**Conclusion**

Pelvic ultrasonography was a useful tool for the in vivo study of polypropylene meshes employed for the vaginal repair of prolapse as the technique can be used to monitor the mesh. This study showed changes in the mesh measurements made by ultrasound. The D3 ultrasound scan should appear to be suitable as a reference for subsequent ultrasonographic monitoring. Performed after mesh spreading, it may take account of the impact of the surgical procedure. Ultrasonography should therefore provide initial mesh measurements post-implantation, in particular that of the sagittal arc. It also served to locate the mesh with respect to the bladder neck and visualize hematomas and mesh folds. Results at longer-term follow-up will be necessary to correlate ultrasonographic data with clinical results. Moreover, the impact of the mesh fixation should be assessed.

**Disclosure of interest**

The authors declare that they have no conflicts of interest concerning this article.

**Appendix A. Supplementary data**

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.puo.2013.03.018.

**References**


