Multidetector CT or MR angiography before endovascular peripheral arterial intervention?

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Aims and objectives

Multidetector CT angiography (MDCTA) and MR angiography (MRA) have replaced in clinical practice diagnostic DSA angiography [1], thus becoming the standard diagnostic modalities in selecting patients with peripheral arterial disease (PAD) for surgical or endovascular intervention [2].

No evidence-based indications are available for patients suitable for both techniques.

Peripheral arterial disease is more prevalent in the femoral and popliteal arteries (80-90% of symptomatic patients), tibial and peroneal arteries (40-50% of symptomatic patients), than in the aorta and iliac artery (30% of symptomatic patients)[3].

Main purpose of the study was to assess the accuracy of MDCTA vs MRA to identify the degree of impairment of the peripheral arterial tree in patients with PAD candidates for endovascular treatment.

We evaluated also the accuracy for classifying patients according to the TASC grading for aorto-iliac and femoro-popliteal and following an "ad hoc" score for infrapopliteal segments, which in last years have become a frequent target of selective and combined endovascular treatment.

Secondary objectives of the study were the assessment of the degree of reliability of both techniques for the evaluation of the arterial tree and the analysis of time consumption of both techniques.
Methods and materials

Informed written consent from patients and approval of the study from the local ethical board were obtained.

In 16 months 35 consecutive patients (20 M, 15 F, mean age 76 years; range 59-87) with PAD selected for possible treatment (Fontaine stage II n° 7 patients; stage III n° 8 and stage IV n° 12) were prospectively enrolled and undertook MDCTA, using 64-slices multidetector CT (LightSpeed VCT, General Electric Healthcare, Waukesha, United States). Slice thickness was 1.25 mm, table speed 11 cm/sec (gantry rotation time 0.5s), field of view (FOV) 40 cm in order to match patient width, matrix size 512x512. Tube voltage was 120 kVp, with Smart mAs dose enabled (noise index set to 22), and Gadolinium subtracted three-station bolus-chase MRA plus time resolved acquisition on the calves (Signa Echospeed 1.5T, General Electric Healthcare), within 30 days before the endovascular treatment (Integris Allura Xper FD 20, Philips, Eindhoven, Netherlands). Inclusion criteria for the study were known PAD lasting at least 6 months and age >18 years.

Exclusion criteria were contraindications to endovascular treatment; previous stent implantation in the target limb; woman in reproductive age with contraindications to MDCTA end/or to MRA (Creatinine clearance <40 ml/min; iodine allergy; claustrophobia; pace-makers, ferromagnetic implants, neurostimulators).

For each arterial segment was blinded assessed at MDCTA and MRA the degree of impairment (from 1 to 4) following a score (Tab. 1) modified from a score proposed by Rutherford [4]. To evaluate diagnostic reliability we adopted a score from 1 to 3 (1 poor; 2 moderate; 3 good).
<table>
<thead>
<tr>
<th>Score</th>
<th>Type of lesion</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>No &gt;50% stenosis</td>
</tr>
<tr>
<td>1</td>
<td>Single &gt; 50% stenosis</td>
</tr>
<tr>
<td>2</td>
<td>Multiple &gt;50% stenoses or Single &lt;5 cm occlusion</td>
</tr>
<tr>
<td>3</td>
<td>Single &gt;5 cm occlusion or Multiple &lt;5 cm occlusions</td>
</tr>
<tr>
<td>4</td>
<td>Multiple &gt;5 cm occlusion or Total occlusion</td>
</tr>
</tbody>
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**Table 1:** Score for assessment of single arterial segment impairment (modified from Rutherford).

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Results

Thirty-two successful procedures were performed in 35 limbs. In 3 patients the endovascular recanalization of the target arterial segment was ineffective (in all cases we founded a long calcified occlusion of tibial arteries with impossibility to achieve an endoluminal recanalization and endoluminal re-entry after attempt of subintimal recanalization). Sites of revascularization were iliac arteries in 8 patients; the femoropopliteal district in 15 and infrapopliteal arteries in 27.

Thirty-five limbs for 330 arterial segments were studied at pre-treatment selective DSA and resulted available for the analysis of MDCTA vs MRA (Fig. 1,2). The distribution of segments was: 54 iliac; 82 femoro-popliteal and 194 above the knee. Significant stenoses or occlusions were detected at DSA in 128 segments. Venous contamination limiting (confidence degree 1) an optimal evaluation of above the knee arteries was founded in 1 case at MDCT and in 2 cases at MRA. Diffuse calcifications of tibial arteries were founded in 11 limbs at MDCTA.

A per-segment analysis was performed to assess the accuracy of MDCTA vs MRA in evaluating the exact degree of impairment of each segment and a pooled analysis was performed for iliac, femoro-popliteal and infrapopliteal segments (Tab. 2).

Overall accuracy of MDCTA was 0.94 (95% confidence interval 0.90-0.96) and accuracy for MRA was 0.92 (95% confidence interval 0.88-0.94)(p>0.05).

Accuracy for iliac segments was 0.98 for MDCTA (95% confidence interval 0.90-0.99) and 0.95 for MRA (95% confidence interval 0.84-0.98) (p>0.05).

Accuracy for femoro-popliteal segments was 0.95 for MDCTA (95% confidence interval 0.88-0.98) and 0.91 for MRA (95% confidence interval 0.83-0.95) (p>0.05).

Accuracy for infrapopliteal segments was 0.92 for MDCTA (95% confidence interval 0.87-0.94) and 0.85 for MRA (95% confidence interval 0.79-0.89) (p=0.02).

For runoff arteries results of the standard MRA sequences plus time resolved acquisitions were also compared to standard acquisitions (Tab. 2).

At per region analysis (Tab. 3) the accuracy for stratification of patients according to TASC classification was the same for MDCTA and MRA for iliac district: 0.92 (95% confidence interval 0.66-0.98; P=0.43). In the femoro-popliteal region MDCTA (accuracy 0.94; 95% confidence interval 0.77-0.99) resulted slightly more accurate than MRA (accuracy 0.9; 95% confidence interval 0.68-0.98) without significant statistical difference (P=0.08).

Regarding the accuracy for the assessment of infrapopliteal region a difference at the statistical limit (P=0.04) was founded between MDCTA (accuracy 0.96; 95% confidence interval 0.84-0.99) and MRA (accuracy 0.90; 95% confidence interval 0.76-0.96).
The mean diagnostic confidence was 2.91 for MDCTA and 2.67 for MRA (P<0.00001) (Tab. 4) with a difference particularly evident in the runoff arteries, while no significant differences were detected in iliac and femoro-popliteal segments.

The mean scanning time (Tab. 5) was 9±2 min for MDCTA and 33±4 min for MRA and the overall examination time was 29±4 min for MDCTA and 43±6 min for MRA, with a statistical significant advantage for MDCTA (p<0.01).
Fig. 1: Sixty-two years-old diabetic man with left toe ulcer. Comparison of MIP MDCTA (A) and MRA (B) reconstructions. Only segments evaluated with the reference technique (DSA, C) were included in the study and evaluated at MDCTA and MRA (dashed box).

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Fig. 2: Close up vision of infrapopliteal arteries. A good correlation is evident between MDCTA (A) and MRA (B) with respect to DSA (C). The focal stenosis of anterior tibial artery is correctly depicted by both techniques before endovascular treatment (D) (0.014" guidewire and dilation by 2.5 mm over the wire balloon).

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Table 2: Per segment analysis of accuracy of MDCTA vs MRA (standard protocol +tricks sequences on calves and feet and standard protocol alone) for assessment of the degree of impairment in each segment. (TOT=total; ILI=iliac; FP=femoro-popliteal; IP=infrapopliteal; ST=standard protocol ; TR=tricks sequences)

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**Table 3:** Per limb analysis of accuracy of MDCTA vs MRA to identify correct TASC II classification (iliac and femoro-popliteal) and "ad hoc" infrapopliteal score. (ILI=iliac; FP=femoro-popliteal; IP=infrapopliteal)

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![Diagnostic Confidence Chart](image)

**Table 4:** Per segment diagnostic confidence of MDCTA vs MRA. (TOT=total; ILI=iliac; FP=femoro-popliteal; IP=infrapopliteal)

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Table 5: Comparative evaluation of time expense (min.) of MDCTA vs MRA

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Conclusion

In conclusion both MDCTA and MRA resulted, in our experience, adequate for stratification of patients according to the TASC classification for iliac and femoro-popliteal regions, without significant differences, while a slight superior accuracy was found for MDCTA in the assessment of run-off segments.

In the evaluation of the exact degree of impairment of arterial segments MDCTA resulted significantly more accurate than MRA in the infrapopliteal segments, with a superior degree of reliability.

According to our results we could suggest the preferential use of MDCTA when clinical history (Fontaine III or IV) or previous instrumental evaluation are indicative of diffuse steno-occlusive involvement of the infrapopliteal district.

Significant differences were found in time consumption of MDCTA vs MRA: the shorter execution time for MDCTA makes this technique more adequate for patients with rest pain and limited compliance to a prolonged immobilization.

Only the additional time resolved sequences on calves and feet permitted an adequate overall accuracy of MRA examination and, according to our experience, if MDCTA is contraindicated such sequences should be part of the standard MRA protocol to avoid venous contamination in patients with suspected diffuse infrapopliteal involvement or in diabetic patients.
References


4. Rutherford RB, Baker JD, Ernst C, at al.