Ethanol embolisation for the cure of complex AVM using the Yakes Classification System: 100 Consecutive AVM Cases

F Rohlffs, K Ivancev, R Vogelzang, W Yakes
Yakes Vascular Malformation Center, Denver, Colorado

Purpose
- To describe the efficacy of the Yakes Classification and its application
- To describe the angiographic outcome, cure rate and clinical correlation in patients with complex AVMs
- To describe associated treatment strategies depending on the Yakes Type angioarchitecture

Methods
- Retrospective Single Center (One Operator) Experience
- Included all AVM patients with minimum of 1 treatment in the period from April 2013 – October 2017
- All consecutive Yakes treatment sessions included
- Endovascular treatment of AVMs using ethanol augmented by coils

Methods
- Demographic Patient data, Previous Treatments
- Extent of AVM: Depth and Distribution
  - Extensive/Localized
- Type of AVM:
  - Yakes Type I
  - Yakes Type II a + b
  - Yakes Type III a + b
  - Yakes Type IV
  - Mixed / acquired
- Angiographic result + angiographic FU + treatment period
- Treatment Sessions
- Clinical result and Complications
- Clinical FU

Angiographic results were defined by expert consensus and based on following categories:
- 4: 100% Cured
- 3: 90 - 99% Markedly improved
- 2: 50 - 89% Improved
- 1: < 50% No change
- 0: Failure or Aggravation
Clinical results were defined by expert consensus and based on following categories:

- Complete resolution of symptoms
- Considerable reduction of symptoms
- Unchanged symptoms
- Worse

Methods

Number of patients included: 100, 55 treatment start before inclusion period (April 2013)

Gender: ♂ = 46, mean age at 1. treatment 32 years (range: 6 - 76 years)

Location:
- Right Arm/Shoulder 22
- Left Arm/Shoulder 22
- Trunk 17
- Right Leg 26
- Left Leg 13

Extend: Extensive: 77 / Localized: 23

56 previously failed treatments at other institution

Results

Yakes Type

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>IIa</th>
<th>VPD (Iib, IIIa, IIIb)</th>
<th>IV</th>
<th>mixed</th>
<th>acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>5</td>
<td>27</td>
<td>43</td>
<td>16</td>
<td>4</td>
</tr>
</tbody>
</table>

Angiographic Outcome:
4: 100% Cured: 49
3: 90-99% Markedly Improved: 23
2: 50-89% Improved: 19
1: < 50% No Change: 7
0: Failure or Aggravtion: 2

Clinical Outcome:
No Symptoms: 34
Reduced Symptoms: 47
Unchanged: 15
Worse: 4

Complications:
Major: 6
- Necrotizing fasciitis, eroding coils rectum pelvis, amputation x 3, Pulmonary Edema
Minor: 33
- Wounds, skin breakdown (healing)
No: 61

Failed previous treatments: 23 patients
No previous treatments: 26 patients
49 patients

Results

Yakes Type

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>IIa</th>
<th>VPD (Iib, IIIa, IIIb)</th>
<th>IV</th>
<th>mixed</th>
<th>acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>5</td>
<td>27</td>
<td>43</td>
<td>16</td>
<td>4</td>
</tr>
</tbody>
</table>

Cured Patients

Clinical Outcome:
No Symptoms: 30
- 1 patient unchanged due to additional VM (Type IV AVM)
- 1 patient with Type I AVM and continued pain
- 1 patient with Type IIIa AVM and continued pain, additional DVT

Reduced Symptoms: 16
Unchanged: 3
Complications:
Major: 2 (1 forefoot amputation, eroding coils rectum pelvis)
Minor: 13 (Wounds, skin breakdown (healing))
No: 34

Results
Cured Patients

Treatment Plan:
- Confirmation angiogram: 28
- Planned for confirmation Angiogram: 12
- Angiographically lost to FU: 9

Completely lost to FU:
- 7 no symptoms, 2 money
Clinical FU available: 2
No symptoms, so did not come back for FU angigram

8 patients were treated in 1 session
Number of treatment sessions: mean 11.7 (range 1 – 71)
Length of treatment period: mean 50 months (range 0 – 169 months), median 39 months
Mean FU after cure: 20 months (range 1 – 120 months)

Conclusion
- The Yakes Classification is highly effective also in extensive and complex AVMs
- The Yakes Classification is a safe guide to achieve high curative and low complication rates
- The Yakes AVM Classification System is superior to other Systems without use of ethanol
- Yakes Type IV AVMs appear to be more complex AVMs associated with longer treatment duration and higher numbers of treatment sessions