Glubran- 2 Acrylic Glue for Percutaneous Embolization of Intramuscular Vascular Malformations of Lower Limbs: Preliminary Experience

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Abstract: *Aims*: Vascular anomalies (VA) represent a heterogeneous and rare group of pathologies. Ethanol is considered the gold standard in endovascular embolization procedures, but its use exposes to the risk of major complications. Glubran-2 is a new glue agent, used mainly for catheter-based cerebral embolization. Our study reported preliminary experiences with a group of 13 patients treated for intramuscular VA of limbs with Glubran-2 solution by venous retrograde percutaneous embolization.

Methods: Through an Angiographic CT/MRI we selected 13 adult patients (6 males, 7 females), seven with limb AVMs and six with limb VM, all intramuscular. All patients reported pain and functional limitation as presenting symptoms. Glubran-2 was injected under fluoroscopic guidance through multiple percutaneous punctures, to cover the entire extension of the lesion.

Results: In the 6-month follow-up, all patients reported pain reduction, rapid recovery of function, favourable post-operative course and absence of major complications. Angio-RMI control was performed in all patients. It showed Glubran-2 in place and the exclusion of the malformation. Percutaneous retrograde embolization with Glubran-2 permanently excluded muscle malformations from circulation: only one embolization procedure was, in 12 of 13 patients, sufficient for a complete and definitive treatment. Rapid polymerization of Glubran-2 glue, after its injection, cancelled the risk of pulmonary embolisms and skin necrosis. Secondary surgical removal was never necessary to complete treatment of these deep muscle malformations.

Conclusions: This study showed that the percutaneous embolization technique with Glubran-2 glue can be considered favorable in the treatment of the VA of the limbs for its easier handling and promising outcome.

Keywords: Glubran-2, Acrylic glue, percutaneous embolization, arteriovenous malformations, venous malformations.

INTRODUCTION

Congenital vascular malformations (VMs) represent a heterogeneous group of pathologies of the vascular system, are classified as rare diseases, are characterized by different morpho-structural and functional aspects, are associated with variable severity and extension. Although it is difficult to identify a definite value, the incidence of these pathologies, in general population, is estimated to be approximately 1.5% [1].

These pathologies can affect vessels of any calibre and can be present in every distinct location of the human body: their common clinical feature is represented by the tendency to grow, with infiltration and compression of the surrounding tissues.

The VMs affecting the muscular areas of the limbs are relatively rare [1] and are present in one case out of eight (ratio of 1: 8) of all the vascular anomalies of the limbs, which are more frequently of the exclusively cutaneous and subcutaneous type.

Among all vascular malformations (Vas) sector, we have to distinguish between arterio-venous malformations (AVMs), characterized by anomalous communications between arterial and venous vessels, connected directly or through a particular network of vessels called "nidus", from pure venous malformations (VMs). Regardless of the presence of a "nidus" or of micro-macro-fistulas, AVMs are generally classified as "high flow" malformations characterized by afferent arteries and efferent discharge veins [2].

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VMs, which are instead, classified as "low flow" malformations, are the most frequently expressed of VAs followed by AVMs; they are congenital anomalies of venous system development caused by genetic mutations that occur in different stages of embryogenesis. The Hamburg classification system distinguishes between VMs of the main veins (defined as “truncular” lesions) and those localized in the tissues, distal to the main venous axes (defined as “extra-truncular” lesions) [3].

“Truncular” VMs induce significant haemodynamic effects on global circulation but they have low proliferative potential and therefore low risk of post-treatment recurrence. “Extra-truncular” VMs consist otherwise of undifferentiated mesenchymal vessels with a high proliferative potential, which represents the reason for their growing tendency and their high rate of post-treatment recurrence. At the same time, they often can produce compressive or infiltrative effects on surrounding anatomical structures [4].

Pain and functional limitations are always present and depend on the anatomical region affected. The presence of hypertrophic arteries that flow into one or more discharge veins, skipping the capillary bed, are typical of AVMs, causing distinct local pulsatility and hyperthermia. An increase in volume due to position changes is characteristic of the VMs [4].

Treatment of VA is considered particularly difficult and controversial in terms of the indications, timing, modalities, frequent recurrences and for their high risk of clinical worsening in cases of incomplete procedures [5].

In both AVMs and VMs, the chances of success from "en bloc" surgical removal are linked to surgical radicality [6], but in many cases it means an extensive tissue demolition and sometimes also dangerous blood loss. Indications for surgery are limited to small extension vascular anomalies, especially if they are localized in the skin and mucosal sites or, in the case of extension to the muscular plane, if they affect a single muscle [7-9].

Endovascular catheter-based therapy and percutaneous venous retrograde embolization are considered alternatives to surgery, or ancillary to surgical treatments. They are often considered the first choice of treatment for extended or surgically inaccessible vascular malformations [10] (Figure **1**).

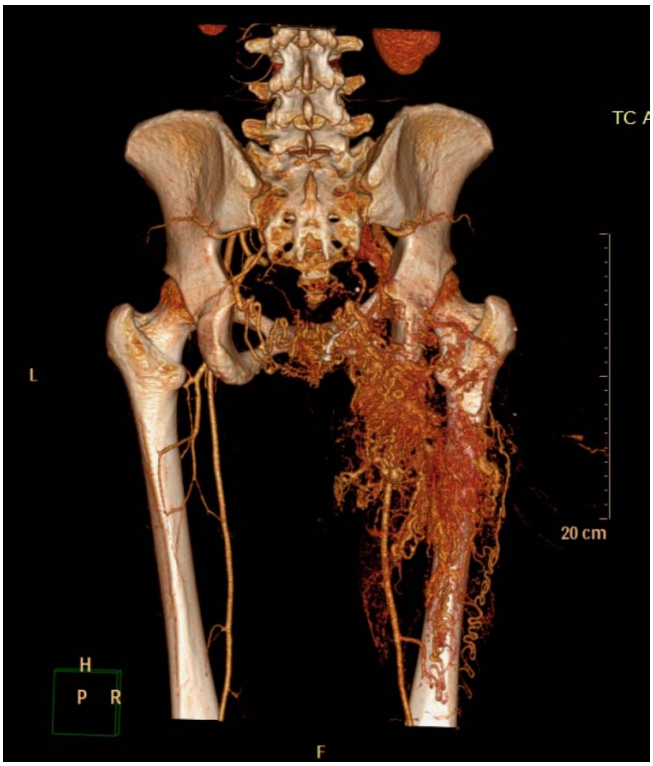


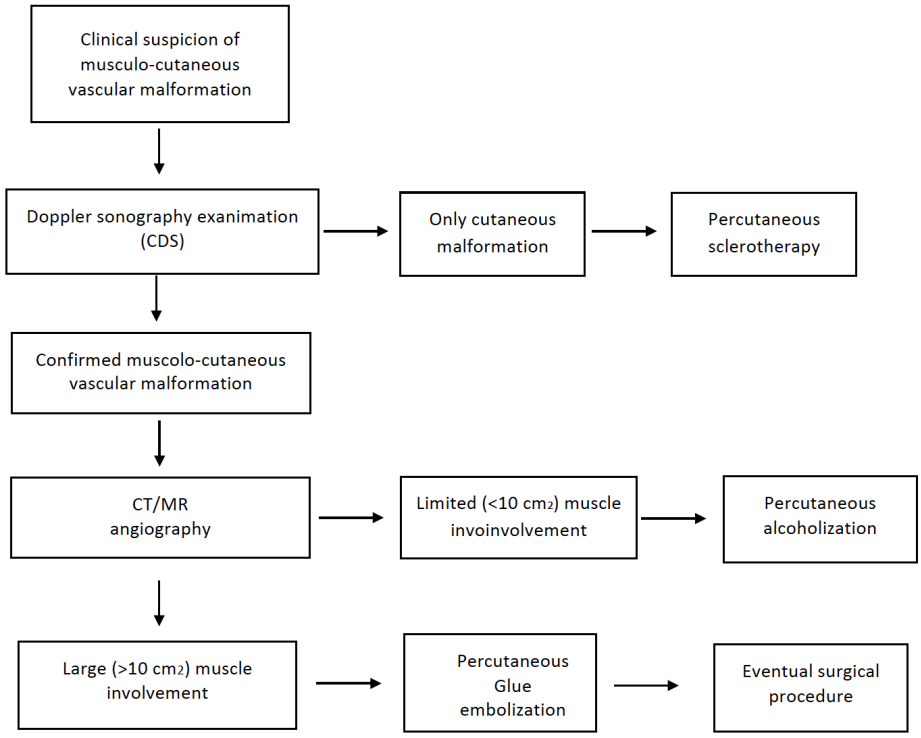
Figure 1: CT angiography of a large muscolo-cutaneous lesion involving the left thigh.

Ethanol at high concentrations has been used, for many years, to perform percutaneous alcoholization of both AVMs and VMs [10,11]. The effective efficacy of ethanol derived from the ability to deeply damage the vascular endothelium, inducing extensive inflammation and fibrosis of the vascular tissue which excludes blood circulation. However, the intravascular use of ethanol is associated with serious risks related to both its neurotoxicity (in the case of proximity of peripheral nerves to the treated vascular malformation), and to the tendency to induce skin necrosis or distal ischaemia due to the passage of ethanol in the peripheral arterial circulation [12-15].

Related to the complications induced by the use of ethanol in the treatment of AVMs and MVs, which is induced in small dosages, with the results of the incomplete radicality of the treatments, we introduced the use of Glubran-2 (GEM, Viareggio, Italy), a CE certified class III medical device, that is already used as a strong fast-acting adhesive agent for the embolization of cerebral AVMs and tumours and for the treatment of the most demanding peripheral vascular malformations (Table **1**) [16-18].

In the literature, the use of this substance has been described exclusively for the treatment of brain AVMs, and only in two extra-brain cases, with catheter-based

Table 1: Flowchart Strategy for Muscolo-Cutaneous Vascular Malformations



applications [18,19]. To date, there is no studies on the use of glue for the elective treatment of intramuscular VA of the limbs, with direct percutaneous application.

MATERIALS AND METHODS

We report an experience carried out at the Centre of Vascular Anomalies of the Guarnieri Clinic (Rome, Italy) on a selected series of patients with extensive AVMs and VMs of the lower limbs, with combined skin, muscle and tendon involvement.

From February 2019 to August 2019, 13 consecutive patients with intramuscular VA of the limbs (6 males and 7 females), aged between 18 and 44 (average age of 28.5 years), were enrolled in this prospective observational study: seven of these patients had an AVM and six of them a VM.

All patients underwent a diagnostic protocol characterized by colour Doppler sonography (CDS) and preoperative CT angiography or MR angiography, for the correct assessment of flow characteristics, as well as the extent and depth of the malformations in relation to the skin surface and muscle planes.

Pain and functional limitation were the most common symptoms. In most cases the affected body location was the lower limb: the gluteus (n = 2), the thigh (n = 4) and the leg (n = 6). Less frequently the upper limb was affected (n = 3). Accurate patient consent was obtained before each procedure.

A total of 14 percutaneous retrograde embolization procedures were performed (Table **2**). Only one patient received a second treatment, two months apart, due to the incomplete first result related to the large extension of his AVM.

All patients underwent a postoperative check with angio-magnetic resonance (MR) one month after each treatment (Figure **2**). In addition, a periodic (two, three and six months after each procedure) duplex ultrasound follow-up was performed.

The primary end point of this study was to evaluate the glue's ability to achieve remission of vascular malformations and their symptoms, through a percutaneous venous retrograde injection procedure.

TECHNIQUE

All embolization procedures were performed under epidural anaesthesia. During the operation, single or multiple percutaneous punctures were performed under ultrasound guidance, with 21 G needles, directly in the VM or in the “nidus” of the AVM.

Table 2: Synoptic Table of Patients, with Indication of Age, Sex, Type and Location of Vascular Malformation, Number of Procedures Performed, Quantity of the Product used and its Dilution

Patient No.	Age (years)	Gender	Type of vascular malformation	Location	Number of procedures	Volume of Glubran-2 (mL)	Ratio Glubran-2: Lipiodol
1	34	M	Venous	Thigh + gluteus	1+1	5+4	1:2
2	18	F	Arteriovenous	Thigh + gluteus	1	3	1:2
3	23	M	Arteriovenous	gastrocnemius	1	1	1:1
4	44	F	Arteriovenous	gastrocnemius	1	2	1:1,5
5	20	F	Arteriovenous	gastrocnemius	1	2	1:1
6	25	M	Venous	Thigh + pelvis	1	3	1:2
7	25	F	Arterovenous	gastrocnemius	1	1	1:1
8	34	M	Arterovenous	thigh	1	4	1:2,5
9	41	M	Venous	arm	1	1	1:1,5
10	31	M	Venous	thigh	1	2	1:2
11	43	F	Venous	thigh	1	2	1:1
12	26	F	Venous	gastrocnemius	1	3	1:1
13	41	F	Arterovenous	thigh	1	3	1:1,2

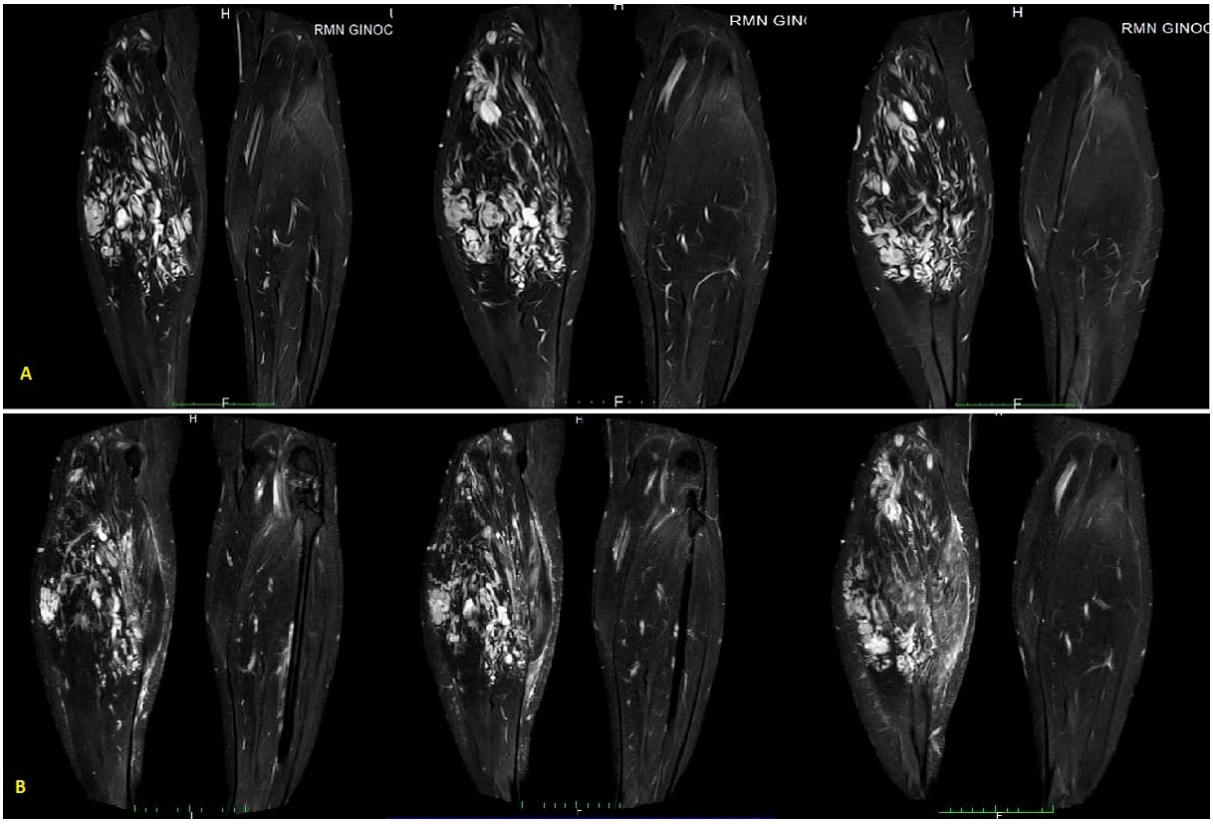


Figure 2: MR angiography of vascular malformation before (**A**) and one month (**B**) after treatment treatment of percutaneous embolization with Glubran-2.

Previous fluoroscopy was performed in all cases to evaluate extension, arterial in-flow, venous out-flow, AV fistulas and "nidus" in the case of AVM (Figure **3**).

Subsequently, complete vascular exclusion was obtained by the percutaneous injection of acrylic glue (Glubran-2 GEM, Viareggio, Italy), a co-monomer glue

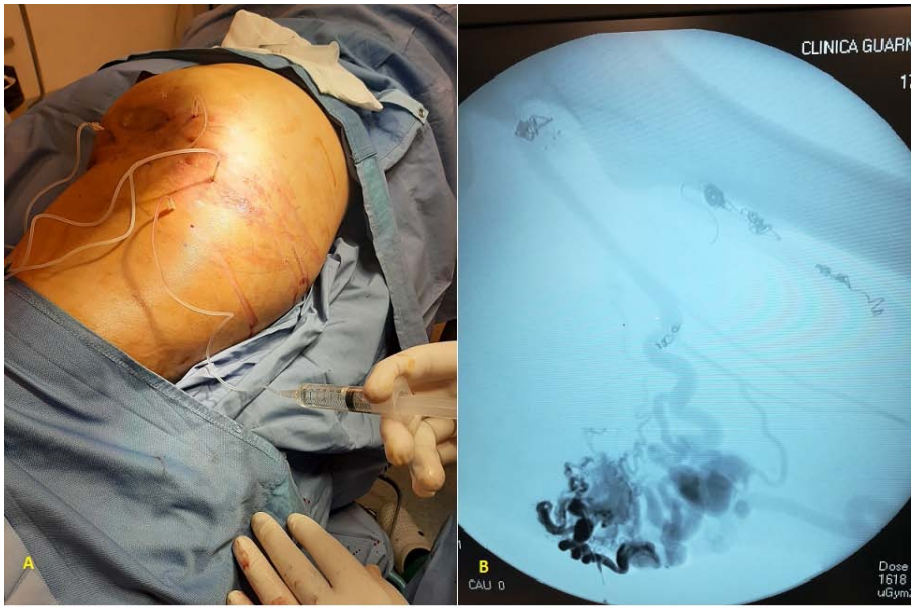


Figure 3: Intra-operative imaging (**A**) and intraoperative fluoroscopic control (**B**) of percutaneous embolization procedure.

consisting of N-butyl-2-cyanoacrylate monomer (NBCA) and methacryloxysulfolane monomer (MS). This occlusive agent had to be previously mixed in solution with Lipiodol (Guerbet, Villepinte, France), an iodized oil, to enable its fluoroscopic visualization and slow down its polymerization time (Figure **4**). The amount of solution and the dilution ratio were calculated and recorded for each patient (Table **2**) based on the size of the malformations and the time required for its polymerization.

Embolization was performed using a continuous injection of Glubran-2 acrylic glue in an amount between 1 and 5 ml. per patient (average of 2.5 ml), diluted with Lipiodol into a ratio ranging from 1: 1 to 1: 3.

Immediately before and after percutaneous injection the catheter was washed with 33% glucose solution. The solution was then injected under fluoroscopic guidance through multiple percutaneous punctures to cover the entire extension of the malformation (Figure **5**).

The procedure was then concluded by applying an elastic bandage on the affected limb.

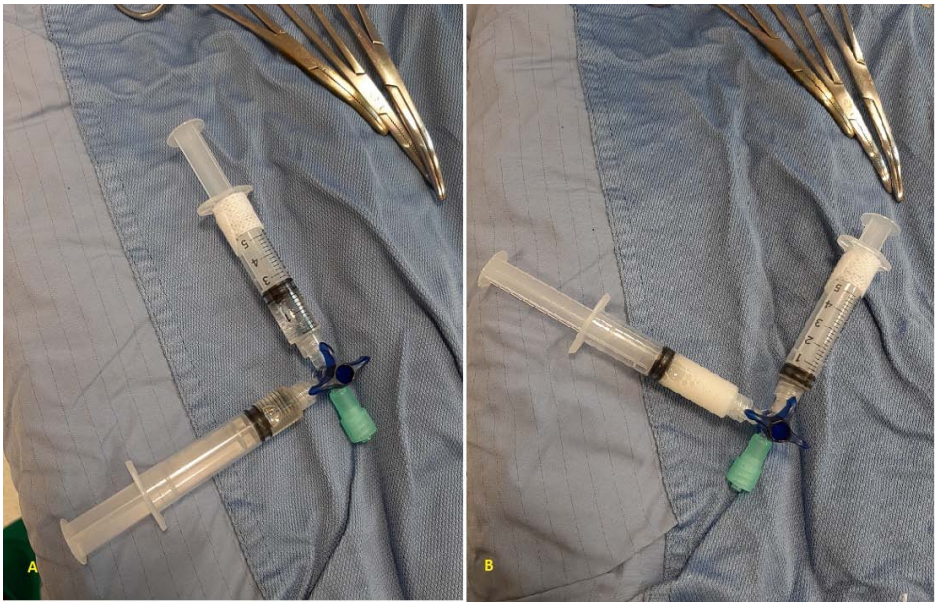


Figure 4: Dilution procedure of curing agent (Glubran-2) with Lipiodol (for fluoroscopic visualization).

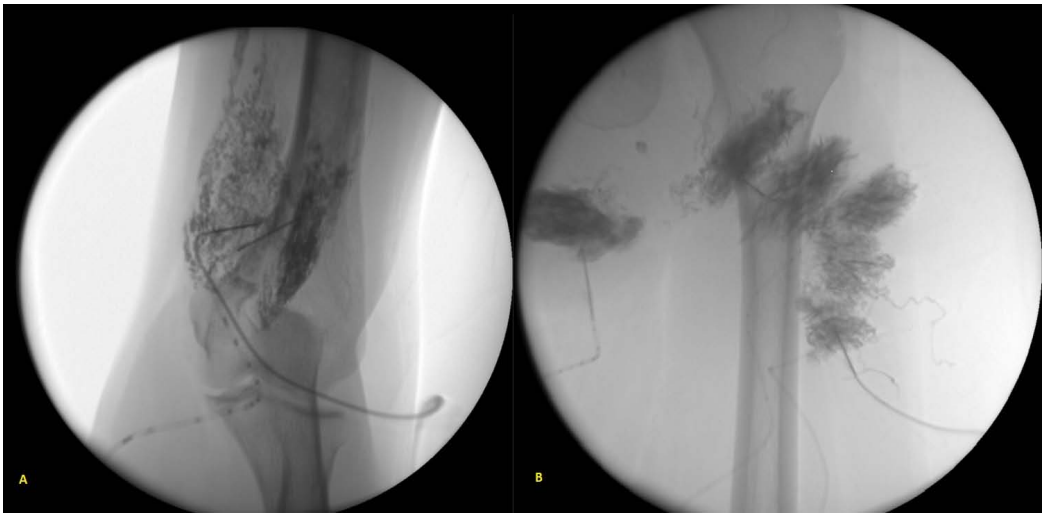


Figure 5: Intraoperative controls of the diffusion of the polymerizing agent in the vascular malformations.

The mean duration of the procedures, including intraoperative fluoroscopic examination and percutaneous injection, was 32 +/- 9 minutes.

RESULTS

The immediate postoperative period was characterized by mild oedema of the tissues of the affected limb, at the treatment site, in ten patients. Postoperative painful symptoms were controlled for the first two days with the administration of non-steroidal pain-relieving drugs after each procedure.

A superficial haematoma at the treatment site was observed in two patients: his regression occurred quickly and spontaneously in the following 7 days. No major complications (pulmonary embolism, skin necrosis and peripheral ischaemia) were observed in any patients, and they all were discharged two days after the procedure.

Follow-up of this series of patients was performed with monthly clinical checks for six months and with angio-MR controls one month after each procedure.

In post-procedure magnetic resonance (MR) controls, it was possible to observe the location of the embolizing glue agent (Glubran-2), since the solution maintained its radio-opacity over time, and due to residual malformation, which extended beyond the area occupied by the glue. By comparing the pre- and postoperative imaging examinations, we were able to observe a clear decrease in the size of the malformation in each patient. This result is related to the action of the Glubran-2 solution which, when injected percutaneously through the venous circulation, also obtained occlusion also of the arterial sector (retrograde occlusion) of the malformation and the subsequent vascular exclusion of both venous and arterial afferent vessels related to the malformation.

The structural evaluation of the treated VM, performed by angio-MR 30 days after each procedure, showed in all cases a reduction in the extent of the vascular formation in all cases, with radiological imaging of fibrosis inside the vessels. In the only case in which a persistence of abnormal vascularization was observed, this was attributed to the particular extension of the treated AVMs. In this case, the embolization procedure with glue was repeated, for completion, 45 days after the first procedure. After the second procedure, complete vascular exclusion of the malformation was observed..

A clear reduction in postoperative pain symptoms at discharge was observed in all patients, with a full recovery four weeks after the procedure. Skin problems, without signs of skin necrosis, were observed in two patients.

With particular regard to painful symptoms, we observed that all patients reported a significant reduction in post-operative pain (at least three points on the VAS - visual analogue scale - within 30 days of the procedure, compared to the preoperative observation), probably connected to the reduction in tension in the muscle and skin tissues.

At the end of the 6-month follow-up, complete disappearance of pain symptoms related to VA was observed in all patients treated with this technique.

DISCUSSION

The extremely low incidence of VA makes it difficult to carry out studies on large series, and their therapeutic management is complex and not yet well defined [5].

Their radical surgical treatment is often impractical due to their extension and infiltration of surrounding tissues, with consequent frequent postoperative recurrences. In addition, the affected vessels are abnormally thin and frail with an extreme tendency to haemorrhage, which is another reason why surgical removal is often dangerous for VA [6,8].

For several years, surgery has been associated with endovascular transcatheter embolization or percutaneous retrograde venous embolization. These procedures are often performed as preoperative treatments, but they are rarely performed as alternatives to surgery, especially for large VA. Among the various sclerosing agents used for embolization, absolute ethanol (98%) represents the most powerful sclerosing agent and is still considered the gold standard: its action develops in contact with the vessel walls, where it generates severe endothelial damage with inflammatory fibrosis which leads to the partial or complete destruction of the VA. However, it must be considered that the action of ethanol in embolization is accompanied by severe postoperative inflammation associated with oedema and pain in the treated region. In the treated area, the damage can also involve the surrounding structures, particularly nerves and skin, causing necrosis. Due to the thrombogenic potential of ethanol, the risk of pulmonary embolization is high, which limits the amount of ethanol that can be used for each procedure to 1-2 ml/kg. In extensive malformations, this therefore involves the necessity for several treatments repeated over time [10-12].

In particular, for AVMs the target of treatment is represented by the "nidus", which is often peripheral to the injection point and difficult to reach since it is vascularized by numerous afferent vessels: the use of arterial catheters can indeed often obtain only the partial occlusion of some of these vessels, with the result of incomplete treatment of the malformation and consequently with only a transitory clinical benefit for the recruitment of new vessels that supply the nidus and determine recurrence.

The percutaneous retrograde venous technique of "nidus" puncture, also performed with ethanol, under fluoroscopy, is therefore most often more effective in the treatment of VA [11].

Nevertheless, much attention is required in the treatment of high-flow AVMs due to numerous AV fistulas that increase the embolic risk, thus limiting the use of ethanol. The same percutaneous technique is extremely effective instead in VMs where transcatheter treatment is not feasible.

Due to the reported complications related to the use of ethanol and on the basis of the previous use of gluing agents in the treatment of cerebral VA, we chose to use a specific glue (Glubran-2 GEM, Viareggio, Italy) for the treatment of our patient group with peripheral VA.

Glubran-2 is a co-monomer derived from N-butyl-2-cyanoacrylate (NBCA) with the addition of methacryloxysulfolane (MS) which gives it unique chemical-physical characteristics. Compared to NBCA alone, Glubran-2 has a polymerization temperature of only 45 degrees, which causes a weak inflammatory reaction of the surrounding tissue, with poor necrosis and poor fibroblastic reaction. From a clinical point of view, this determines a better postoperative course and limited pain and oedema due to poor inflammation.

Glubran-2 is a CE-certified acrylic glue for internal and endovascular use (class III medical surgical device). To date, its application has been aimed at the treatment of brain AVMs and brain tumours, oesophageal varices and fistulas [13-15].

To effectively use this substance, it is advisable to mix it with Lipiodol (Guerbet, Villepinte, France), an oily tri-iodized contrast. It allows the operator to view the position of the glue under fluoroscopy because it makes it radiopaque. Furthermore, the solution delays the polymerization of the glue, and its consequent hardening, which would otherwise take place immediately once in contact with the blood. It is therefore necessary, on a case-by-case basis, to balance the concentration of this solution to obtain the correct polymerization time, which allows the glue to penetrate all the vessels of the VA. To avoid polymerization inside the catheter, it is necessary to wash it in advance with glucose solution, at a concentration of 10% [16].

The adhesive property of Glubran-2 ensures the stable and permanent occlusion of the vessels, without the subsequent recanalization or reabsorption of the

glue. This characteristic has a great importance for the treatment of VA: it involves the complete and permanent exclusion of the malformation from the circulation. In addition, immediate polymerization eliminates the risks of systemic embolization even in high-flow AVMs or those with AV fistulas. On the other hand, it is not possible to use this substance as a remedial treatment in superficial malformations or in those near joints due to the bulkiness that would result [17].

The literature on the use of Glubran-2 in extracranial vascular malformations is limited to two cases: a patient with a pelvic AVM [18] and a patient with an intramuscular AVM [19]. Instead, NBCA alone was used as a pre-treatment for surgery by Uller *et al*. in fourteen young patients with superficial VMs [22].

In our study, we selected only adult patients with intramuscular AVMs and VMs of the limbs based on preoperative imaging. The goal of our study, given the unique characteristics of Glubran-2, was to determine the vascular exclusion of these deep malformations without the need for subsequent surgical removal. The latter would have been highly destructive due to the intramuscular nature of the selected malformations (Figure **1**).

During the procedure, before the injection of Glubran-2, we injected contrast medium through percutaneous puncture to visualize the anatomy of the malformation.

Glubran-2 solution, diluted with Lipiodol, was injected through multiple percutaneous punctures. With this technique, it is possible to cover the maximum extension of the VM and, in the case of AVMs, to exclude the nidus completely and permanently, occluding all the afferent vessels.

Considering that the effects of glue present a low degree of inflammation and a low risk of related pulmonary embolism, the treated patients demonstrating, according to the theoretical predictions, a postoperative course without the aforementioned short-term major complications.

The limitations of this study, however, are represented by the small number of cases, the extremely rare incidence of selected and treated vascular anomalies, and the medium-term follow-up results: larger studies with extended follow-up are therefore necessary to better evaluate this technique.

CONCLUSIONS

The treatment of AV, both in the case of AVMs and VMs, still represents a challenge due to the high incidence of major complications both of surgery, due to the high risk of haemorrhage an incomplete excision, and of embolization with ethanol, which generally requires multiple procedures.

The technique of percutaneous embolization of peripheral AV of the limbs with Glubran-2 glue instead allowed us to observe, even in a limited number of cases with a medium-term follow-up, very favourable results in terms of the efficacy of the treatment for VA, the absence of major complications and the duration in time. The embolizing product used in this study also has features that make the procedure quick, safe, easy to apply and low cost.

Vascular occlusion with the use of Glubran-2 is stable and theoretically permanent; it allows for definitive exclusion of the malformation in a single procedure or with a limited number of procedures in the case of widespread extension of the malformation itself. It is possible to treat extensive and deep intramuscular malformations without clinical or aesthetic repercussions and without the need for subsequent surgical removal. The benefits of this treatment are finally perceived by patients from the immediate postoperative period due to reduced oedema in tissues and the early disappearance of pain.

We therefore believe that the percutaneous embolization technique with Glubran-2 glue can be considered favourable in the treatment of the intramuscular VA of the limbs due to its ease of use and promising outcomes.

REFERENCES

[1] Hassanein AH, Mulliken JB, Fishman SJ, Greene AK. Evaluation of terminology for vascular anomalies in current literature. Plast Reconstr Surg 2011; 127(01): 347-351. https://doi.org/10.1097/PRS.0b013e3181f95b83

[2] Wassef M, Blei F, Adams D, *et al.* Vascular anomalies classification: recommendations from the International Society for the Study of Vascular Anomalies. Pediatrics 2015; 136(01): e203-e214. https://doi.org/10.1542/peds.2014-3673

[3] Stillo F, Baraldini V, Dalmonte P, El Hachem M, Mattassi R, Vercellio G, *et al.* Vascular Anomalies Guidelines by the Italian Society for the study of Vascular Anomalies (SISAV). International Angiology 2015; 34(2 Suppl 1): 1-45.

[4] Gloviczki P, Duncan A, Kalra M, *et al.* Vascular malformations: an update. Perspect Vasc Surg Endovasc Ther 2009; 21: 133-148. https://doi.org/10.1177/1531003509343019

[5] Mattassi R. Surgical treatment of congenital arteriovenous defects. Int Angiol 1990; 9: 196-202.

[6] Lee B-B, Do YS, Yakes W, *et al*. Management of arteriovenous malformations: A multidisciplinary approach. J Vasc Surg 2004; 39: 590. https://doi.org/10.1016/j.jvs.2003.10.048

[7] Visser A, FitzJohn T, Tan ST. Surgical management of arteriovenous malformation. J Plast Reconstr Aesthet Surg 2011; 64: 283. https://doi.org/10.1016/j.bjps.2010.05.033

[8] McCafferty IJ, Jones RG. Imaging and management of vascular malformations. Clin Radiol 2011; 66: 1208. https://doi.org/10.1016/j.crad.2011.06.014

[9] Linden E, Baalen JM, Pattynama PMT. Retrograde transvenous ethanol embolization of high-flow peripheral arteriovenous malformations. Cardiovasc Intervent Radiol 2011; 35: 820. https://doi.org/10.1007/s00270-011-0265-0

[10] Bianchini G, Camilli D and Furgiuele S. Intramuscular Venous Malformations of the Upper and Lower Limbs: Indications and Outcomes of Sclerotherapy. Cardiovasc Intervent Radiol 2018; 41(10): 1505-1512. https://doi.org/10.1007/s00270-018-1997-x

[11] Steiner F, FitzJohn T, Tan ST. Ethanol sclerotherapy for venous malformation. ANZ J Surg 2016; 86: 790-5. https://doi.org/10.1111/ans.12833

[12] Schumacher M, Dupuy P, Bartoli JM, Ernemann U, Herbreteau D, Ghienne C, *et al.* Treatment of venous malformations: first experience with a new sclerosing agent: a multicenter study. Eur J Radiol 2011; 80(3): e366-72. https://doi.org/10.1016/j.ejrad.2010.12.074

[13] Marrocco-Trischitta MM, Nicodemi EM, Stillo F. Sclerotherapy for venous malformations of the glans penis. Urology 2001; 57(2): 310-3. https://doi.org/10.1016/S0090-4295(00)00915-8

[14] Marrocco-Trischitta MM, Nicodemi EM, Nater C, Stillo F. Management of congenital venous malformations of the vulva. Obstet Gynecol 2001; 98(5 Pt 1): 789-93. https://doi.org/10.1097/00006250-200111000-00014

[15] Gajewska K, Herinckx A, Holoye A, *et al*. Antenatal embolization of a large chorioangioma by percutaneous Glubran 2 injection. Ultrasound Obstet Gynecol 2010; 36: 773-5. https://doi.org/10.1002/uog.8806

[16] Desal HA, Toulgoat F, Raoul S, *et al.* Brain arteriovenous malformations technical note of endovascular treatment with Glubran. Interv Neuroradiol 2005; 11(Suppl. 1): 125-130. https://doi.org/10.1177/15910199050110S116

[17] Gandini R, Angelopoulos G, Konda D, *et al.* Transcatheter Embolization of a Large Symptomatic Pelvic Arteriovenous Malformation with Glubran 2 Acrylic Glue. Cardiovasc Intervent Radiol 2008; 31: 1030-1033. https://doi.org/10.1007/s00270-007-9224-1

[18] San Norberto EM, Brizuela JA, Revilla Á, Taylor JH, Vaquero C. Endovascular embolization of a muscular symptomatic arteriovenous malformation with Glubran 2 acrylic glue. Vascular 2015; 23(4): 432-435. https://doi.org/10.1177/1708538114550736

[19] Leonardi M, Barbara C, Simonetti L, Giardino R. Glubran 2: A new acrylic glue for neuroradiological endovascular use. Experimental study on animals. Intervent Neororadiol 2002; 8: 245-50. https://doi.org/10.1177/159101990200800304

[20] Chandra J, Anthony S, Uberoi R. Embolization of the internal iliac artery with Glubran 2 acrylic glue: initial experience with and adjunctive outflow occlusive agent. J Vasc Interv Radiol 2010; 21: 1109-1114. https://doi.org/10.1016/j.jvir.2010.02.034

[21] Raffi L, Simonetti L, Cenni P, *et al.* Use of Glubran 2 acrylic glue in interventional neuroradiology. Neuroradiology 2007; 49: 829-836. https://doi.org/10.1007/s00234-007-0238-9

[22] Uller W, El-sobky S, Alomari AI, Fishman SJ, Spencer SA, Taghinia AH, *et al.* Preoperative Embolization of Venous Malformations Using n-Butyl Cyanoacrylate. Vascular and Endovascular Surgery 2018; 52(4): 269-274. https://doi.org/10.1177/1538574418762192

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