Türk Göğüs Kalp Damar Cerrahisi Dergisi 2017;25(3):381-387
http://dx.doi.org/doi: 10.5606/tgkdc.dergisi.2017.13191

Original Article / Özgün Makale

Requirement of intraoperative supportive procedures and complications in infrarenal abdominal aortic aneurysms due to iliac artery morphology

İnfrarenal abdominal aort anevrizmalarında iliyak arter morfolojisi kaynaklı ameliyat sırası destekleyici işlem gereksinimi ve komplikasyonlar

Tonguç Saba,[1] Enes Duman,[2] Cevahir Haberal,[1] Ali Tünel,[3] Mehmet Özülkü[4]

Institution where the research was done:
Medical Faculty of Başkent University, Ankara, Turkey

Author Affiliations:
[1]Department of Cardiovascular Surgery, Başkent University Alanya Application and Research Center, Antalya, Turkey
Departments of [2]Radiology, [4]Cardiovascular Surgery, Başkent University Konya Application and Research Center, Konya, Turkey
Department of Cardiovascular Surgery, Başkent University Adana Dr. Turgut Noyan Application and Research Center, Adana, Turkey

ABSTRACT

Background: This study aims to evaluate the problems due to the iliac artery morphology which can lead to technical difficulties and complications during the access and the main procedure of the endovascular aortic repair applied in infrarenal abdominal aortic aneurysms.

Methods: This study included a total of 119 patients (100 males, 9 females; mean age 69.4 years; range 52 to 93 years) who underwent endovascular aortic repair between January 2007 and June 2014. The iliac artery morphology problems were evaluated. Morphologies were classified as normal, aneurysmal lesions, stenosis, tortuosity, and dissection. The placement of the main body of the stent graft and the contralateral limb was defined as the main procedure. Additional procedures included intraoperative supportive procedures which were performed due to iliac artery lesions during the procedure. Procedures, challenges, and solutions due to the iliac artery morphology were retrospectively analyzed.

Results: Iliac artery morphology was normal in 22 patients. Sixty-two patients had an aneurysmal lesion, 28 patients had stenosis, 45 patients had tortuosity, and two patients had dissection. The main procedure was sufficient in 27 patients. Intraoperative supportive procedures were required in 92 patients. Additional procedures were applied to 17 patients for complications due to the intraoperative supportive procedures. A surgical intervention was required in three patients, since the complication was unable to be solved by additional procedures.

Conclusion: Being aware of iliac artery morphology has increasingly become a prerequisite for vascular surgeons to gain problem-solving skills in case of complications and to be able to apply intraoperative supportive procedures.

Keywords: Aorta aneurysm; endovascular aortic repair; iliac artery morphology.

ÖZ

Amaç: Bu çalışmada infrarenal abdominal aort anevrizmalarında girişim ve başlıca endovasküler aort tamiri işlemi sırasında teknik zorluklara ve komplikasyonlara yol açabilecek iliyak arter morfolojisine bağlı sorunlar değerlendirildi.

Çalışma planı: Bu çalışmaya Ocak 2007 - Haziran 2014 tarihleri arasında endovasküler aort tamiri uygulanmış 119 hasta (100 erkek, 9 kadın; ort. yaş 69.4 yıl; dağılım 52-93 yıl) alındı. İliyak arter morfolojisi sorunları değerlendirildi. Morfoloji normal, anevrizmatik lezyon, darlık, tortuosite ve diseksiyon olarak sınıflandırıldı. Stent greftin ana gövdesinin ve karşı taraf bacağın yerleştirilmesi, ana işlem olarak tanımlandı. İşlem sırasında ek işlemler, iliyak arter morfolojisine bağlı lezyonların gerektirdiği ameliyat sırası destekleyici işlemlerdi. İliyak arter morfolojisine bağlı işlemler, zorluklar ve çözümler retrospektif olarak değerlendirildi.

Bulgular: Yirmi iki hastada iliyak arter morfolojisi normaldi. Altmış iki hastada anevrizmatik lezyon, 28 hastada darlık, 45 hastada tortuosite ve iki hastada diseksiyon mevcuttu. Ana işlem 27 hastada yeterli oldu. Ameliyat sırasında destekleyici işlemler 92 hastada gerekti. Ameliyat sırası destekleyici işlemlerin neden olduğu komplikasyonlar için 17 hastaya ek işlem uygulandı. Komplikasyonun ek işlemlerle çözülemediği üç hastaya ise cerrahi girişim gerekti.

Sonuç: İliyak arter morfolojisinin bilinmesi, komplikasyonların olması durumunda sorun çözmeye yönelik becerilerin kazanılması ve ameliyat sırası destekleyici işlemlerin uygulanabilmesi amacıyla damar cerrahları için gittikçe artan bir gerekliliktir.

Anahtar sözcükler: Aort anevrizması; endovasküler aort tamiri; iliyak arter morfolojisi.

Available online at
www.tgkdc.dergisi.org
doi: 10.5606/tgkdc.dergisi.2017.13191
QR (Quick Response) Code

Received: February 25, 2016 *Accepted*: January 17, 2017

Correspondence: Enes Duman, MD. Başkent Üniversitesi Konya Uygulama ve Araştırma Hastanesi Radyoloji Kliniği, 42080 Selçuklu, Konya, Turkey.
Tel: +90 332 - 257 06 06 e-mail: drenesduman@hotmail.com

The natural course of abdominal aortic aneurysms (AAAs) is increment in the diameter and rupture.[1] These aneurysms are usually asymptomatic, until ruptured, and rupture is fatal in 85 to 90% of cases.[2] Even if the patients reach the hospital, only 50 to 70% survive.[2] Hence, diagnosis and treatment of AAAs should be performed before rupture.[2]

Although AAA treatment with open surgical technique has been effectively continued today, the mortality rate still remains between 4 and 10%, even in large-scale health centers and institutions.[3] The first endovascular aneurysm repair (EVAR) was performed in 1991 by Parodi et al.,[4] and various equipments and strategies have been developed, since then. These developments facilitate the application of the procedure and increase the success rates in EVAR.

There are various pathophysiological processes in the formation of aneurysms or stenosis of the non-coronary arterial circulation. However, atherosclerosis is the disease which mostly affects the aorta and its branches.[5] In recent years, EVAR has become a treatment strategy which can be performed in high-risk group patients. However, several problems such as aneurysm-ectasia, stenosis-occlusion, tortuosity, and dissection in AAAs may develop due to atherosclerosis, as well as in iliac arteries due to this disease.

The use of EVAR has been increasing due to its high numbers of advantages, compared to open surgical technique. In addition, EVAR is good in short- and mid-term quality of life, compared to open surgery.[6]

The application of EVAR technology has been increasingly facilitated due to the developed technologies, whereas the use of this technique requires experienced professionals with foresight against additional issues that may arise. Iliac artery morphology induced problems in AAA are not exclusion criteria, whereas they still require an attention. While uncorrected and problematic iliac artery anatomy has complication risks such as bleeding, rupture, and dissection and it requires open surgical technique in 15% of the patients.[7] Experience and new stent graft systems reduce this requirement to below 1%.[8-10] Yavuz et al.[11] also reported this problem in their study.

In the present study, we aimed to evaluate the problems due to the iliac artery morphology, which can lead to technical difficulties and complications during the access and the main procedure of the EVAR applied for the treatment of infrarenal AAAs.

PATIENTS AND METHODS

This retrospective study included a total of 119 patients (100 males, 9 females; mean age 69.4 years; range 52 to 93 years) who underwent EVAR for infrarenal AAAs between January 2007 and June 2014. Thoracic aneurysm cases were excluded from the study. Of the patients, 54% had coronary artery disease, 47% had hypertension, 26% had chronic obstructive pulmonary disease, 23% had hyperlipidemia, 19% had chronic renal failure, 16% had diabetes mellitus, 14% had peripheral vascular disease, and 6% had cerebrovascular disease. Ultrasound, digital subtraction angiography (DSA), and computed tomography (CT) were used to assess the iliac artery morphology. The morphology of iliac artery was classified into five groups as normal, aneurysmal lesions, stenotic lesions, tortuosity, and dissection.

The study protocol was approved by the Medical Faculty of Başkent University Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Definitions

Aneurysmal lesions: defined as ectasia or aneurysms in the artery, 1.4 cm and more in main iliac artery and 1 cm or more in the external iliac artery.[12]

Stenotic lesions: defined as critical stenosis (atherosclerosis or 50% stenosis) which can affect the procedure success. The location and the seriousness of stenotic lesions were determined according to the Trans-Atlantic Inter-Society Consensus (TASC) classification for the iliac stenotic diseases.[13]

Tortuosity: Kristmundsson et al.[14] defined the tortuosity as moderate and severe angulations.

Main procedure: defined as the placement of the main body and the contralateral leg.

Intraoperative supportive procedure: Interventions such as embolization, percutaneous transluminal angioplasty (PTA), stent, grafts extension, leak (IIb, IIIb) induced transactions made to graft legs, which can be applied to solve possible problems, were defined as external access operations of iliofemoral access. All interventions which were related to the neck in AAAs and body of the stent graft were excluded from the study.

Complications additional procedures: Rupture, dissection, thrombosis, and migration were defined as complications related to the additional procedures which developed due to the intraoperative supportive procedures and were performed to facilitate the access of the main procedure, solving the iliac artery morphology-related problems. Uncorrected type 1b was also defined as the leakage in the end of all procedures.

Computed tomography was used to visualize the preoperative process. These scans were reconstructed by 0.75-3 mm axial sections. All artery measurements were calculated intraoperatively by DSA images or using CT preoperatively. Procedures were performed with DSA.

Standard sterile conditions were ensured in the endovascular treatment room. Before the intervention, prophylactic antibiotics were administered to the patients, and anticoagulation was ensured with heparin (100 unit/kg). Upon ensuring the required sterilization and the operation environment in the angiography laboratory, local anesthesia was applied to both femoral regions. Under the direction of an experienced anesthesiologist, 67 patients received local anesthesia, 42 patients received spinal epidural anesthesia, and 10 patients received general anesthesia. Femoral arteries, which were previously planned as the access site on both sides, were prepared by either using a percutaneous method or surgical longitudinal incision. Upon entering the femoral artery using a vascular needle, and following the placement of the vascular sheet on the hydrophilic guidewire, a marked pigtail catheter was pushed forward the proximal abdominal aorta under the guidance of aortography. The marked pigtail catheters were used to determine the length of the aorta segment during DSA. Upon the movement of the stiff guidewire through the thoracic aorta, vascular sheath was located in the contralateral femoral artery using a vascular needle. The main body of the stent graft was placed in the infrarenal part of the abdominal aorta on the stiff guidewire. Blood pressure was reduced to 70 mmHg using Na-nitroprusside infusion to prevent the graft to move downwards, while the graft was opening during the systole of the heart. Then, limb extension was linked to the main body on the stiff guidewire by entering the contralateral limb of the main body using a vascular sheet in the contralateral with the assistance of the guidewire. Right after the procedure, the leakage status was evaluated through control images. The patients who had type 1 and type 3 leakage were immediately treated.

Upon control angiographies, incisions in both inguinal regions were sutured and the intervention was finalized. In case there were no findings related to bleeding, infection or intestinal ischemia, the patients were mostly discharged from the hospital in a couple of days.

Regarding the graft selection, we selected the graft with a diameter which was 20% larger than the diameter of the normal aorta as confirmed by CT. The Excluder (W.L. Gore and Associates, Flagstaff, AZ, USA) and Endurant (Medtronic Vascular, Santa Rosa, CA, USA) were used as the stent grafts during the intervention.

Statistical analysis

All analyses were done using IBM SPSS for Windows, version 21.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean and percentage. Continuous variables were presented as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies. In order to test whether the data were normally distributed, the Kolmogorov-Smirnov test was applied. A p value of <0.05 was considered statistically significant.

RESULTS

Of the patients, 36% were 75 years old or above. The mean AAA diameter was 66.8 mm (range 40 to 120 mm).

A total of 62 patients (52%) had an aneurysmal lesion, 28 patients (24%) had a stenotic lesion, 45 patients (38%) had tortuosity, and two patients (1.5%) had dissection. Iliac artery morphology was normal in 22 patients.

Fifty-seven patients (92%) had a common iliac artery aneurysm, 36 of them (58%) had bilateral common iliac artery aneurysms, 13 of them (21%) had an only right common iliac artery aneurysm, and eight of them (13%) had a left common iliac artery aneurysm. Five patients had also an external iliac artery aneurysm.

Seventeen patients (61%) had stenosis on the common iliac artery. Eight patients (28%) had stenosis on the external iliac artery. There were three patients who had both common iliac and external artery problems. For the stenotic lesions, there were 20 patients (71.5%) in the TASC-A, four patients (14%) in the TASC-B, one patient (3.5%) in the TASC-C, and three patients (11%) in the TASC-D class.

There was a tortuosity in 45 patients and 23 of them (51%) had tortuosity in bilateral iliac arteries, 10 of them (22%) had tortuosity in the right iliac artery, and 12 of them (27%) had tortuosity in the left iliac artery.

In addition, there were aneurysmal lesions and tortuosity in 24 patients (20%), aneurysmal lesions and stenotic lesion in 11 patients (9%), stenotic lesions and

Table 1. Classification of iliac artery morphologies

Iliac morphology	n	%	Location	n	%	Side	n	%
Aneurysmal lesions	62	52	Common iliac artery	57	92	Bilateral	36	58
						Right	13	21
						Left	8	13
			External iliac artery	5	8	Bilateral	1	1.5
						Right	2	3
						Left	2	3
Stenotic lesions	28	24	Common iliac artery	17	61	Bilateral	2	7
						Right	4	14
						Left	11	40
			External iliac artery	8	28	Bilateral	1	3.5
						Right	4	14
						Left	3	11
			Common and external iliac arteries	3	11			
Tortuosity	45	38				Bilateral	23	51
						Right	10	22
						Left	12	27
Dissection	2	2.5	Common iliac artery	1				
			External iliac artery	1				
Normal	22	18.5						

tortuosity in three patients (2%), and an aneurysmal lesion-stenotic lesion-tortuosity in three patients (2%). Clinical data are shown in Table 1.

There were seven patients (5%) with femoral artery problems, and one of them (0.84%) had a femoral artery aneurysm, one of them (0.84%) had a femoral artery occlusion, while five of them (4%) had stenosis in the femoral artery.

Totally, 15 patients (12%) were operated under emergency conditions due to ruptured AAAs and 104 patients (87%) were operated under elective conditions. For the access, bilateral surgical exploration was used in 55 patients (46%), bilateral percutaneous intervention was used in 51 patients (42%) and percutaneous surgery was performed in 12 patients (10%). Femoral and brachial accesses were used in one patient (0.84%) who had unilateral iliac artery occlusion and dissection.

The EVAR technique was successful with main procedure only in 27 patients (22.5%). Intraoperative supportive procedures were performed in 92 patients (79%). Problems due to the iliac artery morphology required intraoperative supportive procedures in 78 patients (65.5%).

Before the main procedure, PTA or PTA-stent was placed for stenotic lesions in 28 patients (36%). Internal iliac arteries were embolized in 27 patients (35%) to prevent the back flow. After the main procedure, extension grafts were required in 55 patients (71%) to exclude aneurysmal lesions (Figure 1a-d).

Due to iliac artery morphological problems, 66 intraoperative procedures were applied to 28 patients (23%) before the main procedure and 81 intraoperative supportive procedures were applied to 55 patients (46%) after the main procedure. Brachial access was needed in one patient (0.84%) due to the difficulty in the access induced by tortuosity.

Complication-induced additional procedures were required in 17 patients (14%). Surgical interventions were required for three patients (2.5%), since complications were unable to be solved by additional procedures. None of the patients needed open surgical procedures, due to the main procedure problem. Totally five patients (4%) died upon the procedure. The procedure success rate was 100%, primary stent patency was 100%, and postoperative mortality was 4%.

DISCUSSION

In the primary EVAR studies, short neck, small iliac artery, tortuosity in iliac arteries and atherosclerosis, arteriosclerosis of the aortic bifurcation were accepted as the reasons for non-compliance to EVAR technique and it was predicted that these problems would decrease with further experiences.[15]

Considering the current status of the technology for EVAR, problematic iliac anatomy is still a limiting issue for infrarenal AAAs.[16] The effect of iliac artery tortuosity or stenosis on complications upon EVAR was

Figure 1. (a) White arrows showing stenosis origin of the external iliac artery. **(b)** Black arrows showing stent placed in the stenotic segment. **(c)** White arrows showing an aneurysm on left common iliac artery. **(d)** Black arrows showing that the extending graft was placed in the aneurysmatic segment and white arrows showing coils in internal iliac arteries placed before the placement of extending graft to the external iliac arteries.

reported as 36%.[17] That problem has been reduced by increased experience and new stent graft systems, although it still needs frequent usage of troubleshooter techniques and require longer radiation exposure time for the physicians.[18]

Although there are no long-term data in the literature, the complication-induced additional procedures were needed in 17 patients (14%) in our study. There was a dissection in one patient (needed stent), thrombosis in one patient (needed PTA), rupture in two patients (needed extension), migration in two patients (needed extension), and type 1b leakage in 11 patients at the end of all procedures (needed PTA).

Yazman et al.[19] also reported that additional procedures were seen at a rate of 7.8%; however, surgical correction was often necessary for the problem.

Uncorrected stenotic lesions (24 to 36%) or additional procedure during corrective surgery can lead to life-threatening and severe complications such as thrombosis, rupture, and dissection both during the procedure and at the end of procedures.[19] Additional procedures which are needed to solve complications may be difficult. If complications are not corrected, the necessity to have an emergency surgical intervention would increase. This would be very tiring in case the same vascular surgeon has to continue the operation.

Köksal et al.[20] also reported iliofemoral problems with prolonged procedural time and additional surgical interventions.

In the present study, we classified the patients according to the TASC classification to determine the effect of the iliac stenotic lesions on the treatment type choice. Based on the disease and comorbidities, EVAR could even be applied to four patients in C and D category and the solutions of these problems required PTA-stent procedure skills.

Aneurysmal problems of our patients were frequent (52 to 99 lesions). These problems can increase the intraoperative supportive procedure load. The reason is mostly leakage and migration. This would determine the long-term EVAR success or the requirement of additional and repetitive procedures after the unsuccessful intervention. However, there will be complications such as migration instead of thrombosis which can be observed due to stenotic problems.

In our study, entirely occluded iliac artery and tortuosity changed the access place in two patients and brachial artery was used in these patients. Tortuosity leads to the elongation of the process, and it is no longer a problem thanks to the new generation stent grafts.

Dissections are rarely observed and they do not lead to problem with the help of the appropriate stenting process upon procedure.

Novel techniques are described in the literature which can solve the problems due to the iliac morphology in order to apply the EVAR technique in a proper way. These techniques are expansion of iliofemoral segment simple vascular structures by using over-the-wire dilators, balloon angioplasty, endoluminal balloon endarterectomy, direct retroperitoneal iliac conduits and internal endoconduit.[7]

The success of local anesthesia during intervention is directly related to increased experience. Percutaneous access directed by ultrasonography and usage of closure devices reduces the operation time and decreases the number of physicians required.[21] Local anesthesia has also an advantage to general anesthesia in terms of postoperative outcomes; and it also shortens the hospitalization time according to regional and general anesthesia.[21]

However, EVAR cannot be performed in all patients due to access problems mainly caused by problematic iliac morphology.

Stent graft producers develop new products and technologies to solve the problems due to the problematic iliac anatomy. Therefore, EVAR can be currently applied to a broad range of patients, who were unable to be operated previously.

Iliac artery access problems, which are commonly encountered during EVAR, are observed frequently depending on arteriosclerosis, which leads to infrarenal AAAs. When only one type of lesion is present, it is sufficient to treat the prementioned lesion. However, complex, severe lesions may require additional interventions for the success of the procedure. Therefore, a surgeon should have a holistic way of thinking and he/she should assess both pre- and postoperative EVAR conditions.

In our EVAR experience, we identified frequent iliac artery morphological problems accompanying infrarenal AAAs and processing interventional ratio increased before and after the main procedure. We also excluded patients who had short aortic aneurysm neck and renal artery problems to better emphasize the iliac artery morphology problem. The aortic aneurysm neck and renal artery problems are more standard and they can be predicted before the procedure. Percutaneous transluminal angioplasty and extension are sufficient for these problems. However, iliac region morphology has various and different lesions, and the intervention depends on the experience and the skill of the operator.

As problems of iliac artery morphology are frequently seen, surgeons should be familiar with the spectrum of these problems, and they should also have problem-solving strategies and manipulation skills in case of any complications.

During the EVAR procedure, success requires various skills, such as the access to femoral artery, reaching the aneurysm through the access place, definition of lesions, compliance of the guidewires and catheters with problems, solution of iliofemoral problems before the intervention and preparation of the region for EVAR procedure (PTA, PTA-stent, coil embolization, dissection of the stent), application of the appropriate intervention to observe the aneurysm, placement of the stent graft for the main procedure and the aneurysm neck in this place, additional procedure skills for problems which can arise due to the sac, placement of the opposite leg, placement of the extension grafts, in case the main procedure is not sufficient, and PTA intervention for leakage. Therefore, we suggest that vascular surgeons should gain skills both for standard EVAR procedure and entire interventional vascular procedures.

In conclusion, being aware of iliac artery morphology has increasingly become a prerequisite for vascular surgeons to gain problem-solving skills in case of complications and to be able to apply intraoperative supportive procedures. However, further studies will be more valuable including patients who undergo an intervention for infrarenal abdominal aortic aneurysms, who have fragile tissues, who had an open surgical intervention, and who have ruptured abdominal aortic aneurysms.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Ernst CB. Abdominal aortic aneurysm. N Engl J Med 1993;328:1167-72.
2. Kent KC. Clinical practice. Abdominal aortic aneurysms. N Engl J Med 2014;371:2101-8.
3. Brown LC, Powell JT, Thompson SG, Epstein DM, Sculpher MJ, Greenhalgh RM. The UK EndoVascular Aneurysm Repair (EVAR) trials: randomised trials of EVAR versus standard therapy. Health Technol Assess 2012;16:1-218.
4. Parodi JC, Palmaz JC, Barone HD. Transfemoral intraluminal graft implantation for abdominal aortic aneurysms. Ann Vasc Surg 1991;5:491-9.
5. Hirsch AT, Haskal ZJ, Hertzer NR, Bakal CV, Creager MA, Halperin JL, et al. ACC/AHA 2005 Guidelines for the Management of Patients With Peripheral Arterial Disease (Lower Extremity, Renal, Mesenteric, and Abdominal Aortic). J Am Coll Cardiol 2006;47:1-192.
6. Ozgür B, Demirag MK. hort and mid-term quality of life and outcomes following endovascular and open surgical repair of abdominal aortic aneurysms. Turk Gogus Kalp Dama 2013;21:639-45.
7. Yano OJ, Faries PL, Morrissey N, Teodorescu V, Hollier LH, Marin ML. Ancillary techniques to facilitate endovascular repair of aortic aneurysms. J Vasc Surg 2001;34:69-75.
8. Faure EM, Becquemin JP, Cochennec F. Predictive factors for limb occlusions after endovascular aneurysm repair. J Vasc Surg 2015;61:1138-45.
9. Millon A, Deelchand A, Feugier P, Chevalier JM, Favre JP. Conversion to open repair after endovascular aneurysm repair: causes and results. A French multicentric study. Eur J Vasc Endovasc Surg 2009;38:429-34.
10. Rouwet EV, Torsello G, de Vries JP, Cuypers P, van Herwaarden JA, Eckstein HH, et al. Final results of the prospective European trial of the Endurant stent graft for endovascular abdominal aortic aneurysm repair. Eur J Vasc Endovasc Surg 2011;42:489-97.
11. Yavuz Ş, Özbudak E, Gümüştaş S, Kanko M, Çiftçi E, Berki T. Abdominal aort anevrizmalarında endovasküler stent greft uygulamaları: Orta ve uzun dönem sonuçlar. Turkish J Thorac Cardiovasc Surg 2013;21:333-40.
12. Karch LA, Hodgson KJ, Mattos MA, Bohannon WT, Ramsey DE, McLafferty RB. Management of ectatic, nonaneurysmal iliac arteries during endoluminal aortic aneurysm repair. J Vasc Surg 2001;33:33-8.
13. Norgren L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FG. Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). Eur J Vasc Endovasc Surg 2007;33:1-75.
14. Kristmundsson T, Sonesson B, Resch T. A novel method to estimate iliac tortuosity in evaluating EVAR access. J Endovasc Ther 2012;19:157-64.
15. Naslund TC, Edwards WH Jr, Neuzil DF, Martin RS, Snyder SO Jr, Mulherin JL Jr, et al. Technical complications of endovascular abdominal aortic aneurysm repair. J Vasc Surg 1997;26:502-9.
16. Wu T, Carson JG, Skelly CL. Use of internal endoconduits as an adjunct to endovascular aneurysm repair in the setting of challenging aortoiliac anatomy. Ann Vasc Surg 2010;24:114.
17. Henretta JP, Karch LA, Hodgson KJ, Mattos MA, Ramsey DE, McLafferty R, et al. Special iliac artery considerations during aneurysm endografting. Am J Surg 1999;178:212-8.
18. Georgiadis GS, Trellopoulos G, Antoniou GA, Gallis K, Nikolopoulos ES, Kapoulas KC, et al. Early results of the Endurant endograft system in patients with friendly and hostile infrarenal abdominal aortic aneurysm anatomy. J Vasc Surg 2011;54:616-27.
19. Yazman S, Yurekli I, Yilik L, Yetkin U, Iner H, Gunes T, et al. Our mid-term results of endovascular repair of abdominal aortic aneurysms. Turk Gogus Kalp Dama 2016;24:274-80.
20. Koksal C, Ozcan V, Sarikaya S, Meydan B, Zengin M, Numan F. Supplemental vascular procedures for endovascular aneurysm repair. Turk Gogus Kalp Dama 2004;12:254-8.
21. Karthikesalingam A, Thrumurthy SG, Young EL, Hinchliffe RJ, Holt PJ, Thompson MM. Locoregional anesthesia for endovascular aneurysm repair. J Vasc Surg 2012;56:510-9.