Chron Precis Med Res 2024; 5(2): 70-73
DOI: 10.5281/zenodo.12805585

ORIGINAL ARTICLE
ORİJİNAL ARAŞTIRMA

Assessment of Iliac Artery Stent Patency Using Computed Tomography Angiography and Comparison with Digital Subtraction Angiography

İliak Arter Stent Açıklığının Bilgisayarlı Tomografi Anjiyografi ile Değerlendirilmesi ve Dijital Subtraksiyon Anjiyografi ile Karşılaştırılması

Davut Ünsal CAPKAN[1,2], Erhan Turgut ILGIT[2]

[1]Medical Point Hospital Department of Radiology, Gaziantep, Turkey
[2]Gazi Üniversity Department of Radiology, Ankara, Turkey

ABSTRACT

Aim: To evaluate the effectiveness of computed tomography angiography (CTA) methods in measuring intimal thickening and stenosis in iliac artery stents to digital subtraction angiography (DSA).

Material and Method: Twenty patients who underwent stent implantation for aorto-iliac artery stenosis in our radiology clinic were assessed using CTA and DSA. In addition to CTA axial images, multiplanar reformat, maximum intensity projection (MIP), shaded surface display (SSD), and virtual intravascular endoscopy (VIE) images were generated to evaluate the stents using the CTA data. Statistical analyses were conducted using the McNemar test with the IBM SPSS software program. This study adhered to the principles of the Helsinki Declaration.

Results: Multiplanar reformat images were more effective than other imaging (MIP, SSD, and VIE) in evaluating stent lumens and stenoses.

Conclusion: CTA image processing methods can be used as a non-invasive technique to evaluate iliac vascular stent patency.

Keywords: Atherosclerosis, computed tomography angiography, diagnostic imaging, stent

ÖZ

Amaç: İliak arter stentlerinde intimal kalınlaşma ve darlığın değerlendirilmesinde Bilgisayarlı Tomografi Anjiyografi (CTA) yöntemlerinin etkinliğini araştırmak ve bu yöntemleri Dijital Substraksiyon Anjiyografi (DSA) ile karşılaştırmaktır.

Gereç ve Yöntem: Radyoloji Kliniğimizde aorto-iliak arter stenozu nedeniyle stent implantasyonu yapılan yirmi hasta CTA ve DSA ile analiz edildi. CTA incelemesinde elde edilen verilerden stentleri değerlendirmek için aksiyel görüntülere ek olarak multiplanar reformat (MPR), maksimum yoğunluk projeksiyonu (MIP), gölgeli yüzey görüntüsü (SSD) ve sanal intravasküler endoskopi (VIE) görüntüleri oluşturuldu. İstatistiksel analizler SPSS yazılım paket programı (IBM) kullanılarak Mcnemar testi ile gerçekleştirilmiştir. Bu çalışma Helsinki Deklarasyonu Prensiplerine uygundur.

Bulgular: Stent lümeninin görüntülenmesi açısından, MPR görüntüleri stent lümeninin ve stenozların değerlendirilmesinde diğer görüntülerden (MIP, SSD, VIE) daha etkilidir.

Sonuç: CTA görüntü işleme yöntemleri, iliak vasküler stent açıklığını değerlendirmede non-invaziv bir yöntem olarak uygulanabilir.

Anahtar Kelimeler: Ateroskleroz, stent, bilgisayarlı tomografi anjiyografi, tanısal görüntüleme

Corresponding Author: Davut Ünsal Capkan
Address: Medical Point Hospital Department of Radiology, Gaziantep, Turkey
E-mail: drdavutunsal11@gmail.com

Başvuru Tarihi/Received: 03.05.2024
Kabul Tarihi/Accepted: 22.07.2024

INTRODUCTION

Atherosclerotic peripheral arterial disease in the lower extremities is chronic and progressive. According to several epidemiologic studies, it produces vascular lesions that require treatment in approximately 10% of adults over the age of 65 year. The preferred mode of treatment is endovascular. The two most common types of endovascular treatment are balloon angioplasty and stenting (1).

Digital subtraction angiography (DSA) provides high temporal and spatial resolution in the radiologic evaluation of stent-treated patients. The disadvantages include invasiveness and high radiation exposure.

Computed tomography angiography (CTA), an alternative imaging method, is non-invasive. Compared with DSA, the radiation dose and amount of contrast material used during the test may now be chosen (2).

MATERIAL AND METHOD

In this study, 20 patients who underwent intravascular stenting and a control DSA test for iliac artery stenosis in our radiology clinic were included retrospectively.

Nineteen male and one female patients aged 46–80 year (mean, 63) were assessed with CTA at the one-month and 10-year follow-up visits following intravascular stenting. The CT angiography examination was carried out using the HiSpeed CT/i (GE Medical Systems, Milwaukee, Wisconsin).

To determine the localization of the aorta-iliac artery stents, an initial evaluation was conducted before administering intravenous contrast material. Patients were positioned supine in the gantry to acquire an anterior–posterior anterior image. After the stent was observed in the anterior image, 2–3 cm distal to the stent, beginning at the L4 vertebral level, was examined with 10-mm collimation, 30-mm/s table speed, "pitch" 3/1 with 120 kV, 50-mA X-ray settings to obtain the best image with a minimal number of slices. The examination time ranged from 2.9 to 5.9 s, with a mean of 4.4 s.

After localization was determined, 120 cc (1.5–2 cc/kg) of nonionic contrast medium (Iopamiro-Ultravist or Visipaque 300 mgI/mL) was injected at a rate of 4 cc/s using a 20-G intravenous cannula via an antecubital vein from an automated injector (MedRad OP 100, USA).

The delay time (the time between the initiation of the injection and the formation of maximum contrast intensity in the terminal aorta and iliac artery dissociation level) was 25 s in 19 cases and 15 s in one case (Case 20). In the examinations, 120 kV, 200 mA, 3-mm collimation, 6-mm/s table speed, and "pitch" 2/1 were used. At the end of the delay time, patients were asked to hold their breath before spiral scanning began. The examination was completed in 11.6–22.4 s, with an average time of 17 s.

Following the imaging technique, the 1800 linear interpolation algorithm was used to reconstruct all patients' volumetric data from spiral scanning with a slice thickness of 1 mm using. Reconstruction took roughly 8–10 min.

Nine of the stenting stenoses were detected in the left common iliac artery, seven in the right common iliac artery, three in the right external iliac artery, and one in the terminal aorta. In CTA, oblique reformat images were acquired in all patients from 1-mm reconstructed standard axial images with the stent referenced from the stent plane, allowing the stent to be examined thoroughly in the coronal plane.

The stents were evaluated using axial images, workstation-generated multiplanar reformat (MPR), maximum intensity projection (MIP), shaded surface display (SSD), and virtual intravascular endoscopy (VIE).

Statistical analyses were performed using the IBM SPSS software program. Data are expressed as mean ± standard deviation. The McNemar test was used to assess the effectiveness of CTA and image processing procedures, and stenosis rates and intimal thickness growth were compared with those obtained with DSA.

RESULTS

Sixteen of the 20 patients had a single stent placed in one iliac artery, two patients had two stents implanted for lesions in the right and left iliac arteries, and two patients had an in-stent stent placed after stent stenosis.

Multiplanar reformats are coronal, sagittal, or oblique single-voxel thick planes formed by superimposing axial slices. This method distinguishes calcification and stent from intraluminal contrast. In our study, the stent was visualized separately from the intraluminal contrast in all cases; however, the stent, calcification, and bone structures had similar densities.

Multiplanar reformat images were obtained from standard axial images using the stent as a reference. Depending on the stent's angle with the aorta-iliac artery, the stent lumen was best assessed on sagittal oblique images between 50 and 500 in 18 patients and on axial oblique images in two patients (**Figure 1**).

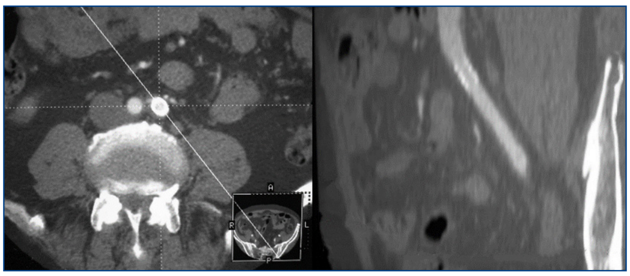

Figure 1. Axial image and the MPR imaging with the stent

Following contrast enhancement, vascular structures distal to the stent were typically visible on MIP images. MIP images with thicknesses ranging from 4.1 to 7 mm provided the best view of vascular structural continuity.

The iliac vascular structures and stents were observed by carefully removing the bones from the image to avoid superposition with MIP images derived from axial images and incorporating the entire scan volume (**Figure 2**).

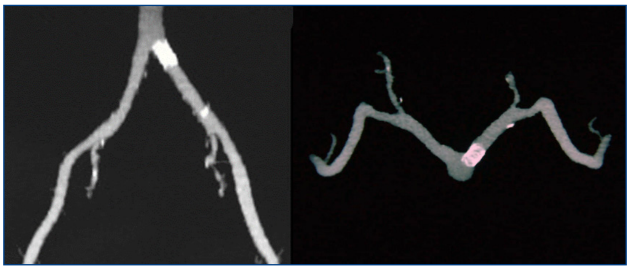

Figure 2. Windowing to visualize vascular structures in MIP images

In 11 cases, the stent was broader than the aorta-iliac artery diameter at the localization site on SSD images. In the other cases, the stent and intraluminal contrast were indistinguishable because their density exceeded the specified threshold value.

SSD images were generated by taking a cutoff value of 160–200 HU on axial images (**Figure 3**).

Figure 3. SSD images viewed from the anterior side. The threshold value was taken as 160 HU

The threshold value in VIE images was set between 90 and 150. In all cases, the stent was seen from the proximal vascular lumen, and the stent lumen and stent distal were assessed. The stent was patent in all cases.

The iliac arteries were also endoluminally imaged using VIE software (**Figure 4**).

In the statistical analysis, it was found that CTA and image processing procedures were similarly effective as DSA in assessing iliac artery stent patency **Tables 1,2**.

Table 1. Comparison of Axial CT, DSA, MIP, SSD, and VIE imaging techniques with intimal thickness increase

Imaging techniques	Intimal thickness increase		p value
	Present (%)	Absent (%)	
Axial CT	10 (50)	10 (50)	>0.05
DSA	0	20 (100)	>0.05
MIP	0	20 (100)	
SSD	0	20 (100)	
VIE	0	20 (100)	

Note. CT, computed tomography; DSA, digital subtraction angiography; MIP, maximum intensity projection; SSD, shaded surface display; VIE, virtual intravascular endoscopy.

Table 2. Comparison of stenosis rates between DSA and MPR imaging techniques

Imaging techniques	Stenosis rates		p value*
	>10%	10%–30%	
MPR	17 (85)	3 (15)	>0.05
DSA	17 (85)	3 (15)	

Note. DSA, digital subtraction angiography; MPR, multiplanar reformation.
*p value shows the results of the Mcnemar test.

DISCUSSION

DSA is the gold standard for diagnosis and treatment. Its main advantage is that a balloon or stent may be placed immediately following the diagnostic test; however, it is an invasive, costly method with a high risk of complications and radiation exposure (3).

CTA is now preferred as an alternative method to DSA because it allows for software-supported MPR and 3D volume images that enable a thorough evaluation of the entire vascular tree (3,4). In our study, MPR, MIP, SSD, and VIE images were generated in all cases.

Figure 4. The created VIE images. In these images, the left iliac artery and the stent are visualized from the aortic lumen by determining the path in the aortic lumen with a “curser”

Calcification and stent may be distinguished from intraluminal contrast in oblique MPR images obtained in relation to the stent. In this study, the stent was visualized separately from the intraluminal contrast. MPR images may be used to assess the relationship between the metallic stent and vascular structures as well as its patency and location.

Maximum intensity projection is highly sensitive in distinguishing calcification from intraluminal contrast (4). In this study, we used MIP to differentiate between stent and intraluminal contrast in all cases.

SSD images cannot be used to evaluate stenosis or patency of the stented segment (5). In our study, the stent appeared as contour overflow in the vessel on SSD images in 11 cases, with the stent, calcification, and intraluminal contrast all having a similar appearance.

Virtual intravascular endoscopy represents a three-dimensional perspective of virtual fiberoptic endoscopy. In aorta-iliac artery stenosis, the location of stents and their relationship with the vascular structure can be evaluated by VIE, ostial or luminal narrowing (6,7).

This study has some limitations. The study group consisted of patients who only had their iliac arteries stented.

Stenoses and stents in other arteries were excluded to avoid increasing the dose of contrast agent used.

The advantages of this study include the possibility of using alternative reconstruction approaches that increase diagnostic sensitivity after the CTA procedure (8,9).

In a study by Napoli et al. (3) on the efficacy of spiral and multidetector CT in the diagnosis, stenosis grading, and treatment of peripheral arterial disease, it was found that the diagnostic performance of CTA was equal to that of DSA (accuracy, >98%), and it is suggested that CTA can be used as a primary imaging method in place of DSA.

CONCLUSION

In conclusion, this study supports the literature data by showing that CTA, when combined with advanced image processing methods, can be as effective as DSA in assessing stent integrity, stent patency, and the stent–aorta-iliac artery relationship following intravascular stenting in aortic and iliac artery stenoses.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study used research data before 2020, and it is among the studies that do not require ethics committee permission as it is produced from my master's/doctoral thesis.

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

Note: The research article was accepted as an oral presentation at the Eastern Mediterranean Family Physicians Association Congress in May 2024.

REFERENCES

1. Meissner O, Prettner R, Kellner WS, et al. Endoluminal repair of peripheral arterial aneurysms: 4-year experience with the Cragg Endopro System I. J Vasc Interv Radiol 2000;11(5):593-600.
2. Alanazi A, Nojiri C, Kido T, et al. Engineering analysis of diamond-like carbon coated polymeric materials for biomedical applications. Artif Organs 2000;24(8):624-7.
3. Napoli A, Anzidei M, Zaccagna F, et al. Peripheral arterial occlusive disease: Diagnostic performance and effect on therapeutic management of 64-section CT angiography. Radiology 2011;261(3):976-86.
4. Ofer A, Nitecki SS, Linn S, et al. Multidetector CT angiography of peripheral vascular disease: A prospective comparison with intraarterial DSA. AJR Am J Roentgenol 2003;180(3):719-24.
5. Hiatt MD, Fleischmann D, Hellinger JC, Rubin GD. Angiographic imaging of the lower extremities with multidetector CT. Radiol Clin North Am 2005;43(6):1119-27.
6. Rubin, GD. Multi-detector row CT angiography of lower extremity arterial inflow and runoff: initial experience. Radiology 2001;221(1):146-58.
7. Ota H, Takase K, Igarashi K et al. MDCT compared with digital subtraction angiography for assessment of lower extremity arterial occlusive disease: important of reviewing cross-sectional images. AJR Am J Roentgenol 2004;182(1):201-9.
8. Mahesh M. Search for isotropic resolution in CT from conventional through multiple-row detector. Radiographics 2002;22(4):949-62.
9. Martinez R, Ferral H: Endovascular treatment of athero-occlusive disease of iliac arteries. La Revista de Investigacion Clinica 2001;53(6):543-51.