The Use of Synthetic Polymer Meshes in the Correction of Pelvic Static Defects

ELVIRA BRATILA[1], CORNEL PETRE BRATILA[2], DIANA ELENA COMANDASU[1], AURORA ANTONIAC[3]*, MONICA MIHAELA CIRSTOIU[4]

[1]Saint Pantelimon Clinical Emergency Hospital, Obstetrics and Gynecology Department, Bucharest, 340-342 Pantelimon Str., 021659, Bucharest, Romania

[2]Euroclinic Hospital, Department of Gynecologic and Pelvic Reconstructive S urgery, 14A Floresca Str.,014461,Bucharest, Romania

[3]University Politehnica of Bucharest, Materials Science and Engineering Faculty, 313 Splaiul Independentei, 060042, Bucharest, Romania

[4]Emergency University Hospital, Obstetrics and Gynecology Department,169 Splaiul Independenței, 050098, Bucharest, Romania

The purpose of this paper is to prove that the use of synthetic meshes in the treatment of pelvic organ prolapse involves specific complications. Pelvic organ prolapse occurs as a result of the distention or rupture of a weakened, inelastic connective tissue that is a major compound of fascia and ligaments which make up the support and suspension system of pelvic organs. Pelvic organ prolapse has genetic determinism and so patients who suffer from it produce a poor quality collagen or it may happen due to premature aging. The risk for a woman to develop various stages of prolapse is appreciated to be 11% and the risk of relapse is 29.25%. Unlike in case of other surgical treated afflictions, pelvic organ prolapse has a very high risk of relapses that need surgical cure - 17%. The failure rate of the traditional surgical treatment using native tissues is 58% for the anterior pelvic compartment. Given the circumstances strengthening the weakened fascia and ligaments using biological grafts or synthetic ones proved itself necessary. The first augmentation attempts using synthetic meshes were performed by Manhes in 1990. Currently the synthetic meshes are widely used and have good outcomes, but they also have specific complications. For transvaginal interventions reconstruction using meshes is superior to the procedures that use native tissues. Surgical treatment for the pelvic floor defects consisting in synthetic mesh implant shall not be recommended unless the benefits exceed the risks for every case in particular. Based on our experimental results, scanning electron microscopy appears to be a very useful tool for surface analysis and retrieval studies of the surgical mesh used in the treatment of pelvic floor defects. Also, we find that the mesh erosion is the main adverse effect in the surgical treatment of pelvic floor defects and this appears due to the polymeric mesh materials modifications.

Keywords: artificial meshes, polymer, pelvic organ prolapse, erosion, pelvic pain

Pelvic organ prolapse occurs as a result of the distention or rupture of a weakened, inelastic connective tissue that is a major compound of fascia and ligaments which make up the support and suspension system of pelvic organs. Pelvic organ prolapse can occur in one or more compartments of the vagina, including the bladder (cystocele), the uterus (procidentia), the rectum (rectocele), the top of the vagina (apical prolapse) or the bowel (enterocele). Figure 1 depicts the lateral cut-away view of the female pelvis normal anatomy and the specific aspects for pelvic organ prolapse.

Pelvic organ prolapse has genetic determinism and so patients who suffer from it produce a poor quality collagen or it may happen due to premature aging. The risk for a woman to develop various stages of prolapse is appreciated to be 11% [1] and the risk of relapse is 29.25% [2]. Unlike in case of other surgical treated afflictions, pelvic organ prolapse has a very high risk of relapses that need surgical cure - 17% (in the surgical treatment of hernias this risk of a second surgical procedure is estimated between 1.7% and 4.3%) [3].The failure rate of the traditional surgical treatment using native tissues is 58% for the anterior pelvic compartment [4]. Given the circumstances, strengthening the weakened fascia and ligaments using biological grafts or synthetic ones proved itself necessary strength.

The first augmentation attempts using synthetic meshes were performed by Manhes in 1990. Currently the synthetic

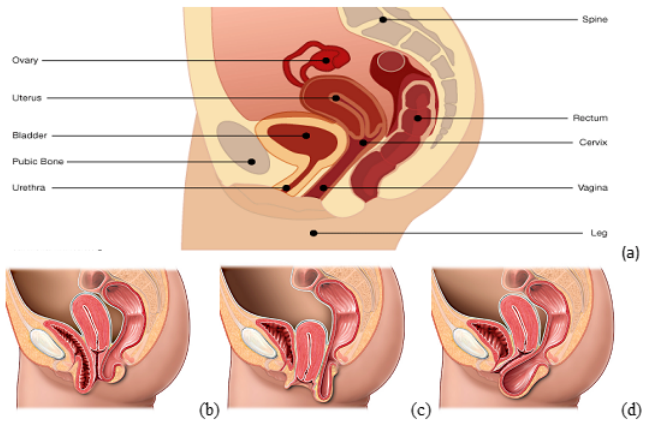


Fig. 1. Schematic image (the lateral cut-away view) of the female pelvis normal anatomy and the specific aspects for pelvic organ prolaps: (a) normal pelvic anatomy; (b) cystocele; (c) procidentia; (d) rectocele

meshes are widely used and have good outcomes, but they also have specific complications. For transvaginal interventions, reconstruction-using meshes is superior to the procedures that use native tissues [5]. The idea of using synthetic meshes for strengthening tissues belongs to the surgeons that used them in the treatment of hernias since 1950. The meshes used in the treatment of various forms

* *email:antoniac.aurora@gmail.com; Phone: 021 4100400; (+40)745206509* *All authors have participated equally in developing this study*

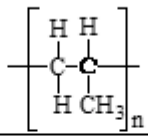
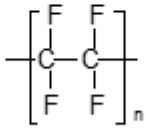
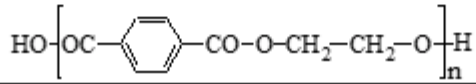
Table 1

MESH CLASSIFICATION ACCORDING TO AMID (ADAPTED AFTER [6])

Mesh type Dimension of the pores / examp	Structure	Synthetic material	Elasticity	Use in pelvic reconstruc
I Macroporous >75µm /Marlex, Prolene	Knitted monofilament	Polypropylene PP	Good	Transobturator Transvaginal Suprapubic
II Microporous <10µm /Gore-Tex	Knitted multifilament	Expanded PTFE	Reduced	Transvaginal Suprapubic Sacropcolpopexy
III Macroporous/microporous <70µm /Mersilene, Surgipro	Nonknitted multifilam	Polytetrafluoro-ethylen Polyethylene terephthal PET	Restricted	Transvaginal Suprapubic Sacropcolpopexy
IV Submicronic pores <1µm /Cellgard, Silastic	Multifilament	Expanded PTFE	Restricted	Transvaginal Suprapubic Sacropcolpopexy

Table 2

THE STRUCTURE AND PROPERTIES OF POLYMERS USED TO MANUFACTURE THE SYNTHETIC

Polymer	Chemical structure	Density [g/cc]	UTS [MPa]	Young modulus [MPa]
Polypropylene PP		0.9	35	1380
Polytetrafluoroethylene PTFE		2.2	23	500
Polyethylene terephthalate PET		1.4	50	1724

of pelvic organ prolapse differ from the ones used in the strengthening of the abdominal wall, as they have a different structure for they need to fulfill some conditions that will allow them to integrate underneath the vaginal wall, where the patient's sexual activity generates mechanical forces, the environment is septic and the tissues have reduced strength and elasticity. Once they are implanted, the meshes become *factories of connective tissue*, for they initiate a biological process of producing a new type of tissue that requires continuous remodeling in order to remain elastic and resistant.

Synthetic meshes are classified by their porosity and by the provenience of the wires they are made from into macroporous or microporous, monofilament or multifilament meshes.

A standardized classification system has been proposed by Amid in order to distinguish between the different types of synthetic mesh shown in table 1. The meshes could be classified by their porosity, polymeric biomaterials used and the way of production [6-9].

The properties of polymers used to manufacture the synthetic meshes are very important for the final properties of the mesh; even these properties are not mentioned by the manufacturers. In table 2, we present the main properties and chemical structure of the synthetic polymers used for manufacturing nonabsorbable surgical meshes.

Due to the dynamic evolution of the synthetic mesh, Klinge and Klosterhalfen proposed recently a more complex classification, (table 3) based on the analysis of 55 different mesh devices from 9 different manufacturers from Germany, who take in consideration the new evolution of the field.

Based on the recently published studies that were made on the topic of mesh integration into the human tissue, it was demonstrated that the large porous, lightweight meshes have the best tissue integration [10].

The reaction of the tissues to the different biomaterials used for synthetic meshes that is placed inside the human body can vary. Williams describes four kinds of tissue reactions [11, 12]:

- a minimum reaction characterized by a thin layer of fibrosis around the implant;
- a chemical answer of the body characterized by a severe chronic inflammation around the implant;
- a physical answer of the body characterized by an inflammatory reaction and giant cells;
- necrotic tissue that makes a debris layer due to exothermic polymerization at the place of implantation.

The reaction of the tissues where the implantation of the mesh was made can be referred to as the so-called *shield-phenomenon*. For example, if a mesh is placed in the anterior compartment between the vaginal wall and the bladder wall, the mesh won't allow the transmission

Table 3
MESH CLASSIFICATION ACCORDING TO KLINGE (ADAPTED AFTER [10, 11])

Mesh type	Characteristics
Class I: Large pore meshes (characterized by a textile porosity of >60 % or an effective porosity of >0 %)	a. Monofilament b. Multifilament c. Mixed structure or polymer (e.g. absorbable + non-absorbable, or different non-absorbable).
Class II: Small pore meshes (characterized by a textile porosity of <60 % and without any effective porosity)	a. Monofilament b. Multifilament c. Mixed structure or polymer.
Class III: Meshes with special features	Porous meshes with special features (surface coating)
Class IV: Meshes with films	The different biological integration film-like meshes without porosity
Class V: 3D meshes	Other than, the flat meshes. a. Pre-shaped b. Pre-formed c. 3D devices
Class VI: Biologicals	a. Non-cross-linked b. Cross-linked c. Special features.

of the mechanic stimuli (generated by the filling of the urinary bladder) to the vaginal wall. This will lead to the stiffening of the vaginal wall and complications regarding the extrusion of the mesh. The factors that can generate this phenomenon are the stiffness of the material, fixing it on multiple structures, the excessive tension applied on the mesh or the meshes that aren't adapted to the dimensions of the anatomical defect.

Experimental part

The aim of our study was to analyze the available synthetic meshes made by polymers used in the treatment of pelvic floor defects and demonstrate that in clinical practice appear some specific complications due to the polymeric materials modifications. Also, we want to present that scanning electron microscopy is an interesting tool for analysis the surface morphology of the synthetic polymer meshes.

Clinical study

During a time period of a year we treated using meshes a number of 210 patients suffering from different types of pelvic organ prolapse. Most of the patients treated were diagnosed with type II or III cystocele or stress urinary incontinence, while some of them suffered from utero-vaginal prolapse. We did not use mesh fixation for the posterior compartment defects, given the high risk of erosion mentioned in the specialty literature. All the patients had one-day surgery, and the rate of complications did not exceed 5%.

The vaginal morphology and the remodeling process of the connective tissue located here are negatively altered by the implantation of thick meshes with high specific weight. These meshes determine a growth of the collagenase activity, they decrease the content of collagen and elastin and they also increase glycosaminoglycan, which indicates a negative impact on the structural integrity of the vagina [13]. Therefore, the meshes used in pelvic reconstruction have a low weight on a square meter and are called ultralight meshes. The synthetic meshes that contain absorbable materials (polyglycolic acid or polyglactin) have been introduced in order to decrease the remaining quantity of foreign material in the patient's body. The downside of these meshes is that they will not allow tissue remodeling to happen after they have been absorbed. The synthetic meshes are supposed to replace the deficient tissues and to stimulate the local synthesis of collagen that will lead to their integration in the native tissues. The new collagen that is produced is constantly remodeling as long as the mesh stays where it was placed and does not disintegrate.

The integration of the mesh is a phasic process in which the organism participates with the natural healing mechanisms. During the first phase that lasts for 48 hours, the mesh is included in a layer of fibrin where by chemotaxis polymorphonuclear leukocytes at first and then macrophages will intervene. During this phase the porosity of the mesh is a key factor because if it has pores smaller than 70μm, which won't allow the passage of macrophages therefore blocking their process of embedding. Later on the fibroblastic colonization will begin and that will be the start of another phase-the reconstructive one. During this time, the processes of angiogenesis and producing collagen will finish the embedding of the mesh in the 10th day. From now on, a continuous process of collagen remodeling will begin. The process of acceptance and embedding of the mesh has a specific determinism for each case, but there are also some general factors that can alter it.

Materials and methods

We evaluated 210 patients, admitted in the Department of Gynecologic and Pelvic Reconstructive Surgery at Euroclinic Hospital and in the Department of Obstetrics and Gynecology at *Saint Pantelimon* Clinical Emergency Hospital during between January 2014 and January 2015, whom were surgically treated for various types of pelvic organ prolapse using polymer meshes. From them, 105 patients were diagnosed with grade II or III cystocele, 85 with stress urinary incontinence and the rest of 20 with utero-vaginal prolapse. The mean age of the patients was 52 years (42-73 years), most of them having in their gynecologic history one or more vaginal deliveries. The posterior compartment defects – rectocele, enterocele, were treated without inserting artificial meshes, because of the well-known high risk of erosion. All the patients had one-day admissions, respectively one-day surgery, with no significant immediate postoperative adverse events. Postoperative the patients received oral treatment with antibiotics and anti-inflammatory suppository. Considering the long-term complications, from the entire group, 5 patients presented mesh erosion, respectively 2 patients presented chronic pain. The mesh erosion cases occurred in patients treated for anterior compartment defects, especially large cystoceles, while the chronic pelvic pain cases appeared in patients treated with meshes for stress urinary incontinence. There were no recorded cases of

mesh infection in this group. All the mesh erosion cases needed surgical excision and repair.

We performed the surface analysis using scanning electron microscopy [14, 15] on different types of synthetic meshes used in clinical practice for pelvic floor defects, in order to identify the differences between monofilament and multifilament meshes. Also, using the scanning electron microscope type Philips XL-30-ESEM TMP equipped with EDAX was evaluate several parts of the explanted mesh obtained during surgical interventions.

Results and discussions

The experimental results obtained after the surface morphology analysis of different commercial synthetic meshes using scanning electron microscopy are shown in figure 2.

According the results shown in figure 2, it is possible to see clearly the different design for each surgical synthetic mesh. Apart of the polymer used, the surgical meshes could be monofilament or multifilament [16]. Using the scanning electron microscopy analysis, it was easy to identify the type of filament used for each mesh as is shown in figure 3.

In the clinical part of our study, we evaluated and compared the postoperative specific complications of polymer mesh surgery used in the surgical treatment of different pelvic floor defects. The short-term and long-term complications included 5 cases of mesh erosion and 2 cases of chronic pelvic pain, secondary to the insertion of a polymer mesh. The mesh erosion was specific to the anterior compartment defects, especially in women treated for large cystoceles.

The chronic pain syndrome manifested as moderate to increased intensity spontaneous pelvic pain and dyspareunia due to the use of meshes appeared in 2 patients who were operated for stress urinary incontinence.

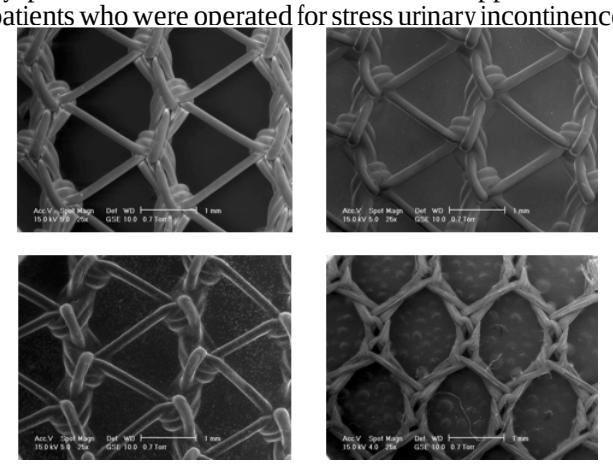


Fig. 2. Scanning electron microscopy images of different meshes used in clinical practice

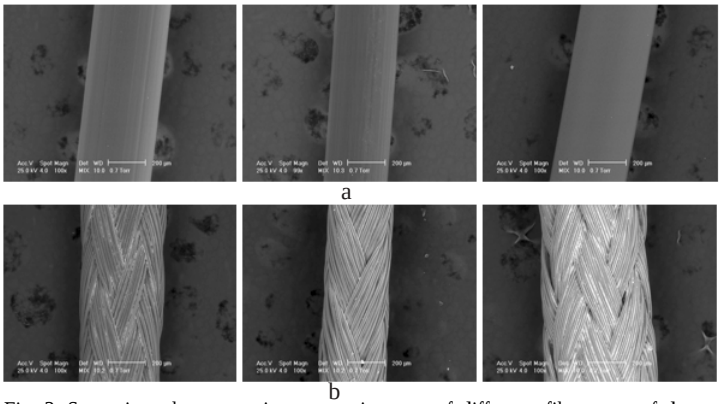


Fig. 3. Scanning electron microscopy images of different filaments of the commercial meshes: a) monofilament; b) multifilament

In our study group, there were no cases of mesh infection recorded.

Complications of the synthetic mesh surgical treatment

In 2011 FDA (US Food and Drug Administration) has stated a warning document concerning the safety of using synthetic meshes in the surgical treatment of pelvic organ prolapse, presenting 3979 cases of patients who suffered from side effects between 2007 and 2010 and also some recommendations on using biocompatible materials specific to a certain surgical procedure. Among the clinical cases described in the article, there are many cases of pelvic organs prolapse and of stress urinary incontinence. Most of the cases were caused by a poor integration of the synthetic materials that were used [17]. As an answer to that problem, in 2012 the American Society of Urogynecology has developed a guide on how to use synthetic meshes in the surgical treatment of pelvic organ prolapse. This guide offers both the doctor and the patient the right to decide and is now used by specialists worldwide [17].

One important factor that can generate complications in the area of synthetic mesh surgery is related to the surgical technique that is used such as vaginal dissection in a superficial plan or putting tension on the mesh. Placing the mesh in a septic vaginal environment or on a vaginal atrophy can also alter the process of healing and integration. Also, other factors like smoking, immuno-suppressive treatment or vicious scarring of the mesh's arms can also generate complications.

Based on the type of tissue reaction that appears we can say that some complications are exclusively generated by the implantation of the synthetic mesh. Cosson classifies them into three major groups [17]:

- type 1 complications: the infection of the implant - it can go from the simple intravaginal exposure to local abscesses, fistulas and sometimes even pelvic cellulitis. This type of complications is rarely met and it is generated by the quality of the material used in the mesh. The treatment consists in the full removal of the implant;

- type 2 complications: the exposure of the implant. Intravaginal exposure is the most common form and can be represented by the exposure of the mesh on the incision line or a distant exposure and also by the erosion of the underlying organ such as the urethra, urinary bladder or rectum. You can choose the conservative treatment for small defects or the excision of the mesh's part that has been exposed.

The defect that remains after the excision of the mesh can sometimes be incredibly important for it may need myocutaneous Martius flap graft or Surgisis second generation biological graft (fig. 4).

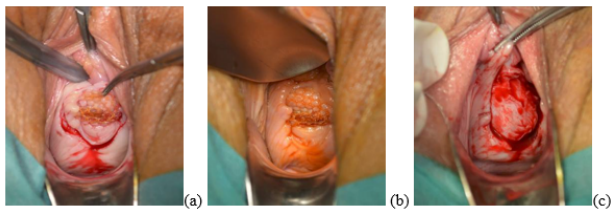


Fig. 4. Clinical aspects during practical surgery for the correction of pelvic static defects: (a) large excision of vaginal wall and mesh extruded; (b) double mesh extrusion after cystocele and stress urinary incontinence repair; (c) large vaginal defect after mesh excision

Rank	Adverse effects	Rate (%)
1	Erosion	35,1
2	Pain	31,4
3	Infection	16,8
4	Other adverse effects (bleeding, dyspareunia, organ perforation, urinary problems, neuro-muscular problems, vaginal scarring /shrinkage, recurrence, prolapse)	<10%

Table 4
ADVERSE EFFECTS REPORTED FOR SURGICAL MESH USED FOR POP REPAIR (ADAPTED AFTER FDA REPORT 2011 [19])

·Type 3 complications: The symptomatic contraction of the mesh - tissue retraction around the mesh is a frequent phenomenon and it can take up to 20-30% of the implant's surface. The symptoms that describe this phenomenon may vary: the patient can be asymptomatic or she can feel pain at intravaginal palpation or spontaneous at various intensities. High intensity pain or dyspareunia are the situations in which the implant must be removed.

The erosion or exposure of the mesh

Vaginal walls are the main support for the urinary bladder and urethra in order to maintain the anatomical disposition within normal limits. The patients with pelvic static defects often have a vaginal walls' prolapse. The lack of vaginal support for the urinary bladder and urethra can lead to the appearance of stress urinary stress incontinence [18]. Synthetic meshes are used in order to restore the suburethral support in the treatment of stress urinary incontinence or in order to reconstruct the vaginal walls' support.

The indications for augmentation treatment with synthetic meshes are:

- the lack of autologous tissues that are necessary for a stable, long-lasting reconstruction;
- the need to strengthen the weakened tissue of the endopelvic fascia;
- the failure of the preceding surgical treatment in which native tissues have been used;
- colposacropexy as a technique that cannot be performed without the usage of synthetic meshes.

Intravaginal exposure or the extrusion of the mesh is defined as the partial exposure at the vaginal walls' surface of mesh's segment.

The erosion determined by the meshes consists in the perforation of the wall of an underlying organ such as the urinary bladder or the rectum.

The percentage of vaginal exposures or erosions is globally expressed and the most relevant statistic is the one introduced by the FDA in 2013 where the percentage of vaginal exposures is 35.1% and organ perforations represent 5.8% of the total number of adverse events generated by the meshes [17].

The adverse events reported for surgical mesh indicated for POP repair are presented in Table 4.

Depending on the severity of the adverse events, required interventions ranged from application of topical estrogen cream, a course of antibiotics or trimming of the exposed mesh, to admission to the ER or hospital, bowel resection, and blood transfusion. The most frequent required interventions were additional surgical procedure (n=416), partial or complete mesh removal (n=182), and hospitalization (n=71). Multiple required interventions were reported for some patients.

In the published literature, mesh erosion into the vagina is the most common and consistently reported mesh-related complication following vaginal POP repair with mesh. Mesh erosion can result in serious complications unique to mesh procedures and is not experienced by patients who undergo traditional repair. Mesh erosion may require mesh removal to manage the sequelae (e.g., pain, dyspareunia). This complication can be life altering for some women as mesh removal may require multiple surgeries and sequelae may persist despite mesh removal [10]. A 2011 systematic review of the safety of vaginal POP repair with mesh by Abed et al cited a summary incidence of mesh erosion of 10.3% (95% CI, 9.7-10.9%; range 0- 29.7%) within 12 months of surgery from 110 studies including 11,785 women in which mesh was used for vaginal POP repair [12]. The incidence of mesh erosion did not differ for non-absorbable synthetic mesh (10.3%) compared to biologic graft material (10.1%). For non-absorbable synthetic mesh erosions, 56% (448/795) required surgical excision in the operating room, with some women requiring two to three additional surgeries [12]. Less information is available about management of erosion from biologic grafts. For 35 women in which management of erosion from biologic grafts was discussed, half responded to local treatment with topical agents. The one

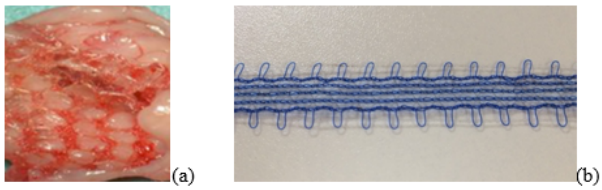


Fig. 5. Practical aspects related to the analysis of the retrieved mesh that was used for the correction of pelvic static defects: (a) mesh partially removed with vaginal wall; (b) preoperative aspect of the mesh

RCT for anterior repair with non-absorbable synthetic mesh with 3 year follow-up found that 5% of patients had unresolved mesh erosion at 3 years [13].

The factors involved in the extrusion and erosion of the meshes are connected to the extensive dissection of the vaginal walls, the dissection in a wrong plan (between the epithelium and the muscular layer), the devascularization of the vaginal tissue, estrogenic deficiency, excessive tension applied on tissues, subclinical vaginal infections, not knowing the surgical procedure, immunosuppressive treatment and smoking.

Cosson has summarized the qualities that synthetic meshes must have in order to generate minimal complications this way [20]:

·The mesh should not be physically modified by the tissue fluids;
- the mesh has to be chemically inert;
- the mesh should not provoke an inflammatory reaction or stimulate the body to produce antibodies;
- the mesh should not be carcinogenic;
- the mesh should not provoke allergic reactions or hypersensitivity;
- it should be mechanically resistant;
- it should be adaptable to the necessities;
- it should be sterile;
- it should be resistant to infection;
- it should prevent adherence to surrounding organs;
-it should have an in vivo response better than autologous tissues.

Wong et al. considers the surgical treatment in the OR as the most efficient one for artificial mesh induced complications [21].

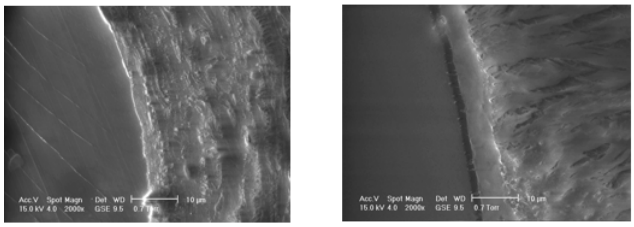


Fig. 6. Scanning electron microscopy results obtained after the analysis of the retrieved mesh

Based on the analysis of the retrieved polymeric mesh made by polypropylene made by scanning electron microscopy (fig. 6), we observed clearly the sign of the mesh erosion.

These results confirm that the mesh erosion is the main adverse effect that appears in the case of using synthetic meshes for POP repair [22].

Conclusions

Surgical treatment for the pelvic floor defects consisting in synthetic mesh implant shall not be recommended unless the benefits exceed the risks for every case in particular. The alternative, as in the surgical treatment of the anatomical pelvic defect without meshes can be offered as a first intention treatment for curing primary forms of pelvic organ prolapse. The patients shall accept an informed consent only after the explicit presentation of risks and benefits.

Based on our experimental results, scanning electron microscopy appears to be a very useful tool for surface analysis and retrieval studies of the surgical mesh used in the treatment of pelvic floor defects.

Also, we find that the mesh erosion is the main adverse effect in the surgical treatment of pelvic floor defects and this appears due to the polymeric mesh materials modifications.

References

1. COX, A., HERSCHORN, S., Curr. Urol. Rep., **13**, nr. 3, 2012, p. 247.
2. SWIFT, S., WOODMAN, P., O'BOYLE, A., KAHN, M., VALLEY, M., BLAND, D., WANG, W., SCHAFFER, J., Am. J. Obstet. Gynecol., **192**, nr. 3, 2005, p. 795
3. BAY-NIELSEN, M., KEHLET, H., STRAND, Lancet, **358**, nr. 6, 2001, p. 1124
4. ALPERIN, M., ELLISON, R., MEYN, L., FRANKMAN, E., ZYCZYNSKI, H.M., Female Pelvic Med. Reconstr. Surg., **19**, nr. 2, 2013, p. 72
5. MAHER, C.M., Int. Urogynecol. J., **22**, nr. 11, 2011, p. 1445
6. AMID, P.K., Hernia, **1**, nr. 1, 1997, p. 15
7. BAESSLER, K., MAHER, C.F., Curr. Opin. Obstet. Gynecol., **18**, nr. 5, 2006, p. 560
8. HUEBNER, M., HSU, Y., FENNER, D.E., Int. J. Gynecol. Obstet., **92**, nr. 4, 2006, p. 279
9. BADER, G., FAUCONNIER, A., GUYOT, B., VILLE, Y., Gynecol. Obstet. Fertil., **34**, nr. 4, 2006, p. 292
10. KLOSTERHALFEN, B., JUNGE, K., KLINGE, U., Expert Rev. Med. Devices, **2**, nr. 1, 2005, p. 103.
11. KLINGE, U., KLOSTERHALFEN, B., Hernia, **16**, nr. 2, 2012, p. 251.
12. WILLIAMS, D.F., Implants in surgery. Philadelphia, PA: WB Saunders, 1973, p. 203.
13. RUI LIANG, M.D., Bjog, **120**, nr. 2, 2013, p. 233.
14. MARINESCU, R., ANTONIAC, I., LAPTOIU, D., ANTONIAC, A., GRECU, D., Mat. Plast., **52,** no.3, 2015, p.340
15. CIRSTOIU, M., CIRSTOIU, C., ANTONIAC, I., MUNTEANU, O., Mat. Plast., **52,** no.3, 2015, p.258
16. PARIZA, G., MAVRODIN, C. I., GANGONE, M. E., ANTONIAC, V. I., Adv. Mat. Res., **1114**, nr. 4, 2015, p. 253.
17.*** AMERICAN UROGYNECOLOGIC SOCIETY'S GUIDELINES DEVELOPMENT COMMITTEE, Female Pelvic Med. Reconstr. Surg., **18**, nr. 4, 2012, p. 194.
18. HENDRIX, S.L., CLARK, A., NYGAARD, I., ARAGAKI, A., BARNABEI, V., MCTIERNAN, A., Am. J. Obstet. Gyencol., **186**, nr. 6, 2002, p.1160.
19. FDA EXECUTIVE SUMMARY, Proceedings of the Obstetrics & Gynecology Devices Advisory Committee Meeting; 2011; p.1
20. VON THEOBALD, P., ZIMMERMAN, C.W., DAVILLA, G.W., New techniques in genital prolapse surgery. Springer Verlag London Limited, 2011, p. 69.
21.WONG, K.S., NGUYEN, J.N., WHITE, T., MENEFEE, S.A., WALTER, A.J, KRULEWITCH, C.J., ANDERSON-SMITS, C.T., JAKUS-WALDMAN, S.M., Obstet. Gyencol., **122**, nr. 3, 2013, p. 1239.
22.MAVRODIN, C. I., ANTONIAC, V. I., PARIZA, G., Adv. Mat. Res., **1114**, nr. 4, 2015, p. 278.

Manuscript received: 14.01.2016