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ORIGINAL ARTICLE

Factors associated with exposure of transvaginally placed polypropylene mesh for pelvic organ prolapse

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Abstract
Introduction and hypothesis This study evaluates potential risk factors for mesh exposure following transvaginal placement of polypropylene mesh for pelvic organ prolapse requiring reoperation.
Methods We performed a case-control study. Cases had mesh exposure requiring surgical revision; controls had no mesh exposures and were chosen for similar surgical date and type of mesh.
Results We identified 48 cases and 48 controls. The adjusted odds ratio of having a bleeding complication at the time of mesh implantation was 7.25 [95% confidence interval (CI) 1.47–35.66], smokers versus nonsmokers was 3.17 (95% CI 0.59–17.12), and being 1 year older was 0.96 (95% CI 0.92–1.0), among women with mesh exposure.
Conclusions We identified bleeding complications at the time of mesh implantation as a risk factor for mesh exposure requiring reoperation. Despite being one of the largest studies on this topic, our data were inconclusive regarding the impact of other possible factors on mesh exposure.

Keywords Mesh exposure · Pelvic organ prolapse · Polypropylene mesh · Transvaginal mesh

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Introduction

Approximately 40% of women over the age of 50 will experience pelvic organ prolapse (POP) [1], and nearly 200,000 women undergo inpatient procedures for POP each year in the USA [2]. As life expectancies increase and the population ages, the number of women with POP is estimated to increase 46% from 3.3 to 4.9 million between 2010 and 2050 [3], many of whom will desire surgical repair. Traditional transvaginal surgeries have been associated with recurrence rates as high as 58% [4]. This has led pelvic surgeons to seek alternatives in an effort to improve patient outcomes. Mesh has been used successfully in the general surgery armamentarium for many years for the repair of abdominal hernias [5]. Analogous augmentation of vaginal repairs for POP has been attempted with a wide variety of biologic and synthetic materials. Even with a lack of scientific evidence to support the use of mesh augmentation in this manner, it is becoming increasingly popular [6]. Complications do occur, including mesh exposure which has been reported at rates of 15.6% [7] to 17.3% [8]. A search of the literature revealed several case series with small numbers of cases reporting an increased risk of mesh exposure with concurrent vaginal hysterectomy, intraoperative bladder injury, smoking, age, current treatment for diabetes, and sexual activity [9–13]. We have attempted to collect a larger series of patients as well as a control group for

comparison to address the question of possible risk factors for mesh exposure (Figs. 1, 2, 3).

Our primary objective was to assess whether smoking is associated with mesh exposure requiring reoperation following transvaginal placement of polypropylene mesh for POP; and, secondarily, to assess whether age, body mass index (BMI), medical comorbidities, prior gynecologic surgeries, concurrent hysterectomy, or complications at the time of surgery are associated with mesh exposure requiring reoperation following transvaginal placement of polypropylene mesh for POP.

We hypothesize that smoking increases the risk of mesh exposure requiring reoperation following transvaginal implantation of polypropylene mesh for the repair of POP.

Materials and methods

The Vanderbilt University Institutional Review Board approved this study. A case-control study was performed. The inclusion criteria were women, 18 years or older, with transvaginally placed polypropylene mesh for the repair of POP between 1 January 2004 and 31 May 2009. Cases and controls were selected from the Department of Obstetrics and Gynecology and the Department of Urologic Surgery at Vanderbilt University Medical Center. Cases were treated at our tertiary care center with polypropylene mesh exposure requiring surgical revision. Mesh exposure was defined as "a condition of displaying, revealing, exhibiting or making accessible e.g. vaginal mesh visualized through separated vaginal epithelium" in accordance with the International Urogynecological Association (IUGA)/International Continence Society (ICS) joint terminology and classification of the complications related directly to the insertion of prostheses (meshes, implants, tapes) and grafts in female pelvic floor surgery [14]. Cases were identified by CPT codes 57295 and 57296, indicating a surgical mesh revision, and included women initially operated upon at our facility, as well as women referred here after a primary surgery at another institution. Controls did not develop mesh exposure, which was confirmed by manual review of the medical records, and were chosen for similar surgical date and type of mesh. Type I mesh and type III mesh were matched with similar products. Type I mesh is macroporous (>75 μm) and monofilament. Type III mesh is macroporous with multifilamentous or microporous components [15]. Controls were identified by CPT code+57267, indicating the vaginal insertion of mesh for repair of pelvic floor defects. This is an add-on code to be used along with the primary code such as anterior colporrhaphy (57240-+57267) and posterior colporrhaphy (57250- +57267). The controls were selected from women who were seen for the treatment of POP with transvaginally placed mesh at our medical center.

We excluded women with biologic grafts placed for POP, those with minor exposures managed in the office, and suture exposures. We also excluded exposures from

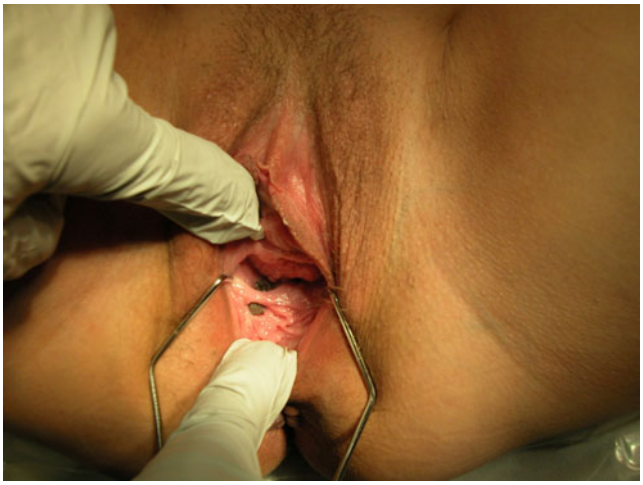

Fig. 2 Mesh exposure in the posterior vagina

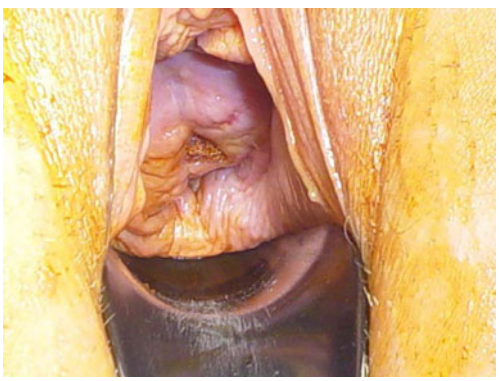

Fig. 1 Mesh exposure in the anterior vagina

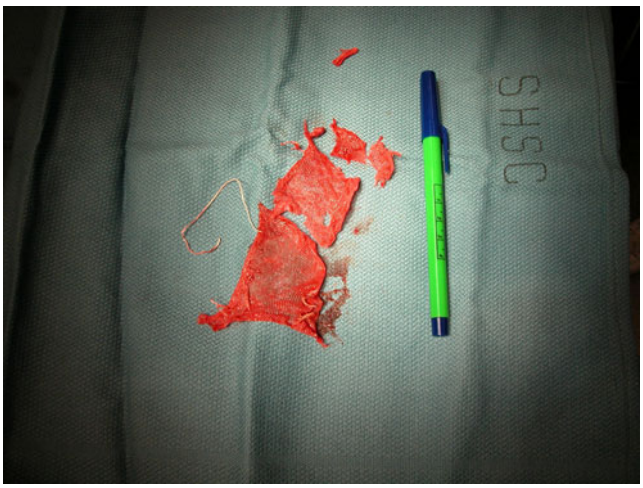

Fig. 3 Excised mesh

midurethral slings or other procedures for urinary incontinence. Charts identified by CPT codes were manually reviewed to evaluate for eligibility criteria. Patient demographics, characteristics, comorbidities, perioperative variables, complications, and exposure status were ascertained from the medical record. Perioperative complications were those identified in the medical records either in the operative report or in follow-up visits. Simple logistic regression was used to estimate the odds of developing mesh exposure for each variable of interest. We also used multivariable logistic regression to determine if age, smoking, and bleeding complications were independently associated with developing mesh exposure. In the multivariable model we chose to include bleeding complications and smoking while adjusting for a common confounder, age. Bleeding complication was included because of its strong association with mesh exposure in the univariable analysis and smoking was our prespecified predictor of interest. All results are summarized as odds ratios (OR) comparing cases to controls with accompanying 95% confidence intervals (CI). Analysis was performed with STATA (version 9) and R (version 2.10.0).

Results

Ninety-six women met the inclusion criteria for this study: 48 cases with a vaginal mesh exposure and 48 controls without a vaginal mesh exposure. Women with and without mesh exposures were of similar gravidity, parity, BMI, menopausal status, and had similar rates of medical comorbidities (Table 1). They also had similar rates of prior and concomitant urogynecologic surgeries. The overall estimated blood loss (EBL) between the cases and controls was not found to be significantly different (Table 2). The complication of excessive bleeding, defined as EBL in excess of 500 ml, hematoma formation requiring intervention, or the need for a postoperative transfusion, was found to be a predictor of mesh exposure in both the univariable analysis and the multivariable model, with an adjusted OR of 7.25 (95% CI 1.47–35.66). In the unadjusted analysis, younger age was associated with increased odds of developing mesh exposure; however, there was no evidence of association when we controlled for smoking and bleeding complications in the multivariable model. The rate of smoking was higher in women developing mesh exposure (15%) than in controls (4%), but there is no evidence that these rates differ in either unadjusted (Table 2) or adjusted (Table 3) analysis.

The rate of hysterectomy concurrent with placement of mesh was similar among women with and without subsequent mesh exposure. The type of hysterectomy among the two groups was varied. Seven women with mesh exposure underwent a concomitant hysterectomy at the time of mesh placement: total vaginal hysterectomy 71% (5/7), laparoscopic supracervical hysterectomy 14% (1/7), and laparoscopic assisted vaginal hysterectomy 14% (1/7). In the control group, 13 hysterectomies were done at the time of mesh placement: total vaginal hysterectomy 38% (5/13) and laparoscopic supracervical hysterectomy 62% (8/13).

Table 1 Demographics and characteristics of women with a mesh exposure (cases) and no exposure (controls)

	Cases (*N*=48)	Controls (*N*=48)
Age (years), mean±SD	54.5±12.9	59.9±9.5
Gravidity, median	3	3
Parity, median	3	3
BMI (kg/m^2), mean±SD	28.11±4.59	27.16±4.32
Postmenopausal	79% (38)	83% (40)
Hormone replacement therapy	38% (18)	29% (14)
Hyperlipidemia	21% (10)	21% (10)
Hypertension	38% (18)	46% (22)
Diabetes mellitus	6% (3)	10% (5)
Previous hysterectomy	73% (35)	62% (30)
Previous surgery for POP	27% (13)	31% (15)
Previous surgery for urinary incontinence	21% (10)	17% (8)
Concomitant hysterectomy	15% (7)	27% (13)
Concomitant surgery for urinary incontinence	60% (29)	54% (26)
EBL (ml), mean±SD	380±388	297±155
Smoker	15% (7)	4% (2)
Bleeding complications	23% (11)	4% (2)

Table 2 Univariable analysis of potential risk factors for mesh exposure

Risk factor	Unadjusted OR (95% CI)
Age (1 year older)	0.96 (0.92–0.99)
BMI (1 unit higher)	1.05 (0.96–1.15)
Smoker	3.93 (0.77–19.98)
Diabetes mellitus	0.57 (0.13–2.55)
Postmenopausal	0.76 (0.27–2.13)
Hormone replacement therapy	1.46 (0.62–3.42)
Hyperlipidemia	1.00 (0.37–2.68)
Hypertension	0.71 (0.31–1.60)
Previous hysterectomy	1.62 (0.68–3.83)
Previous surgery for POP	0.82 (0.34–1.97)
Previous surgery for urinary incontinence	1.32 (0.47–3.69)
Concomitant hysterectomy	0.46 (0.17–1.28)
Concomitant surgery for urinary incontinence	1.33 (0.56–3.16)
EBL (100 units more)	1.12 (0.95–1.33)
Bleeding complication	6.84 (1.43–32.79)

N=96 (48 cases and 48 controls)

Table 3 Multivariable model of potential risk factors for mesh exposure

N=96 (48 cases and 48 controls)

Risk factor	Adjusted OR (95% CI)
Age (1 year older)	0.96 (0.92–1.00)
Smoker	3.17 (0.59–17.12)
Bleeding complication	7.25 (1.47–35.66)

Table 4 Multivariable model of potential risk factors for mesh exposure in patients who underwent surgery at our facility only

N=56 (28 cases and 28 controls)

Risk factor	Adjusted OR (95% CI)
Age (1 year older)	0.96 (0.91–1.02)
Smoker	1.96 (0.16–24.62)
Bleeding complication	4.28 (0.77–23.75)

Sixteen patients (33%) had perioperative complications in the mesh exposure group, including EBL in excess of 500 ml (*N*=9), posterior vault hematoma requiring drainage (*N*=1), vascular injury with resultant hematoma requiring embolization of anterior and posterior branches of the internal iliac artery (*N*=1), cystotomy repaired at the time of surgery (*N*=2), rectal perforation with repair at the time of surgery (*N*=1), right sciatic pain (*N*=1), and groin and leg pain (*N*=1). Only two controls (4%) had a complication: EBL in excess of 500 ml. The complications involving excessive bleeding were found to be predictive of mesh exposure. The remainder of the complications were heterogeneous and too few in number to analyze.

Only polypropylene mesh implanted transvaginally was included in this study. The types of mesh placed included Gynemesh (Ethicon: Johnson & Johnson, Cincinnati, OH, USA), Pelvitex and Prolene (Bard Medical Division, Covington, GA, USA), as well as mesh placed as a kit: Apogee and/or Perogee (American Medical Systems, Minnetonka, MN, USA), Avaulta (Bard Medical Division, Covington, GA, USA), Prolift (Ethicon: Johnson & Johnson, Cincinnati, OH, USA), and IVS Tunneler (Tyco Healthcare, Norwalk, CT, USA). The type of mesh was similar in the two groups; among the cases there were 11 type III mesh kits (IVS Tunneler), 22 type I mesh kits (Prolift, Avaulta, Apogee, and Perogee) and 18 type I mesh implants (Gynecare, Pelvitex, and Prolene). Three of the cases had concomitant placement of an IVS Tunneler and mesh implants. Of the cases, 28 had their original surgery for the placement of transvaginal mesh performed at our facility and 20 were referred to us from outside facilities. All of the controls had mesh placed at our institution. All of the cases had mesh exposure into the vagina and one had vaginal exposure as well as mesh in the bladder.

A subanalysis using only the 28 cases with mesh placement at our facility and their matching controls was also performed. Univariable analysis and multivariable analysis of the subgroup was carried out in the same manner as that for the entire group, including smoking, age, and bleeding complications in the multivariable model. In this analysis no risk factors for mesh exposure following vaginal mesh implantation for POP were identified (Table 4).

Discussion

We identified bleeding complications at the time of transvaginal mesh implantation for POP as a significant predictor for mesh exposure requiring reoperation, but this association could be due to multiple testing.

We did not identify age, gravidity, parity, BMI, medical comorbidities, prior and concurrent urogynecologic surgeries, or smoking as risk factors for subsequent mesh exposure requiring reoperation. It is important to recognize that inconclusive findings are not synonymous with evidence of a lack of association. Larger studies are needed in order to evaluate the impact of these and other potential comorbidities on mesh complications.

Strengths of this study include its size and the use of a comparison group. To our knowledge, this is one of the largest series of patients with mesh exposure requiring surgical correction reported in the literature, although larger studies are still needed in order to adequately evaluate this topic. Previous studies each report on fewer than 27 cases of mesh exposure. While there are many case series in the literature, our use of a case-control study design allowed us to make comparisons among those with and without a mesh exposure and is a more robust study design. By choosing cases and controls with similar surgical date and type of mesh placed, we prevented these factors from being confounders. The variety of surgeons and techniques represented in our study is a representation of the population of patients seen at our tertiary care center and may represent the population mix seen at similar facilities.

Limitations of our study included its retrospective design, multiple surgeons of varying skill levels, and its inclusion of surgeries involving mesh placement at other institutions. Since we are a tertiary care center, our cases came from many different referring surgeons. The disadvantage of this is that a wide variety of different surgical experience levels, techniques, and mesh products were used. It also offers the opportunity for bias, as it was not possible to collect all of the exposures for our geographic referral area. Surgical technique and skill level varied among the surgeons performing the mesh procedures represented in this study and surgical technique may play a role in the risk of mesh exposure. We were not able to assess for the impact of surgical learning curves, which is especially important with the use of new techniques and technology. Smoking status

was self-reported and may not have been accurately recorded. Also, it was not always clear if the patient was taking hormone replacement therapy at the time of mesh placement. In many situations we were only able to confirm if the patient was using hormone replacement therapy at the time of mesh removal.

Few studies have been published concerning the risk factors for mesh exposure of transvaginally placed mesh for the repair of POP. Of those available, the number of subjects with exposure is low. In a retrospective review, Ganj et al. evaluated 127 women who underwent transvaginal polypropylene mesh placement in the repair of POP. Of the 127, 13 (10.2%) developed mesh erosion; of these, a significant association between mesh erosion and concomitant vaginal hysterectomy (p=0.008) as well as mesh erosion and intraoperative bladder injury (p=0.028) was demonstrated [9]. We did not identify concurrent hysterectomy as a risk factor for mesh exposure in our study. Interestingly, we had more hysterectomies at the time of mesh placement in our control group than in our cases. Of the concurrent hysterectomies done, 62% (8/13) were laparoscopic supracervical hysterectomy. This may suggest that supracervical hysterectomy is protective against mesh exposure and should be further investigated. We did not identify enough intraoperative bladder injuries to comment on this. A threefold increase in vaginal mesh erosion was seen with smoking and a 1.6-fold increase for advanced age after transvaginal mesh repair of POP in 19 of 325 (6%) patients reported by Araco et al. [10]. In a series of patients who had transvaginal repair of a cystocele using polypropylene mesh (Gynemesh or Gynemesh-Soft mesh, Ethicon) Deffieux et al. reported on 27 of 138 (20%) with mesh erosion in which multivariable analysis revealed that age group was an independent predictive factor of vaginal exposure (age >70 years, OR 3.6, 95% CI 1.3–9.7 [11]. Hefni and colleagues showed the risk of tape exposure with the IVS Tunneler to be 17% (21/127) with an increased risk related to patient age above 60 years of age (RR 1.6, 95% CI 1.02–2.5) and current treatment for diabetes (RR 4, 95% CI 1.7–9.2) [12]. In a prospective observational study from Canada, younger age and sexual activity were shown to be risk factors for mesh exposure following POP repair with the Gynecare Prolift system in 14 (12.3%) of 114 patients. For each decrease in age of 10 years, the OR of exposure was 1.99 (95% CI 1.10–3.59); in sexually active patients, late mesh exposure was more common (p=0.016) [13]. We were unable to confirm the risk factors shown by these authors.

A lack of data concerning the efficacy and risks of transvaginally placed mesh for the repair of POP has led to statements by several prominent organizations. The American College of Obstetricians and Gynecologists published a practice guideline addressing POP in 2007 in which it was recommended that patients consenting to vaginal surgery for prolapse repair with mesh should understand the postoperative risks and complications (especially mesh exposure), and be informed regarding the lack of data on long-term outcomes [16]. On 20 October 2008, the Food and Drug Administration (FDA) released an alert to physicians concerning the potential risks of transvaginal surgical mesh used to treat POP and stress urinary incontinence. The most frequent complications included exposure through vaginal epithelium, infection, pain, urinary problems, and recurrence of prolapse and/or incontinence. In some cases, vaginal scarring and mesh exposure led to a significant decrease in patient quality of life due to discomfort and pain, including dyspareunia. Recommendations were given to help reduce the risk of possible complications, increase the recognition of complications, and inform patients of possible risks and complications [17]. More recently an FDA Safety Communication concerning serious complications associated with transvaginal placement of surgical mesh for POP reported that the most common and consistently reported mesh-related complication is erosion of mesh through the vagina [18].

The Society of Gynecologic Surgeons formed a work group to develop evidence-based guidelines on biologic and synthetic graft use compared with native tissue repair in vaginal prolapse repair. Based on the overall low quality of evidence, only weak recommendations could be provided. They suggested that native tissue repair remains appropriate when compared with biologic graft, absorbable synthetic graft, and nonabsorbable synthetic graft in most circumstances [19].

In conclusion, the use of polypropylene mesh to augment the vaginal repair of POP must be weighed against the risk of mesh exposure and the potential need for additional surgery. The individual risk-benefit profile of each surgical candidate must be considered. Further knowledge concerning factors associated with an increased risk of mesh exposure is essential for presurgical counseling if polypropylene mesh is offered in the vaginal repair of POP. We were able to identify bleeding complications as predictors for mesh exposure. Although it may not be possible to predict which patients will have excessive bleeding at the time of surgery, those who do have this complication may merit heightened postoperative surveillance for mesh exposure. This study's strengths are the use of a comparative study design and the inclusion of one of the largest reported series of mesh exposures. Even with our relatively large sample size we had limited power to replicate the findings of smaller case series, underscoring the importance of additional research to obtain more precise risk estimates.

Conflicts of interest Supported in part by Vanderbilt CTSA grant 1 UL1 RR024975 from NCRR/NIH. D.H. Biller: consultant AMS; C.W. Zimmerman: consultant Cook and Boston Scientific; R.R. Dmochowski: consultant Allergan, Pfizer, J&J, and Medtronic. K.P. Gold, R.M. Ward, S. McGuinn, and J.C. Slaughter have no conflict of interest.

References

1. Hendrix SL, Clark A, Nygaard I, Aragaki A, Barnabei V, McTierman A (2002) Pelvic organ prolapse in the Women's Health Initiative: gravity and gravidity. Am J Obstet Gynecol 186:1160–1166
2. Boyles SH, Weber AM, Meyn L (2003) Procedures for pelvic organ prolapse in the United States, 1979–1997. Am J Obstet Gynecol 188:108–115
3. Wu JM, Hundley AF, Fulton RG, Myers ER (2009) Forecasting the prevalence of pelvic floor disorders in U.S. women: 2010 to 2050. Obstet Gynecol 114:1278–1283
4. Whiteside JL, Weber AM, Meyn LA, Walters MD (2004) Risk factors for prolapse recurrence after vaginal repair. Am J Obstet Gynecol 191:1533–1538
5. den Hartog D, Dur AH, Tuinebreijer WE, Kreis RW (2008) Open surgical procedures for incisional hernias. Cochrane Database Syst Rev:CD006438
6. Silva WA, Karram MM (2005) Scientific basis for use of grafts during vaginal reconstructive procedures. Curr Opin Obstet Gynecol 17:519–529
7. Iglesia CB, Sokol AI, Sokol ER et al (2010) Vaginal mesh for prolapse: a randomized controlled trial. Obstet Gynecol 116:293–303
8. Hiltunen R, Nieminen K, Takala T et al (2007) Low-weight polypropylene mesh for anterior vaginal wall prolapse: a randomized controlled trial. Obstet Gynecol 110:455–462
9. Ganj FA, Ibeanu OA, Bedestani A, Nolan TE, Chesson RR (2009) Complications of transvaginal monofilament polypropylene mesh in pelvic organ prolapse repair. Int Urogynecol J Pelvic Floor Dysfunct 20:919–925
10. Araco F, Gravante G, Sorge R, De Vita D, Piccione E (2008) Risk evaluation of smoking and age on the occurrence of postoperative erosions after transvaginal mesh repair for pelvic organ prolapse. Int Urogynecol J Pelvic Floor Dysfunct 19:473–479
11. Deffieux X, de Tayrac R, Huel C et al (2007) Vaginal mesh erosion after transvaginal repair of cystocele using Gynemesh or Gynemesh-Soft in 138 women: a comparative study. Int Urogynecol J Pelvic Floor Dysfunct 18:73–79
12. Hefni M, Yousri N, El-Toukhy T, Koutromanis P, Mossa M, Davies A (2007) Morbidity associated with posterior intravaginal slingplasty for uterovaginal and vault prolapse. Arch Gynecol Obstet 276:499–504
13. Kaufman Y, Singh SS, Alturki H, Lam A (2011) Age and sexual activity are risk factors for mesh exposure following transvaginal mesh repair. Int Urogynecol J 22:307–313
14. Haylen BT, Freeman RM, Swift SE et al (2011) An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint terminology and classification of the complications related directly to the insertion of prostheses (meshes, implants, tapes) & grafts in female pelvic floor surgery. Int Urogynecol J 22:3–15
15. Amid PK (1997) Classification of biomaterials and their related complications in abdominal wall hernia surgery. Hernia 1:15–21
16. ACOG Committee on Practice Bulletins–Gynecology (2007) ACOG Practice Bulletin No. 85: pelvic organ prolapse. Obstet Gynecol 110:717–729
17. Schultz DG (2008) FDA Public Health Notification: serious complications associated with transvaginal placement of surgical mesh in repair of pelvic organ prolapse and stress urinary incontinence. http://www.fda.gov./cdrh/safety/102008-surgicalmesh.html. Accessed 21 Mar 2010
18. FDA Safety Communication (2011) Update on serious complications associated with transvaginal placement of surgical mesh for pelvic organ prolapse. Available via http://www.fda.gov/medicaldevices/safety/alertsandnotices/publichealthnotifications/ucm061976.htm. Accessed 5 Oct 2011
19. Sung VW, Rogers RG, Schaffer JI et al (2008) Graft use in transvaginal pelvic organ prolapse repair: a systematic review. Obstet Gynecol 112:1131–1142