Percutaneous Deep Venous Arterialisation (DVA) – An Introduction, Clinical Follow-up and Pipeline

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Disclosure

Speaker name:

I have the following potential conflicts of interest to report:

- [ ] Consulting
- [ ] Employment in industry
- [ ] Stockholder of a healthcare company
- [ ] Owner of a healthcare company
- [ ] Other(s)

- [ ] I do not have any potential conflict of interest
Disclosure

• Workshop/Speaker Honourarium: Medtronic, Covidien, Cook, Biotronik, Abbott, Straub Medical, Boston Scientific, Bard
• Consultancy: MdStart/Limflow, KCI Medical
• The LimFlow device is investigational
• The use of off label devices in this presentation should not be construed as an endorsement
• Minor equity for method and device patents related to LimFlow
What are the current unmet needs and solutions?

**Problem**

1. No distal runoff/small target vessels aka the “DESSERT FOOT”
2. Unable to revascularize Direct Angiosome
3. Recoil/Calcium
4. Clinically relevant restenosis

**Current Solutions**

- Distal vessel angioplasty
- TMA or Choparts
- Plantar loop technique
- Retrograde angioplasty
- Better Stents
- Arterectomy
- PIERCE Technique
- DEB, DES
- Early wound closure and SSG
Concept of Deep Venous Arteriolisation (DVA) in other Vascular beds

Can we perfuse tissues by routeing blood the other way??
Coronary venous retroperfusion: an old concept, a new approach

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The Cutaneous Microvascular Architecture of Human Diabetic Toe Studied by Corrosion Casting and Scanning Electron Microscopy Analysis

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3Department of Orthopaedics and Trauma Sciences, University of Insubria, Varese, Italy

ABSTRACT

In this morphological study, we report on the three-dimensional microvascular architecture constituting the toes of a patient affected by diabetic microangiopathy. We applied corrosion casting (CC) technique to the

Scheme 2. Graphical representation of vascular layer constituting the human toe skin: dermal layer (dl), with big arteries (aa) and veins (vv); subepidermal layer (sl) characterized by arterioles (al) and venules (vl); papillary layer (pl) characterized by vascular villi made up of an ascending branch (ab) and a descending branch (db).
Numerous open procedures..some with endovascular augmentation

- 26 patients
- 19 (73%) had complete wound healing & no rest pain within 6 months
- At 24 months, 87% survival, 76% Limb Salvage
Meta-analysis of the Clinical Effectiveness of Venous Arterialization for Salvage of Critically Ischaemic Limbs

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Departments of ¹Surgery, and ²Clinical Epidemiology and Biostatistics, Academic Medical Center, Amsterdam, The Netherlands

Objective. The aim of this study is to assess the clinical effectiveness of venous arterialization in patients with critical limb ischaemia not reconstructable by conventional bypass.


Materials. Eligible studies concerning treatment by venous arterialization for chronic critical leg ischaemia were identified from electronic database, cross-reference search and pertinent articles. There was no language restriction.

Methods. All relevant studies were systematically reviewed and data extracted by two independent reviewers. Study endpoints were foot preservation, secondary graft patency, postoperative clinical improvement and complications.

Results. A total of 56 studies were selected for comprehensive review. No RCTs were identified. Seven patient series, comprising 228 patients, matched the selection criteria. Overall 1-year foot preservation was 71% (95% CI: 64–77%) and 1-year secondary patency was 46% (95% CI: 39–53%). The large majority of patients in whom major amputation was avoided experienced successful wound healing, disappearance of rest pain and absence of serious complications.

Conclusion. On the basis of limited evidence, venous arterialization may be considered as a viable alternative before major amputation is undertaken in patients with ‘inoperable’ chronic critical leg ischaemia.
COMPLETE
ENDOVASCULAR APPROACH?
One of our Initial Attempts

Operators:
Steven Kum
Andrej Schmidt
Tan Yih Kai

Pre and Post iFlow

Day 92
Clinical Trial

• Prospective Single Centre (Changi General Hospital, Singapore)
• Ethics Review Board Approved
• Rutherford 5 and 6
• 7 Patients, Clinical Follow-up
• Objective and Subjective measures of Perfusion + Wound outcomes
LimFlow: CLI Treatment

- Technology would include:
  - 2 catheters for positioning (artery & vein)
  - Needle with wire
  - Covered stent
  - Valvulotome
LimFlow: Review of Procedure

- Ultrasound Receive catheter
- Ultrasound send catheter

1. Retrograde insertion of Receive catheter into target vein
2. Insertion of Send catheter into artery and orientation
3. Crossover and insertion of GW
4. Predil and insertion of covered stent
LimFlow Reversed OTW Valvulotome
Animation of the Procedure
A Recent LimFlow Patient..

60 Male, DM, Hyperlipidemia, Renal Impairment, Smoker x 40 years (recently quit), IHD with Cath 2014 ➔ diffuse disease, EF 55% SWMA
# Clinical Course

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<th>Procedure</th>
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<th>Clinical Result</th>
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Attempted Retrograde DP under USG and Fluoro failed

The “Desert” Foot
LimFlow 5

PT Artery

PT Vein
Popliteal Block and Sedation

- Popliteal Block + Saphenous nerve block
- Blocking the sciatic nerve at level of popliteal fossa
- Achieves *Anaesthesia* for 4 hrs of entire distal 2/3 of lower leg and *Analgesia* for 24 hrs (Marcaine and Lignocaine used)
Antegrade 7 x 55 COOK Flexor Sheath
Torniquet above the knee
Retrograde 5F access under US
Retrograde puncture under Ultrasound
(Longitudinal section view)
Retrograde 5F Sheath Insertion
over Supracore
Double injection
The ‘A’ Catheter (Send)

Slider pushes needle out

Insertion Port for 0.014 Cross Wire

Monorail Design
Advancing the 7F “A” catheter
‘V’ Catheter (Receive)
Advancing the 5F “V” catheter
Aligning the Catheters (Rotation + Depth)
Contrast injection into vein

0.014 Spartacore wire pre-positioned
Aligning the Catheters
(Rotation + Depth)
Wire into sheath

Crossover point
Sending Spartacore across puncture site
Injection thru CXI and change for V18
3mm Pacific

Crossover point
Unable to disrupt Valve with POBA @ High Pressure

4 x 60 Pacific

5 x 20 REEF

20 ATM

26 ATM
5F Reverse Valvulotome over V18
5 x 60 Pacific finally Effaced

20 ATM
Balloon Mounted Covered stent

5 x 38

Crossover point
5mm Self Expanding Covered Stent
Post Dil

Crossover point
Final Runs

Crossover point
Final Runs and iFlow
Simultaneous Debridement
Post op
Day 12

Preop
Day 20 - SSG
Day 27
Flow on PW Doppler
Summary of Experience - Angiographic

LimFlow No. 5

LimFlow No. 3
Summary of Experience – Objective Measurement of Perfusion with TCPO2
Summary of Experience – Wound Healing & FLIR Thermography

LimFlow No. 4

LimFlow No. 3
Summary of Experience – Wound Healing & FLIR Thermography

Pre LimFlow
No. 1

LimFlow No. 1
Re-Intervention

LimFlow Patient 4

4 months after initial intervention
Re-intervention was not difficult
DEB to Plantar Arch and DP Vein
Post Rotarex and DEB
Post Rotarex and DEB
Summary of Experience

7 patients with DVA in total (5 with LimFlow Study)

• Clinical Performance
  – 3 wounds healed, 3 wounds granulating, 1 amputated due to infection
  – 2 out of 7 patients with Rest Pain – all resolved post op
  – All rising TCPO2s
  – FLIR Thermography shows improved skin temperature
  – 3 patients had re-interventions to maintain graft patency
  – 4 out of 5 still patent (longest is 6 months with no reintervention)

• Safety Indicators
  – Primary Safety: freedom from BTK MALE @ 30 days
    • All-cause death: 0/7
    • Above the ankle amputation: 0/7
    • Major re-intervention: 0/7
  – 1 amputation for Ostemyelitis of the Calcaneum from heel gangrene (but wound bled well on debridement)
  – 1 Death from pneumonia (94 years old) @ 6 months after index procedure
  – 2 myocardial leaks with insignificant bearing on clinical outcome
Lessons Learned

• There is a learning curve. Especially when dealing with veins (procedure time 90 min vs 4 hrs)
• The degree to which the full vein needs to be stented still being explored
• **Wound and post op care is critical**
  – Foot swelling ➔ need to nurse with foot elevated for a week
  – Fluid status – keep them dry
  – Infection
• Pilot study underway and will involve up to a total of 15 pts at 3 centers:
  – Changi General Hospital (Singapore) – Dr. Steven Kum/Tan Yih Kai
  – Univ. Leipzig (Germany) – Dr. Andrej Schmidt/Dierk Scheinert
  – Milan (Italy) – Dr. Roberto Ferraresi
• CE Mark of Full System in Q4 2015
  – Crossing Catheters
  – Conical Covered Crossing Stent
  – Ultrasound Alignment System
  – Percutaneous Reverse Valvulotome
LimFlow: Future Steps – FDA

- Pre-IDE submitted to FDA and accepted into “Early Feasibility Study” program
- First US Site will be Metro Health Hospital, Michigan – Dr. Jihad Mustapha
  - In discussions with FDA on pre-clinical testing plan
- Plan to enroll patients in Q3-4 2015
- Early discussion with FDA to be included in new program
  - “Expedited Access for Premarket Approval Medical Devices Intended for Unmet Medical Need for Life Threatening or Irreversibly Debilitating Diseases or Conditions”
Acknowledgements

• Fellow LimFlow investigators in Singapore, Leipzig and Milan:
  – Tan Yih Kai
  – Tang Tjun Yip
  – Andrej Schmidt
  – Dierk Scheinert
  – Roberto Ferraresi

• Folks at LimFlow/MdStart: Tim Lenihan, Gunnar Bock, Martin Rothman, Jan and Team

• Vlad Alexandrescu, Jihad Mustapha, Pramook
Thank You

www.LimFlow.com

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