“CO2 angiography guided interventions in critical limb ischemia: how to do it?”

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Disclosure

Speaker name: Luis Mariano Palena

I have the following potential conflicts of interest to report:

☒ Consulting ANGIODROID
☐ Employment in industry
☐ Stockholder of a healthcare company
☐ Owner of a healthcare company
☐ Other(s)

☐ I do not have any potential conflict of interest
Peripheral diagnostic and interventional procedures using an automated injection system for carbon dioxide (CO2): case series and learning curve

Carbon Dioxide Digital Subtraction Angiography (CO2 DSA): A Comprehensive User Guide for All Operators

Automated Carbon Dioxide Digital Angiography for Lower-Limb Arterial Disease Evaluation: Safety Assessment and Comparison With Standard Iodinated Contrast Media Angiography
Automated Carbon Dioxide Angiography for the Evaluation and Endovascular Treatment of Diabetic Patients With Critical Limb Ischemia

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Automated Carbon Dioxide Angiography for the Evaluation and Endovascular Treatment of Diabetic Patients with Critical Limb Ischemia.

Abstract

Purpose. To test the safety, efficacy, and diagnostic accuracy of Automated Carbon Dioxide (CO₂) Angiography (ACDA) for the evaluation and endovascular treatment with angioplasty (PTA), of diabetic patients with critical limb ischemia (CLI) and baseline renal insufficiency.

Methods. From November 2014 to January 2015, 36 consecutive diabetic patients (27 men; mean age 74.84 ± 5.82 years) with stage ≥ 3 chronic kidney disease (CKD ≥3) and CLI underwent lower limb angiography with both CO₂ and iodinated contrast medium (ICM) followed by PTA, in a prospective, single-center study. The primary end-point was to evaluate the safety and efficacy of ACDA as the exclusive agent utilized to guide PTA in this cohort. The secondary end-points were the safety and diagnostic accuracy of ACDA injection as compared with ICM digital subtraction angiography (DSA) for the invasive evaluation of these patients.

Results. All patients underwent selective diagnostic angiography with CO₂ and then with ICM, followed by endovascular revascularization. The primary endpoint was achieved in 100% of the patients: ACDA successfully guided PTA, without complications. TcPO₂ improved from 11.8 ± 6.3 mmHg to 58.4 ± 7.6 mmHg (p < 0.0001). Secondary endpoints: there were no complications related to ACDA during diagnostic imaging. There were no significant changes in eGFR from baseline to 24-hours follow-up (44.75 ± 13.31 vs. 47.02 ± 0.84 mL/min/1.73 m², p=NS). The diagnostic accuracy of CO₂ was 89.9% (sensitivity: 92.3%; specificity: 75%; positive predictive value: 95.5%; negative predictive value: 63.1%). There was no statistically significant difference in the qualitative diagnostic accuracy of both media (p=0.197).

Conclusions. ACDA is an accurate, safe and efficacious technique that can be utilized to guide endovascular interventions in diabetics with CLI and baseline CKD ≥ 3. Larger multicenter, randomized studies are needed to validate the results of this single center prospective study.
How I do It?

Technical strategy

# Antegrade access in di CFA
# 6F short sheath (11 cm)
# Single use Kit, directly connected to the sheath
How I do It?

Technical strategy

[Images and diagrams related to medical equipment and procedures]
# Purpose 1:
To compare diagnostic accuracy with ICM
# Purpose 2:
The endovascular treatment using only CO$_2$
56 Y-O Female, Obesity, Diabetes, Dislipidemia, Hypertension, CKD, Atrial Fibrillation. CLI TcPO2: 21 mmHg. WIFI 3,3,2. Plantar Flegmon on the right foot
The table describes the diagnostic accuracy of the contrast in terms of the categorical scale evaluated by two independent observers (*Kruskal Wallis).

<table>
<thead>
<tr>
<th>Score</th>
<th>CO₂</th>
<th>ICM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>38.8% (14/36)</td>
<td>50% (18/36)</td>
</tr>
<tr>
<td>Good</td>
<td>44.4% (16/36)</td>
<td>44.4% (16/36)</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>16.6% (6/36)</td>
<td>5.6% (2/36)</td>
</tr>
<tr>
<td>Uns. repeated</td>
<td>0.0% (0/36)</td>
<td>0.0% (0/36)</td>
</tr>
</tbody>
</table>

\[ p^* = 0.197 \]
**CO₂ DSA Data:**
Quantitative Diagnostic Accuracy – Injected Volumens

<table>
<thead>
<tr>
<th>Table 3. Quantitative Diagnostic Accuracy.</th>
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</thead>
<tbody>
<tr>
<td><strong>ATK, %</strong></td>
</tr>
<tr>
<td>Sensitivity</td>
</tr>
<tr>
<td>Specificity</td>
</tr>
<tr>
<td>PPV</td>
</tr>
<tr>
<td>NPV</td>
</tr>
<tr>
<td>Accuracy</td>
</tr>
</tbody>
</table>

Abbreviations: ATK, above the knee; BTK, below the knee; NPV, negative predictive value.

<table>
<thead>
<tr>
<th>Table 4. Injected Volumes</th>
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</thead>
<tbody>
<tr>
<td>Arterial System</td>
</tr>
<tr>
<td>Genicular + Prox Tibial</td>
</tr>
<tr>
<td>Distal Tibial</td>
</tr>
<tr>
<td>Foot (AP)</td>
</tr>
<tr>
<td>Foot (Lateral)</td>
</tr>
</tbody>
</table>

Abbreviations: CO₂, carbon dioxide; P, popliteal.

Data presented as mean ± standard deviation.
How I do it today?

- Standard technique:
  ① Fix *Pressure* injection: 120 mmHg (Not considering the systolic pressure. Low pressure reduce PAIN sensation.
  ② Fix *Volume* : 20 cc. Low volume reduce PAIN sensation
  ① Less PAIN sensation : LESS Movement
CO₂ DSA Limits

Forefoot Movements

Movement

No Movement
Current Experience
DEVELOPMENT OF THE ACDA PRACTICE

September – December 2018
137 total cases
21 patients with clear indications for CO₂
33/137 (24%) total cases with CO₂
Average ICM per patient: 110 ml
Total ICM consumption: 15.1 L

September – December 2019
163 total cases
33 patients with clear indications for CO₂
132/163 (81%) total cases with CO₂
Average ICM per patient: 38.9 ml
Total ICM consumption: 6.3 L
58% reduction of ICM used
Current Experience
DEVELOPMENT OF THE ACDA PRACTICE

Procedures with CO₂

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>20%</td>
</tr>
<tr>
<td>2018</td>
<td>24%</td>
</tr>
<tr>
<td>2019</td>
<td>81%</td>
</tr>
</tbody>
</table>

Maria Cecilia Hospital

GVM CARE & RESEARCH
CO$_2$ DSA: Conclusions

# CO$_2$ appear a safe and useful contrast agent for DSA in CLI patients

# Provide high quality images with excellent diagnostic accuracy

# Useful for endovascular treatment of CLI, avoiding or reducing ICM agents

# Pressure injection and volume need to be correctly set up to reduce pain and leg movements

# Today CO2 DSA is our “STANDARD OF CARE” in CLI patients
THANK YOU VERY MUCH