**Categorization of tibial artery disease on Computer Tomography Angiography according to the TASC II classification**

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**ABSTRACT**

**Purpose:** Computer Tomography Angiography (CTA) is used to assess peripheral arterial disease (PAD). Its preference over other imaging modalities is based upon its rapid acquisition and high spatial resolution, along with ease of access. TASC II have recently updated their vascular lesion classification to include infra-popliteal lesions, and our aim is to assess the reproducibility of TASC II on infrapopliteal disease when using CTA.

**Methods:** A retrospective analysis of a series of consecutive CTAs was performed by seven assessors (3 Consultant Radiologists, 2 Consultant Vascular Surgeons, and 2 Vascular Specialty Trainees). Each was asked to classify the target vessel based on the TASC II classification. Statistical analysis was performed using Cohen’s Weighted Kappa.

**Results:** Seven assessors analysed 48 target vessels in 25 patients (20 men), with a mean age of 72.9 years. 20 posterior tibial, 27 anterior tibial and 1 peroneal artery were analysed. Poor agreement was demonstrated between the two vascular consultants, with a kappa of 0.094. Weak agreement was demonstrated among the radiologists, with a kappa of 0.547. The total group of assessors had a kappa of 0.176.

**Conclusion:** This study showed poor agreement between assessors when applying the TASC II classification to infra-popliteal lesions on CTA. TASC II should not be used to classify lesions, for clinical or research purposes, with this image modality.

Keywords: TASC, CTA, agreement, kappa, angioplasty

**MANUSCRIPT**

**Introduction**

Multi-detector Computer Tomography Angiography (CTA) is used to assess peripheral arterial disease (PAD) prior to intervention, and for treatment planning, case performance and bypass graft or stent surveillance. CTA is often preferred over other imaging modalities as it is quick to obtain (10-15 minutes), allows multi-planar reconstruction, acquisition speeds of 30mm/sec and more, and is an accurate non-invasive diagnostic study (1). A meta-analysis of comparative studies showed 95% sensitivity and 91% specificity in detection of >50% stenosis or occlusion in tibial artery disease (2). Another review concluded that CTA has high diagnostic performance in evaluating PAD, but also noted the limitations in lumen evaluation of extensive calcified arteries, and that CTA is often less valuable in critical limb ischaemia due to extensive crural artery calcifications (3).

TASC II have recently updated their vascular lesion classification to include below-the-knee arteries (4).

The aim of this study was to investigate the reproducibility of TASC II for tibial artery disease, when assessed by CTA.

**Methods**

We performed a retrospective analysis of a series of CTAs on consecutive patients who, later, underwent percutaneous intervention for tibial artery disease at our centre. We asked 7 assessors to view each scan, and classify tibial artery lesions according to TASC II. As, ideally, ease of classifications should be consistent across a range of abilities, we included experienced consultant vascular surgeons and radiologists, and less experienced vascular trainee surgeons.

*Patients*

Infra-popliteal CTAs of 39 patients, who underwent tibial angioplasty between May 2014 and May 2015, were retrieved from the institutional digital imaging system. We excluded 9 because of severe calcification of the vessels which precluded analysis, as determined by a consultant radiologist external to the study (5).

Scanners were either dual source with 256-slice data acquisition, or single source with 64-slice data acquisition (SOMATOM CT scanner, Siemens, Berlin, Germany).

Each scan was performed using a standard protocol. The scan window was from the aortic bifurcation to the feet with a monitoring slice performed at the level of the mid abdominal aorta. A bolus of 100mls of Optiray 300 (ioversol) was administered via a 4-5mls/sec pump injection (Liebel-Flarsheim, Ohio, USA), with a 15 second monitoring delay, followed by a triggered start. Two mm thick, with 2mm increment slices were performed.

In one limb, the target vessels were those that, later, were chosen as targets for angioplasty. In the contralateral limb, the target vessel was chosen, by the first author, as the most diseased of the three. The target vessels were clearly conveyed to the assessors in a spreadsheet, which outlined patients’ identifiers, the date of the relevant scan, and target vessels.

*Measurements*

The assessors viewed the CTA images using Carestream software (CareStream Vue Picture Archiving and Communications System, version 11.4.1.0324). Each was familiar with the use of the software and required no further training. Workstations were standardised to screen resolutions of 1024x768 pixels, to minimise disparity between qualities of viewed images.

Assessors were allowed to use their own preferred technique to manipulate and analyse images, as this would replicate standard practice, and input the data into a spreadsheet. Each assessor was allowed to complete the measurements at his/her own pace.

*Statistical analysis*

Agreement between raters was assessed using Cohen’s weighted kappa statistics, with linear weights. For groups of more than 2 raters, kappa was calculated using the Berry-Mielke (6) Universal R coefficient of agreement, which is equivalent to linearly weighted kappa. Weighted kappa is categorised into poor, weak, moderate and good agreement, which are defined by values of 0.21-0.39, 0.40-0.59, 0.60-0.79 and 0.80-0.90, respectively.

**Results**

Seven assessors reviewed CTAs of 25 patients (20 men; mean age 72.9 years) performed between 29th May 2014 and 6th May 2015, with a total of 48 target vessels. Twelve patients were diabetic. Imaging was performed for critical limb ischaemia (CLI) in all patients, with 4 having evidence of ulceration.

In the right leg, the target arteries were the posterior tibial in 11 patients and the anterior tibial in 13. In the left leg, the target arteries were the posterior tibial in 9, the anterior tibial in 14, and the peroneal in one.

Figure 2 shows the classifications assigned by each assessor.

Four assessors found ambiguity in assigning some lesions to a class, and commented that the lesion would be appropriate for 2 classes. They eventually chose the class which they deemed most appropriate.

Two assessors found difficulty in analysis due to calcification of the vessel. This was not seen in other assessors.

The group of 7 raters had an overall kappa of 0.176, representing poor agreement. The kappa statistics for each pair of raters are shown in Table 1.

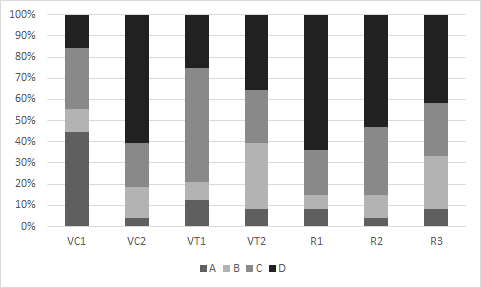


Figure 1 TASC II classification by individual raters. VC = Vascular consultants. VT = Vascular trainees. R = Radiologists.

Table 1 Individual pairs’ agreement in TASC II classifiction

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Vascular consultants** | | **Vascular trainees** | | **Radiologists** | | |
|  |  | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **Vascular consultants** | **1** |  | 0.094 | 0.064 | 0.083 | 0.021 | 0.124 | -0.065 |
| **2** | 0.094 |  | 0.188 | 0.385 | 0.579 | 0.563 | 0.434 |
| **Vascular trainees** | **3** | 0.064 | 0.188 |  | 0.091 | 0.275 | 0.232 | 0.126 |
| **4** | 0.083 | 0.385 | 0.091 |  | 0.34 | 0.436 | 0.505 |
| **Radiologists** | **5** | 0.021 | 0.579 | 0.275 | 0.340 |  | 0.484 | 0.538 |
| **6** | 0.124 | 0.563 | 0.232 | 0.436 | 0.484 |  | 0.500 |
| **7** | -0.065 | 0.434 | 0.126 | 0.505 | 0.538 | 0.500 |  |

Agreement between the two vascular consultants and the two vascular trainees was poor (kappa=0.094 and 0.091 respectively). Agreement among the three radiologists was weak (kappa=0.547).

**Discussion**

A standardised classification for tibial artery disease should allow uniformity in reporting, both for clinical and research purposes. This study shows there is poor agreement amongst assessors reviewing CTAs when the TASC II classification is used. Even radiologists displayed only weak agreement in classifying tibial lesions. In contrast to previous studies (2), our results suggest that either CTA is inadequate for the assessment of occlusive tibial artery disease, or that the TASC II classification is not reproducible, when used for tibial lesions. Our scans were obtained with 2mm thickness slices. However, the real acquisition with our 64-channel helical machine is submillimetric, excluding our technique as a reason for poor agreement.

A study observing accuracy of CT in diabetes mellitus showed dual energy CT able to identify critical stenosis with a high sensitivity and good specificity using curved multiplanar reconstruction (100 % and 93.1 %, respectively) and maximum intensity projection images (99 % and 91.8 %, respectively) (7). A meta-analysis looking at accuracy of CTAs concluded sensitivity and specificity, in lower extremity arterial disease (>50% stenosis), of 92% and 93% respectively (8).

Limitations of the study included a small population size in a single centre. The number of assessors was small.

However, if the findings of this study are confirmed, TASC II should not be used to classify tibial artery disease on CTAs.

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References:

1. Fleischmann D, Hallett R, Rubin G. CT Angiography of Periperal Arterial Disease. *J Vasc Interv Radiol* 2006;17:3-26.
2. Met R, Bipat S, Legemate DA et al. Diagnostic Performance of Computed Tomography Angiography in Peripheral Arterial Disease: A systematic review and meta-analysis. *JAMA* 2009;301:415-424.
3. Kock MCJM, Dijkshoorn M, Pattynama P et al. Multi-detector row computed tomography angiography of peripheral arterial disease. *Eur Radiol* 2007;12:3208-3222.
4. TASC Steering Committee, Jaff MR, White CJ, Hiatt WR et al. An Update on Methods for Revascularization and Expansion of the TASC Lesion Classification to Include Below-the-Knee Arteries: A Supplement to the Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). *J Endovasc Ther* 2015;22:663-77.
5. Pollak AW, Norton MP, Christopher M et al. Multimodality Imaging of Lower Extremity Peripheral Arterial Disease: Current Role and Future Directions. *Circ Cardiovasc Imaging.* 2012;5:797–807.
6. Berry KJ, Mielke PW. Weighted kappa for multiple raters. *Perceptual and Motor Skills* 2008;107:837-848.
7. Schabel C, Bongers MN, Ketelsen D et al. Diagnostic accuracy of dual energy CT angiography in patients with diabetes mellitus. *Radiologe* 2015;55:314-22.
8. Heijenbrok-Kal MH, Kock MC, Hunink MG. Lower Extremity Arterial Disease: Multidetector CT Angiography—Meta-Analysis. *Radiology* 2007;245:433-9.