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UTILITY OF DOPPLER ULTRASOUND IN EVALUATION AND MANAGEMENT OF VASCULAR MALFORMATIONS – A COMPARATIVE STUDY WITH CONVENTIONAL ANGIOGRAPHY

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Introduction:
In last few years, thanks to laser technology with minimally invasive approach, there was a growing need for treatment of oral vascular malformations inside the dental offices. Generally, the diagnosis of oral vascular malformations is based on clinical history, clinical examination and imaging exams. Hence the present study was designed to assess Doppler ultrasound findings of vascular malformations and compare the findings with DSA and to descry role of Doppler USG in management of vascular malformations.

Methods:

36 patients of clinically suspected vascular malformations were included in our study. USG B-mode and Doppler study was done for all these patients and the findings were recorded. USG examination was performed by two well experienced Interventional Radiologists in our institution. Clinical details and imaging parameters were documented and analyzed. Initial provisional imaging diagnosis was framed and treatment strategies were further formulated depending on the diagnostic angiogram findings

Results:

Out of 36 patients included in our study, 8 patients had high flow arteriovenous malformations, 3 patients had lymphatic malformations and 25 patients had low flow venous malformations, with DSA being gold standard modality for confirming the diagnosis. We observed that Doppler USG was able to diagnose all of malformations and accurately classify them into high flow and low flow malformations. We also observed that certain key characteristics like early draining vein and presence of nidus was better demonstrated by conventional angiography which steered the management plan from routine sclerotherapy to embolization

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Conclusion:

We conclude that the USG Doppler has diagnostic accuracy which is similar to conventional angiography and can be a valuable adjunctive imaging tool in characterizing vascular malformations and further categorizing the management plan; more so in cases posing with clinical dilemma. However, further evaluation with MRI/CT may be necessary to in complex and deep-seated lesions.

Keywords: Ultrasonography; Vascular malformations; Slow flow; high flow; Conventional angiography

Introduction:

Vascular malformations are a subset of vascular anomalies which present with wide variety of symptoms and morphology. They tend to be present at birth, although they can manifest later. Unlike hemangiomas, vascular malformations do not regress spontaneously. They are broadly classified into three groups - simple malformations, combined vascular malformations and vascular malformations associated with other anomalies [1]. Simple malformations are further classified based on their flow characteristics – slow flow malformations (which include capillary malformation, lymphatic malformation and venous malformation) and fast flow malformations (which include areterio-venous malformations and arterio-venous fistula). Some present at birth like capillary and lymphatic malformations. Others like venous and arterio-venous malformations present later in life, when they grow because of hormonal or mechanical factors. Consequently, they may cause significant structural and functional impairment, which is especially evident in the malformations of cervicofacial region [2]. Management profoundly relies on proper diagnosis. Thereupon, accurate diagnosis carries foremost importance in further management. Imaging characteristics such as size, location and extent of the malformation, feeding and draining vessels, flow characteristics play an important role in determining the type of treatment.

Although clinical diagnosis can be deftly derived, to know the type, extent and additional characteristics of the lesion, we require multimodality imaging approach [3]. The utility of cross-sectional imaging and conventional angiography is well validated in the literature and fundamentally remain the cardinal investigations in evaluation of vascular malformations [4]. Although Doppler ultrasound is used as supplementary discipline, and its ability in differentiating the vascular tumors from malformations is well documented, the data on its utility in characterizing the malformation and subsequently guiding the management is very limited in the current literature [5]. And since it is very safe and economical, it is prudent to establish its role. In our study, we assessed the utility of Doppler ultrasound in adjunction with cross sectional imaging and its role in guiding the management of vascular malformations.

Materials and Methods :

Study details

The ethical committee of VIMS & RC gave the ethical clearance and informed consent was obtained from all the patients. The study population included 36 patients with clinical suspected vascular malformations who presented for USG imaging in department of Radiodiagnosis and in whom the possibility of vascular tumor is excluded with histopathological diagnosis [6].

Inclusion and exclusion criteria

All patients with clinically diagnosed vascular malformations who present for ultrasound evaluation in department of radiology. Patients with final diagnosis of vascular tumors (hypervascular malignant tumors or benign tumors such as hemangiomas), contraindication for contrast studies such as renal impairment and contrast allergy were excluded from the study. [7].

Imaging protocols

In all the patients Doppler USG examination was performed (PHILIPS HD 7 and PHILIPS HD 15) to assess various lesion characteristics such as presence of high flow components in case of AVMs and the dynamic characteristic of a typical low flow malformation "compressibility". CDUS was invariably used in conjunction to visualize the feeding vessels and draining veins if any. USG B-mode and Doppler findings included: Location, size and extent of the lesion; Presence of high flow components and compressibility; Detection of Nidus; Presence of phleboliths. Digital subtraction angiography was performed in all these patients to confirm the diagnosis and managed by sclerotherapy or embolization.

A reasonable follow up of the patients was done following to ascertain the effectiveness of these measures on the overall patient's outcome

Statistical analysis

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagram, Pie diagram. p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

RESULTS:

A total of 36 patients who presented with clinical features of vascular malformations who had undergone Doppler USG and in whom the diagnosis was confirmed by DSA were analyzed.

This included 18 males and 18 females. The age range of the patients was from 2 to 53 years and mean age was 24.5. The age range in male patients was 11 to 50 and in female patients from 2 to 53 years and the mean age of male patients was 27 years and of female patients was 22 years. The chief complaints of the patients were swelling and pain which were present for variable duration. 4 out of 36 patients presented with mild functional disability. The average duration of symptoms was of 3 months and ranged from 2 weeks to 1 year.

Overall, we had 8 cases of high flow malformations and 28 cases of low flow malformations. In high flow malformations, patients underwent embolization with glue and few patients were managed with concurrent sclerotherapy for the venous component of arteriovenous malformation. In low flow malformations, sclerotherapy was planned. Doppler USG was able to accurately categorize the malformation into high flow and low flow in all the cases and directly impacted the therapeutic call. Few of the lesion characteristics like nidus, arterial feeders and draining veins were not detected with Doppler USG in case of high flow malformation, which were identified and characterized by DSA.

Table 1 – Age and Sex distribution

		Count	%
Sex	**Female**	18	50%
	Male	18	50%
Age	**<10 years**	4	11.1%
	11 to 20 years	13	36.1%
	21 to 30 years	9	25.0%
	31 to 40 years	5	13.8%
	41 to 50 years	2	5.5%
	>50 years	3	8.3%
	Total	36	100.0%

The principal characteristic that altered the flow of management was flow characteristic of the malformation. Both cross sectional studies and Doppler USG were able to ascertain the flow within the lesion, which were then compared against the gold standard DSA. Along with flow characteristics, the presence and number of arterial feeders, presence and number of prominent draining veins were identified in various modalities. The principal characteristic that altered the flow of management was flow characteristic of the malformation. Both cross sectional studies and Doppler USG were able to ascertain the flow within the lesion, which were then compared against the gold standard DSA.

Duration	< 1 year	3
	1-5 years	20
	5-10 years	8
	10-15 years	2
	>15 years	3
Size	Mean	9.81
	Median	7.35
	Geometric mean	8.19

Table 2 – Duration and Size distribution

After detailed analysis of the imaging features and the confirmation with DSA, the management plan was discussed in a multidisciplinary team consisting of radiologists specializing in vascular interventions. Based on the imaging findings above glue embolization was planned for 8 cases and sclerotherapy was planned for 28 cases. Overall, USG provided valuable information on the malformation which directly impacted the plan of therapy and subsequent need for follow up. In high flow malformations, patients underwent embolization with glue and few patients were managed with concurrent sclerotherapy for the venous component of arteriovenous malformation. In Low flow malformation cases, sclerotherapy was planned. Doppler USG was able to accurately categorize the malformation into high flow and low flow and directly impacted the therapeutic call.

Table 3 – Distribution of other parameters

		Count	%
Extent	Localised	24	66.6%
	Diffuse	12	33.3%
Diagnosis	Venous Malformation	25	69.4%
	Lymphatic Malformation	3	8.3%
	Arteriovenous Malformation	8	22.2%
Lesion characteristics			
USG	Hypoechoic	29	80.5%
	Isoechoic	3	8.3%
	Hyperechoic	4	11.1%
Flow characteristics			
USG	High flow	8	22.2%
	Low flow	28	77.7%

DSA	High flow	8	22.2%
	Low flow	28	77.7%
Lesion vascularity			
USG	Presence of arterial feeders	2	5.5%
	Presence of prominent draining veins	7	19.4%
DSA	Presence of arterial feeders	8	22.2%
	Presence of prominent draining veins	19	52.7%
Management distribution			
Management	Embolization	8	22.2%
	Sclerotherapy	28	77.7%

Discussion:

Our study analyses the role of Doppler USG imaging study in patients presenting with vascular malformations. Vascular malformations and tumors are frequently encountered in tertiary care center such as ours and this study helped us to gain insights into different dimensions of this important clinical entity with regards to its imaging especially versatile modality like Doppler USG, which ultimately plays a pivotal role in subsequent patient management. The mean age of our patients was 24.5 years and there was no significant gender preponderance. The most common clinical presentation was clinical features of pain and swelling of a relatively long duration (range from 3 months to >15 years) [8]. This was accompanied by typical complaints of functional disability, especially in patients with malformations near joints.

A small proportion of our patients did present acutely with superadded infection, identified with fever and local rise of tenderness & elevated total leukocyte counts. Most of this patient population subset presenting with fever were diagnosed as lymphatic malformations and were managed with antibiotics by the treating surgeon and subsequently planned for sclerotherapy [9]. We found that Doppler USG must be incorporated to get holistic look on the lesion, as Doppler USG can demonstrate real time flow dynamics & presence of phleboliths which is virtually confirming the diagnosis of most commonly occurring venous malformation. Approximately two third of the malformations were localized, sequestered in single compartment, whereas one third of malformations were diffuse, involving multiple compartments [10]. Venous malformation is a common benign condition in our country and is usually associated with a good prognosis following appropriate therapeutic interventions. In our study as well, we found the majority of cases responded extremely well to endovascular interventions (34 cases). Most of the venous malformations were sequestered

malformations, typically involving subcutaneous and intramuscular planes. Most of the malformations presented in head & neck region and in the extremities. Doppler USG contribution to diagnosis in terms of identifying the low flow was better and it also helped in treatment in terms of guided puncture for sclerotherapy. In those cases DSA can be used to identify the absence of high flow components and confirm the diagnosis of low flow malformation [11]. 7 cases in our study were identified to be arteriovenous malformations; these lesions were subjected to gray scale USG as well as colour Doppler interrogation which then revealed the slow flow within the malformation. In absence of flow, a simple maneuver as 'manual compression' can help in detecting the slow flow within the lesion and reach to a diagnosis of VMs. Indeed these 7 cases were identified as low flow malformations on Doppler USG. Further, DSA confirmed the diagnosis. This shows the role Doppler USG can play in making accurate diagnosis and further management as well. Venous malformations are typically managed by sclerotherapy. Sequestered malformations are accessed percutaneously under USG guidance. 22 cases in our study were localized VMs which were managed by sclerotherapy. Once foam sclerosant is injected into the malformation under fluoroscopic or USG guidance, the lesion is compressed manually to evenly distribute the sclerosant and achieve satisfactory wall opposition which is crucial for sclerosant activity. Post sclerotherapy, the lesion may be monitored in the form of short term follow up. Most patients had post procedure pain for couple of days; however they were easily managed by analgesics and proteolytic medications [12].

The other complications followed by sclerotherapy are redness of skin, skin ulceration and necrosis. In such cases, examination with Doppler USG becomes much more crucial as inadvertent thrombosis of systemic vein need to be ruled out in such cases. The adequacy of sclerotherapy is usually determined by relief of patient symptoms. However, Doppler USG can be used to record the response to therapy. Doppler USG being simple bed side procedure can demonstrate the sclerosed vessels evidenced by presence of hyperechogenicity within the vessel or presence of thrombus. Real time dynamic assessment is possible. By employing Doppler interrogation flow within the malformation can be determined. Manual compression of the lesion can accentuate slow flow within and can give us valuable information regarding the flow within sclerosed malformation. Again, Doppler USG plays the major role in post therapeutic management. The only limitation of Doppler USG being deep seated malformations and malformations adjacent to poor acoustic structures like bones.

In few VMs, prominent draining veins may be identified which usually drain into systemic veins. In our study 11 cases of VMs were found to have prominent veins draining into systemic veins. Identification of draining veins is of paramount importance as knowledge of this will guide sclerotherapy and to steer clear of inadvertent injection of sclerosant into systemic veins and avert major complication of pulmonary embolism. The application of tourniquet is one of the methods to tackle this problem. Initial angiograms after percutaneous access of malformation maybe used as reference to decide the level of tourniquet application. Applying tourniquets suits to malformations of extremities. In case of head and neck VMs, other methods like manual compression maybe employed. Indeed, in one of our cases, patient

presented with malformation of left temporal region in which there was a prominent draining vein draining into left internal jugular vein, for which manual compression was given initially which did not achieve the satisfactory compression. A simple maneuver like probe compression was employed which was very successful. Doppler USGs added advantage of operator creative independence and versatility could not be more apparent than in this case. Identification and morphological characterization of deep veins forms essential part of imaging goals in vascular malformations as either absence or dysplastic deep veins are contraindications for sclerotherapy. Our study has 1 such case, where deep venae comitans were absent in the upper limb. The case was diagnosed as KlippelTrenaunay syndrome. In such cases performing sclerotherapy would result in detrimental complications [13].

Lymphatic malformations are quintessentially found in cervical region. Our study includes 3 cases of LMs. These appear as multiloculated cystic channels on imaging and can be differentiated from LMs based on flow within the channels. The flow on compression is absent as opposed to VMs. These are managed by sclerotherapy with agents like bleomycin or doxycycline. Doppler USG guided percutaneous access is gained, followed by aspiration of the fluid which is proportionate to the amount of sclerosant to be injected. Doppler USG allows us to monitor the aspiration and instillation of sclerosant in real time; and hence reduces the overall procedure complication rates.

Arteriovenous malformations are subjected to more scrutiny than VMs or LMs before proceeding with a management plan. The presence of nidus, number of arterial feeders and presence of prominent draining veins are meticulously studied. Procedure complications like inadvertent non-target embolization, pulmonary embolism, stroke etc can be avoided by careful preprocedural planning. Doppler USG has limited role in this aspect. In such cases, appropriate pre procedural CT/MRI with contrast may be performed.

Conclusion:

To conclude, Doppler USG becomes indispensable in characterizing the vascular malformation and establish a diagnosis. Furthermore, Doppler USG maybe used for guiding sclerotherapy/ embolization procedure. However further studies with large volume and sample size and randomization may be needed to elucidate this aspect further and to statistically determine the sensitivity and specificity indicators of Doppler USG in diagnosing and differentiating various vascular malformations.

References:

1. Merrow AC, Gupta A, Patel MN, Adams DM. 2014 revised classification of vascular lesions from the international society for the study of vascular anomalies: radiologic-pathologic update. Radiographics. 2016 Aug 12;36(5):1494-516.

2. Legiehn GM, Heran MK. Venous malformations: classification, development, diagnosis, and interventional radiologic management. Radiologic clinics of North America. 2008 May 1;46(3):545-97

3. McCafferty I. Management of low-flow vascular malformations: clinical presentation, classification, patient selection, imaging and treatment. Cardiovascular and interventional radiology. 2015 Oct;38(5):1082-104.

4. Merrow AC, Gupta A, Patel MN, Adams DM. 2014 revised classification of vascular lesions from the international society for the study of vascular anomalies: radiologic-pathologic update. Radiographics. 2016 Aug 12;36(5):1494-516.

5. Legiehn GM, Heran MK. Venous malformations: classification, development, diagnosis, and interventional radiologic management. Radiologic clinics of North America. 2008 May 1;46(3):545-97

6. McCafferty I. Management of low-flow vascular malformations: clinical presentation, classification, patient selection, imaging and treatment. Cardiovascular and interventional radiology. 2015 Oct;38(5):1082-104.

7. Merrow AC, Gupta A, Patel MN, Adams DM. 2014 revised classification of vascular lesions from the international society for the study of vascular anomalies: radiologic-pathologic update. Radiographics. 2016 Aug 12;36(5):1494-516.

8. Legiehn GM, Heran MK. Venous malformations: classification, development, diagnosis, and interventional radiologic management. Radiologic clinics of North America. 2008 May 1;46(3):545-97

9. Gold L, Nazarian LN, Johar AS, Rao VM. Characterization of maxillofacial soft tissue vascular anomalies by ultrasound and color Doppler imaging: an adjuvant to computed tomography and magnetic resonance imaging. Journal of oral and maxillofacial surgery. 2003 Jan 1;61(1):19-31.

10. Johnson CM, Navarro OM. Clinical and sonographic features of pediatric soft-tissue vascular anomalies part 2: vascular malformations. Pediatric radiology. 2017 Aug;47(9):1196-208
11. Greene AK, Liu AS, Mulliken JB, Chalache K, Fishman SJ. Vascular anomalies in 5621 patients: guidelines for referral. Journal of pediatric surgery. 2011 Sep 1;46(9):1784-9.
12. Calvo-Garcia MA, Kline-Fath BM, Adams DM, Gupta A, Koch BL, Lim FY, Laor T. Imaging evaluation of fetal vascular anomalies. Pediatric radiology. 2015 Aug;45(8):1218-29Dunham GM, Ingraham CR, Maki JH, Vaidya SS. Finding the nidus: detection and workup of non–central nervous system arteriovenous malformations. Radiographics. 2016 May 10;36(3):891-903.
13. Paltiel HJ, Burrows PE, Kozakewich HP, Zurakowski D, Mulliken JB. Soft-tissue vascular anomalies: utility of US for diagnosis. Radiology. 2000 Mar;214(3):747-54.

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