REVIEW

Endovascular surgery in gynecology

Cirurgia endovascular em ginecologia

Marcos de Lorenzo Messina[1], Fernanda Deutsch[2], Eduardo Zlotnik[3], Felipe Nasser[4], Breno Boueri Affonso[5], Nilson Roberto de Melo[6], Edmund Chada Baracat[7]

ABSTRACT

Endovascular surgery has presented a high evolution since 1960 with Charles Dotter, who changed the concept of catheter utilization as a mean to diagnose and introduce therapeutic in interventionist vascular environment. The first reports of bleeding control of gastrointestinal and transluminal angioplasty input the development of new techniques for endovascular access, and new materials use, such as microcatheters and embolic agents, become this procedure effective and viable for treatment of several pathologies. The embolization of several organs of human body is a procedure carried out for more than 30 years all over the world showing safety, efficacy and of simple execution. In obstetrics and gynecology, particularly, the first reports refer to pelvic hemorrhage control of varied etiology, including pelvic trauma, bladder and gynecology neoplasia, anteriovenous fistulas and puerperal hemorrhages. The embolization of uterine myoma appears in the 1990's as an alternative for treat of uterine leiomyoma, and a number of studies try to clarify the risks and benefits of this procedure. It is a multidisciplinary technique, with diagnostic and indication performed by gynecologist and the procedure done by interventional vascular radiologist. This review is a critical analysis of interventionist vascular radiologic methods and its main therapeutic indications in gynecology.

Keywords: Embolization, therapeutic; Varicose veins; Endometriosis; Myoma; Cervix uteri

RESUMO

A cirurgia endovascular apresentou grande evolução a partir de 1960, com Charles Dotter, ao modificar o conceito de utilização de cateteres como meio diagnóstico e introduzir a terapêutica no ambiente vascular intervencionista. Os primeiros relatos de contenção de sangramento do trato gastrintestinal e angioplastia transluminal impulsionaram o desenvolvimento de novas técnicas de acesso endovascular, e a utilização de novos materiais como os microcateteres e agentes embolizantes tornaram o procedimento efetivo e viável no tratamento de diversas doenças. A embolização de diversos órgãos do corpo humano é procedimento realizado há mais de 30 anos em todo o mundo, mostrando ser seguro, eficaz e de simples execução. Particularmente em ginecologia e obstetrícia, os primeiros relatos referem-se à contenção de hemorragias pélvicas de etiologia variada, incluindo trauma pélvico, neoplasias de bexiga e ginecológicas, fístulas arteriovenosas e hemorragias puerperais. A embolização do mioma uterino surgiu em 1990 como alternativa ao tratamento cirúrgico do leiomioma uterino, sendo que vários estudos buscam esclarecer riscos e benefícios desse procedimento. Trata-se de uma técnica multidisciplinar, cujo diagnóstico e indicação são feitos pelo ginecologista e o procedimento pelo radiologista vascular intervencionista. Esta revisão é uma análise crítica de métodos radiológicos vasculares intervencionistas e suas principais indicações terapêuticas em ginecologia.

Descritores: Embolização terapêutica; Varizes; Endometriose; Mioma; Colo do útero

INTRODUCTION

The use of endovascular catheters has enjoyed a major development since the 1960's, when angiography – a merely diagnostic technique – was turned into an interventional radiology procedure, enabling the treatment of hemorrhage through therapeutic embolizations or that of arterial stenosis through angioplasty by means of an endovascular access.

These procedures act on vascularization, dilating and infusing drugs, which are indicated in gynecology to control uterine bleeding arising from uterine

[1] PhD; MD of Endovascular Surgery Division at the Hospital das Clínicas of the Faculdade de Medicina of Universidade de São Paulo – USP, São Paulo (SP), Brazil.

[2] MD of Endovascular Surgery Division of the Department of Gynecology of the Hospital das Clínicas of the Faculdade de Medicina of Universidade de São Paulo – USP, São Paulo (SP), Brazil.

[3] PhD student of the Department of Gynecology of the Hospital das Clínicas of the Faculdade de Medicina of Universidade de São Paulo – USP, São Paulo (SP), Brazil; Assistant physician at Hospital Isralita Albert Einstein – HIAE, São Paulo (SP), Brazil.

[4] PhD, Assistant physician at Hospital Israelita Albert Einstein – HIAE, São Paulo (SP), Brazil.

[5] Assistant physician at Hospital Israelita Albert Einstein – HIAE São Paulo (SP), Brazil.

[6] Post-doctorate degree; Lecturer of Gynecology at Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo – USP, São Paulo (SP), Brazil.

[7] Full Professor of Gynecology at Hospital das Clínicas of the Faculdade de Medicina of Universidade de São Paulo – USP, São Paulo (SP), Brazil.

Corresponding author: Marcos de Lorenzo Messina – Avenida Dr. Enéas de Carvalho Aguiar, 255 – Cerqueira Cesar – CEP 05403-000 – São Paulo (SP), Brazil – Tel.: (11) 3069-7621 – e-mail: mmessina@uol.com.br

Received on Jun 12, 2009 – Accepted on Jun 9, 2010

myomatosis and/or adenomyosis, to treat pelvic congestion syndrome (PCS), and to occlude the vessels nourishing tumors, especially when surgical treatment is not possible.

The main characteristics of endovascular surgery are:

- minimally invasive technique, because it is carried out through a percutaneous catheterism with a small incision;
- performance under local anesthesia and/or sedation;
- short hospital stay and low cost as compared to the conventional surgical procedure.

The limitations for this procedure are specially associated with the cost of equipment, materials and human resources, since specifically trained professionals are required to do it.

OBJECTIVE

To conduct a review of the main indications for endovascular surgery in gynecology.

METHODS

A bibliographic search of studies associated with endovascular treatment, based on the following criteria.

Criteria used to select the studies

Types of studies

Randomized clinical trials including embolization as treatment of uterine myoma, adenomyosis, pelvic congestion and uterine cervical tumor were taken into account.

Search strategy to identify the studies

The following electronic databases were searched: MedLine (1970 to 2009), Lilacs and The Cochrane Library.

RESULTS

Uterine myoma embolization

This is an alternative treatment to patients with symptomatic uterine myomas. The clinical improvement after the procedure is significant and approximately 90% of the patients submitted to this treatment present remission of symptoms, such as excessive menstrual flow and dysmenorrhea. There is a mean reduction of 45% in uterine volume and in the myoma largest node[1-4].

The major complications are[1-4]:

1. associated with the procedure:
   1.1. hematoma on the puncture site;
   1.2. allergic reaction or nephrotoxicity to the iodine contrast;
   1.3. arterial dissection during catheterization;
2. post-embolization syndrome characterized by pain, fever and vomits; it may occur after any embolization. Having these symptoms is only considered a complication when patients have to be re-admitted to hospital;
3. necrosis of submucosal leiomyoma after uterine artery embolization (UAE) causing secondary intrauterine infectious process;
4. leiomyoma expulsion after UAE, in some cases it is necessary to surgically remove it in order to control related symptoms;
5. permanent or transient amenorrhea and ovarian failure after UAE, especially in the perimenopause, associated with embolization of ovarian vessels and endometrial atrophy in consequence of hypoestrogenism or local ischemia[5,6].

Embolization is indicated in patients whom, regardless of age, have an indication for hysterectomy. Among young women, the indication is usually due to desire for future pregnancy, and in perimenopausal patients for the desire to keep the organ[7,8].

Myomectomy, through hysteroscopy, laparoscopy or laparotomy, depending on the number and position of the nodules, is the gold standard treatment. Nonetheless, in women at high risk for myomectomy, such as those submitted to several prior myomectomies or multiple myoma nodules, embolization is a valid alternative[9-11].

Embolization of pelvic varicose veins

The PCS is characterized by chronic pelvic pain associated with pelvic varicose veins. Congestion is associated with blood stasis, caused by functional change in the pelvic venous plexus. Contrary to varicocele in men, diagnosis in women is clinically difficult. For not having clinical signs, most of the times the diagnosis is made through exclusion, eventually identifying vulvar and vaginal varicose veins during physical exam[12-14].

PCS, as a cause of pelvic pain, usually requires a multidisciplinary approach, because it has complex components and consequently difficult diagnosis, most of the times representing a diagnosis of exclusion[15,16].

About 2 to 10% of patients who routinely go to the gynecologist complain of chronic pelvic pain; and in approximately 15 to 20% of them the pain has no clear cause, leading the physician to infer the presence of pelvic varices[17].

Conventional therapy with medication is limited and pelvic varices embolization is an option with good results and low rate of complications.

Venous anatomy

Venous drainage of the lower limbs is carried out by means of the internal and external iliac veins and vena cava; together with the gonadal veins, they make up the pelvic venous plexus, which can be submitted to compressive syndromes or events associated with a venous escape through the gonadal axis and hypogastric tributary branches.

Patients with chronic venous insufficiency (CVI) in the pelvis have symptoms of venous stasis, such as feeling of heavy hypogastrium, chronic pelvic pain, dyspareunia, dysmenorrhea, heavy leg syndrome and sciatalgia.

The main CVI risk factors are: multiparity, vulvar varices during gestation, prolonged use of anovulatory agents, thyroid diseases, deep venous thrombosis, hemorrhoids and lower limb edema[18].

Clinical diagnosis

The clinical diagnosis of the PCS is difficult to make. It should be based on pain features, and patients may present pain for at least six months, usually associated with other symptoms, such as dyspareunia and bladder irritability.

The pain characteristics vary in intensity and duration; and it can extend to the posteromedial region of the thigh and buttocks, and in most of the times it is stronger on the left side, because of the higher incidence of absent valves in the left ovarian vein (LOV). According to some authors, pain is located on the ovarian point, an anatomical point located on the outer third of an imaginary line uniting the umbilicus and the anterosuperior iliac spine. Standing up for longer periods makes it worse and it improves in the supine position.

In cases of pelvic pain, thorough physical examination must be performed, assessing the abdomen, lumbosacral region and the internal and external genitalia. It is important to evaluate the lower limbs because of the relevant association with varicose veins.

Clinical diagnosis often times does not identify an apparent cause, even after exhaustive investigation. A large number of autopsies and venographies carried out reinforce the correlation between ovarian venous insufficiency and chronic pelvic pain. Some series of laparoscopic studies correlated to the venography of women with chronic pelvic pain of indefinite cause revalidated the presence of pelvic congestion in more than 91% of the cases evaluated[19].

Imaging diagnosis

The most used investigation methods in PCS comprise venography, Doppler ultrasonography (Doppler US), magnetic resonance angiography (angio-MRI), computed tomography angiography (CTA) and laparoscopy[19].

Venography is considered the gold standard test to diagnose PCS, enabling evaluation of dilation and tortuosity of the uterine and ovarian veins and confirming an increased contrast emptying time; these facts allow inferring presence of valvular incompetence or absence of valves. This method also enables assessing diameter and distribution of veins.

The Doppler US is an important diagnostic method, and it can be carried out by transabdominal and endovaginal approaches. It is a non-invasive method that enables anatomical evaluation as well as characterization of local flow because of the Doppler. The endovaginal approach is more precise as far as pelvic varicose vein detection is concerned. The transabdominal technique offers better results for detecting ovarian veins in the abdomen; nonetheless, abdominal wall thickness and the presence of gas in the bowels may impair the test. It can be done in supine and standing position, whether or not associated with Valsalva maneuver. PCS findings include multiple dilated veins around the ovaries and uterus, with amplitude signs which vary in the Doppler. The presence of veins with diameters larger than 5 mm is indicative of pelvic varicose veins.

Gadolinium-enhanced venous angio-MRI provides high sensitivity and also helps detecting other associated pelvic diseases. The main advantage is the fact that this is a non-invasive method that can be used in patients with allergy to iodine contrast[19].

CTA evaluates pelvic and ovarian veins. Although considered a non-invasive approach, it is necessary to use iodine contrast, which makes it impossible to do in patients who have some contraindication to its use[19,20].

Approximately 40% of women have some reflux in the LOV upon CTA. This finding led to classification of reflux grade, associating it to development of PCS[20].

By laparoscopy it is possible to directly identify varicose veins and drainage in the Trendelenburg position. Nonetheless, it is an invasive method that should be performed under general anesthesia, and in many cases, it fails to identify the presence of collateral vein branches and anatomical variations[20,21].

Differential diagnosis

The differential diagnoses of PCS include pelvic inflammatory disease, endometriosis, pelvic tumors, cystitis and inflammatory bowel disease. Classified

among the causes of chronic pelvic pain, and for being a diagnosis of exclusion, PCS can have even more differential diagnoses. Thus, the differential diagnosis can be based on gynecological, neurological, gastrointestinal, musculoskeletal and urological causes.

Patients with chronic pelvic pain are frequently anxious and depressed. They usually fail gynecological clinical treatment and, in many cases, may have been submitted to multiple unsuccessful surgeries to control pain. Approximately 12% of hysterectomies are done on account of pelvic pain. Among the gastrointestinal causes, inflammatory bowel diseases stand out. And in musculoskeletal disorders, it is worth highlighting myofascial pain, considered one of the main causes of pelvic pain[22,23].

Among the causes of urological etiology, the nutcracker syndrome is very relevant, characterized by compression of the left renal vein, between the aorta and the superior mesenteric artery[24-28].

The causes of gynecological origin include adherences, endometriosis, salpingo-oophoritis and ovarian neoplasms. Endometriosis and pelvic adherences are the most common gynecological disorders. Endometriosis is detected in approximately 15 to 40% of the patients submitted to laparoscopy for the purpose of evaluating chronic pelvic pain.

Adenomyosis embolization

Adenomyosis is characterized by finding endometrial glands and stroma inside the myometrium, whether or not associated with its hypertrophy and hyperplasia. It is a disease that can be asymptomatic, but most of the times it is associated with menorrhagia, metrorrhagia, progressive dysmenorrhea, enlarged uterus, chronic pelvic pain and dyspareunia. The clinical picture often restricts daily activities of women. Today, hysterectomy is the treatment option considered effective and definitive.

Clinically speaking, adenomyosis is similar to uterine myomatosis, and both can coexist in 30 to 40% of the patients. Initially, some reports of patients with myomatosis and adenomyosis who improved after UAE awakened researchers' interest in the role of procedure to treat adenomyosis.

In a retrospective study, Siskin et al.[29] reported 15 patients submitted to UAE and who were submitted to MRI for control purposes before the procedure and 3 months later. Of these, only six patients had adenomyosis and the results in six months pointed towards a possible benefit. Similarly, Jha et al.[30] found good results in a series of 30 patients with adenomyosis submitted to UAE, although their results were limited for having only three patients with adenomyosis alone.

The most significant study was published by Kitamura et al.[31], in 2006, with 19 adenomyosis patients, and 11 of them had adenomyosis without uterine myomas. The follow-up was carried out by means of an MRI test and clinical questionnaires up to 12 months after the procedure. The results are encouraging and indicated that embolization can represent an important tool in the minimally invasive treatment of uterine adenomyosis.

Intra-arterial chemotherapy for gynecological tumors

Uterine cervical cancer is the third most common neoplasm affecting women in Brazil, and its incidence ranks third, after skin and breast cancers.

Despite being a slow and predictable disease, and the existence of efficient early detection methods, more than half of the invasive uterine cervical cancers are still diagnosed in advanced stages, when surgery is no longer an option[32].

Tumors extending beyond the uterine cervix or beyond the upper third of the vagina are considered advanced (IIB to IVB stages, according to the International Federation of Gynecology and Obstetrics, FIGO). For these tumors, the treatment of choice was, for many decades, radiation therapy only. The five-year disease-free survival of patients treated by radiation therapy only varies inversely to tumor stage. Perez et al.[33] reported 68% in stage IIB, 45% in stage III and 5% in stage IV.

Since the late 1990's, numerous authors have proven that the association of chemotherapy with platinum and simultaneous radiation therapy increase the survival of patients with advanced uterine cervical carcinoma. Since then, chemo and radiation therapy have become the standard treatment of these patients.

Catheters with skin reservoir (Port-A-Cath) are broadly used to treat neoplasms. Nonetheless, they can be associated with infectious processes, occlusion, arterial thrombosis and hemorrhages on the puncture site.

The intra-arterial chemotherapy infusion in patients with uterine cervical carcinoma started back in 1993, when they presented improvement in pelvic pain after infusion of carboplatin.

The advance in interventional vascular radiology techniques with the introduction of microspheres carrying chemotherapy agents allows for the guided infusion of the drug, greater local effect, lower incidence of side effects; stage-IIIb patients have an 85% five-year survival rate, when neoadjuvant chemotherapy is associated with radical surgery[34,35].

Different authors studied this option in the treatment of advanced uterine cervical carcinoma, with results that were far better than those obtained in conventional treatment.

Neoadjuvant treatment by the intra-arterial infusion of chemotherapy, followed by hysterectomy or radiation therapy, was described by Yamakawa et al.[36], showing good acceptability, safety, better quality of life and increased survival rates.

Treatment of postoperative bleeding

Hemorrhage urgencies in the postoperative period of gynecological patients are rare and usually of low intensity, being treated with local compression, packing or cauterization of bleeding vessels.

Careful history taking and physical examination, assessment of hematological parameters and coagulation tests, associated with imaging exams are fundamental to establish presumptive diagnoses and initiate timely appropriate treatment.

In case of hemorrhagic acute abdomen, it is crucial to provide wide venous access, hydration to maintain cardiovascular conditions and careful evaluation of the need for blood transfusion.

Simultaneously to hemodynamic control, laparotomy to ligate bleeding vessels is curative and stabilizes blood loss.

In selected cases, the arterial embolization of pelvic pain is an alternative to surgical ligation, such as presence of ruptured pseudoaneurysms of uterine arteries.

Arterial pseudoaneurysms are rare complications, resulting from inflammatory processes, traumas or of iatrogenic nature (surgical procedure, percutaneous biopsies, drainage of collections). The etiology of pseudoaneurysm is related to lesion on one layer of the vascular epithelium with later formation of a pulsatile hematoma and dissection of the perivascular space, forming a pseudoaneurysm[37].

Diagnosis is made by means of Doppler flowmetry, confirmed and treated at the same time by arteriography and selective embolization.

The rupture of these pseudoaneurisms is unpredictable, usually in late postoperative period and is associated with high morbidity and mortality rates.

The difficult-to-treat bleedings caused by laparotomy, such as retroperitoneal ones, represent another situation of endovascular surgery applicability.

Anatomical variations of pelvic vascularization can be assessed by arteriography; eventually, bleeding vessels not associated to the internal iliac artery, can maintain bleeding after surgical ligation of the hypogastric artery.

Endovascular surgery can be an alternative to conventional surgery and must be included in the therapeutic armamentarium of gynecologists facing situations of postoperative bleeding.

DISCUSSION

Pelvic vessel embolization used to control post-partum hemorrhage was described by Heston et al.[37] in 1979. Since then, it is indicated to stop bleeding after C-sections, ectopic pregnancy, post-hysterectomy bleedings, venous malformations and as a prophylactic method in patients under risk of developing intraoperative hemorrhage[37].

This is a multidisciplinary approach. Treatment is indicated by gynecologists and the technique is performed by interventional radiologists. The evolution of vascular access techniques, with the use of microcatheters, calibrated particles and the very quality of angiographies represents an important step on applicability of endovascular treatments.

Uterine myoma embolization has been performed since 1991, and is defined as safe and effective (American College of Obstetricians and Gynecologists, ACOG, evidence level A); however, for women who desire to reproduce, the application of this therapy must be individualized and, in such situation, is confirmed by ACOG as an evidence level C[38].

The treatment of the PCS by embolization represents a minimally invasive alternative with encouraging results and low complication rates. The main difficulty is associated to the need to rule out all other causes of pelvic pain in order to establish an accurate diagnosis[21].

Quality of life questionnaires applied to evaluate mental, physical and urogenital health in women undergoing pelvic vessel embolization or hysterectomy demonstrated after a five year period that there were no differences between the groups. However, evaluating in this same period of time the symptoms related to defecation function, the embolization group had a more apparent positive effect than the hysterectomy group. The patients' degree of satisfaction in the myoma embolization group was similar to those who had hysterectomy[39].

The conservative approach keeping the uterus in patients with symptomatic adenomyosis has been a dilemma among gynecologists, and the clinical treatment through administration of hormones is the alternative indicated; however, it bears low compliance. Embolization comes as a minimally invasive alternative and its real applicability has been studied by numerous authors and still there is no consensus in the literature about the use of this technique in these patients[40].

Chemotherapy in patients with advanced uterine cervical through endovascular approach represents a major innovation, since it can make inoperable tumors eligible to radical surgical treatment[41].

CONCLUSION

Gynecological bleedings can be controlled by vascular embolization, a technique broadly described in other medical specialties.

Multiprofessional relationship in Medicine represents an unavoidable evolution of medical practice, and gynecologists can count on interventional radiologists to support and apply the best treatment option for the diseases described in this review.

REFERENCES

1. Ravina JH, Herbreteau D, Ciraru-Vigneron N, Bouret JM, Houdart E, Aymard A, et al. Arterial embolisation to treat uterine myomata. Lancet. 1995;346(8976):671-2.
2. Goodwin SC, Vedantham S, McLucas B, Forno AE, Perrella R. Preliminary experience with uterine artery embolization for uterine fibroids. J Vasc Interv Radiol. 1997;8(4):517-26.
3. Ravina J, Bouret J, Ciraru-Vigneron N, Repiquet D, Herbreteau D, Aymard A, et al. Aplication of particulate arterial embolization in the treatment of uterine fibromyomata. Bull Natl Med. 1997;181(2):233-43.
4. Hutchins FL Jr, Worthington-Kirsch R, Berkowitz RP. Selective uterine artery embolization as primary treatment for symptomatic leiomyomata uteri. J Am Assoc Gynecol Laparosc. 1999;6(3):279-84.
5. Ravina JH, Ciraru-Vigneron N, Aymard A, Ferrand J, Merland JJ. Uterine artery embolisation for fibroids disease: results of a 6 years study. Min Invas Ther Allied Technol. 1999;8(6):441-7.
6. Spies JB, Roth AR, Gonsalves SM, Murphy-Skrzyniarz KM. Ovarian function after uterine artery embolization for leiomyomata: assessment with use of serum follicle stimulating hormone assay. J Vasc Interv Radiol. 2001;12(4):437-42.
7. Chua GC, Wilsher M, Young MP, Manyonda I, Morgan R, Belli AM. Comparison of particle penetration with non-spherical polyvinyl alcohol versus trisacryl gelatin microspheres in women undergoing premyomectomy uterine artery embolization. Clin Radiol. 2005;60(1):116-22.
8. Chiesa AG, Hart WR. Uterine artery embolization of leiomyomas with trisacryl gelatin microspheres (TGM): pathologic features and comparison with polyvinyl alcohol emboli. Int J Gynecol Pathol. 2004;23(4):386-92.
9. Katsumori T, Nakajima K, Mihara T, Tokuhiro M. Uterine artery embolization using gelatin sponge particles alone for symptomatic uterine fibroids: midterm results. AJR Am J Roentgenol. 2002;178(1):135-9.
10. Shimada K, Ohashi I, Kasahara I, Miyasaka N, Shibuya H. Triple-phase dynamic MRI of intratumoral vessel density and hyalinization grade in uterine leiomyomas. AJR Am J Roentgenol. 2004;182(4):1043-50.
11. Jha RC, Ascher SM, Imaoka I, Spies JB. Symptomatic fibroleiomyomata: MR imaging of the uterus before and after uterine arterial embolization. Radiology. 2000;217(1):228-35.
12. Park SJ, Lim JW, Ko YT, Lee DH, Yoon Y, Oh JH, et al. Diagnosis of pelvic congestion syndrome using transabdominal and transvaginal sonography. AJR Am J Roentgenol. 2004;182(3):683-8.
13. Gadolinium enhanced magnetic resonance venography as a potential modality to screen for incompetent gonadal veins in patients suspected of having pelvic congestion syndrome [abstract]. J Vasc Interv Radiol. 2000;11(Suppl):221-2.
14. Farquhar CM, Rogers V, Franks S, Pearce S, Wadsworth J, Beard RW. A randomized controlled trial of medroxyprogesterone acetate and psychotherapy for the treatment of pelvic congestion. Br J Obstet Gynaecol. 1989;96(10):1153-62.
15. Edwards RD, Robertson IR, MacLean AB, Hemingway AP. Case report: pelvic pain syndrome--successful treatment of a case by ovarian vein embolization. Clin Radiol. 1993;47(6):429-31.
16. Beard RW, Highman JH, Pearce S, Reginald PW. Diagnosis of pelvic varicosities in women with chronic pelvic pain. Lancet. 1984;2(8409):946-9.
17. Cordts PR, Eclavea A, Buckley PJ, DeMaioribus CA, Cockerill ML, Yeager TD. Pelvic congestion syndrome: early clinical results after transcatheter ovarian vein embolization. J Vasc Surg. 1998;28(5):862-8.
18. Sichlau MJ, Yao JS, Vogelzang RL. Transcatheter embolotherapy for the treatment of pelvic congestion syndrome. Obstet Gynecol. 1994;83(5 Pt 2):892-6.
19. Ahlberg NE, Bartley O, Chidekel N. Right and left gonadal veins. An anatomical and statistical study. Acta Radiol Diagn (Stockh). 1966;4(6):593-601.
20. Castaneda F, Goodwin SC, Swischuk JL, Wong GC, Bonilla SM, Wang MJ, et al. Treatment of pelvic arteriovenous malformations with ethylene vinyl alcohol copolymer (Onyx). J Vasc Interv Radiol. 2002;13(5):513-6.
21. Maleux G, Stockx L, Wilms G, Marchal G. Ovarian vein embolization for the treatment of pelvic congestion syndrome: long-term technical and clinical results. J Vasc Interv Radiol. 2000;11(7):859-64.
22. Scultetus AH, Villavicencio JL, Gillespie DL, Kao TC, Rich NM. The pelvic venous syndromes: analysis of our experience with 57 patients. J Vasc Surg. 2002;36(5):881-8.
23. Cheong Y, Stones W. Investigations for chronic pelvic pain. Rev Gynaecol Pract. 2005;5(4):227-36.
24. Hartung O, Grisoli D, Boufi M, Marani I, Hakam Z, Barthelemy P, et al. Endovascular stenting in the treatment of pelvic vein congestion caused by nutcracker syndrome: lessons learned from the first five cases. J Vasc Surg. 2005;42(2):275-80.
25. Venbrux AC, Chang AH, Kim HS, Montague BJ, Hebert JB, Arepally A, et al. Pelvic congestion syndrome (pelvic venous incompetence): impact of ovarian and internal iliac vein embolotherapy on menstrual cycle and chronic pelvic pain. J Vasc Interv Radiol. 2002;13(2 Pt 1):171-8.
26. Chung MH, Huh CY. Comparison of treatments for pelvic congestion syndrome. Tohoku J Exp Med. 2003;201(3):131-8.
27. Belenky A, Bartal G, Atar E, Cohen M, Bachar GN. Ovarian varices in healthy female kidney donors: incidence, morbidity, and clinical outcome. AJR Am J Roentgenol. 2002;179(3):625-7.
28. Rudloff U, Holmes RJ, Prem JT, Faust GR, Moldwin R, Siegel D. Mesoaortic compression of the left renal vein (nutcracker syndrome): case reports and review of the literature. Ann Vasc Surg. 2006;20(1):120-9.
29. Siskin GP, Tublin ME, Stainken BF, Dowling K, Dolen EG. Uterine artery embolization for the treatment of adenomyosis: clinical response and evaluation with MR imaging. AJR Am J Roentgenol. 2001;177(2):297-302.
30. Jha RC, Takahama J, Imaoka I, Korangy SJ, Spies JB, Cooper C, et al. Adenomyosis: MRI of the uterus treated with uterine artery embolization. AJR Am J Roentgenol. 2003;181(3):851-6.
31. Kitamura Y, Allison SJ, Jha RC, Spies JB, Flick PA, Ascher SM. MRI of adenomyosis: changes with uterine artery embolization. AJR Am J Roentgenol. 2006;186(3):855-64.
32. Singh H. Interventional radiology in the gynaecological oncology patient. Best Pract Res Clin Obstet Gynaecol. 2001;15(2):279-90.
33. Perez CA, Camel HM, Kuske RR, Kao MS, Galakatos A, Hederman MA, et al. Radiation therapy alone in the treatment of carcinoma of the uterine cervix: a 20-year experience. Gynecol Oncol. 1986;23(2):127-40.
34. Morris M, Eifel PJ, Lu J, Grigsby PW, Levenback C, Stevens RE, et al. Pelvic radiation with concurrent chemotherapy compared with pelvic and para-aortic radiation for high-risk cervical cancer. N Engl J Med. 1999;340(15):1137-43.
35. Motoyama S, Hamana S, Ku Y, Laoag-Fernandez JB, Deguchi M, Yoshida S, et al. Neoadjuvant high-dose intraarterial infusion chemotherapy under percutaneous pelvic perfusion with extracorporeal chemofiltration in patients with stages IIIa-IVa cervical cancer. Gynecol Oncol. 2004;95(3):576-82.
36. Yamakawa Y, Fujimura M, Hidaka T, Hori S, Saito S. Neoadjuvant intraarterial infusion chemotherapy in patients with stage IB2-IIIB cervical cancer. Gynecol Oncol. 2000;77(2):264-70.

37. Heaston DK, Mineau DE, Brown BJ, Miller FJ Jr. Transcatheter arterial embolization for control of persistent massive puerperal hemorrhage after bilateral surgical hypogastric artery ligation. AJR Am J Roentgenol. 1979;133(1):152-4.

38. ACOG Committee on Practice Bulletins--Obstetrics. ACOG Practice Bulletin: Clinical management guidelines for obstetrician-gynecologists number 92, April 2008 (replaces practice bulletin number 87, November 2007). Use of psychiatric medications during pregnancy and lactation. Obstet Gynecol. 2008;111(4):1001-20.

39. van der Kooji SM, Helfenkamp WJK, Volkers NA, Birnie E, Ankum WM, Reekers JA. Uterine artery embolization vs hysterectomy in the treatment of symptomatic uterine fibroids: 5-year outcome from the randomized EMMY trial. Am J Obstet Gynecol. 2010;203(2):105.e1-13.

40. Rabinovici J, Stewart EA. New interventional techniques for adenomyosis. Best Pract Res Clin Obstet Gynaecol. 2006;20(4):617-36.

41. Sugiyama T, Nishida T, Hasuo Y, Fujiyoshi K, Yakushiji M. Neoadjuvant intraarterial chemotherapy followed by radical hysterectomy and/or radiotherapy for locally advanced cervical cancer. Gynecol Oncol. 1998;69(2):130-6.