Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies ***NLM ID:*** *101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Indian Citation Index (ICI) Index Copernicus value = 100

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Review Article

Head & Neck hemangiomas and vascular malformations: A Review

[1]Mansha Hassan, [2]Maroofa Hafiz, [3]Asiya Basheer, [4]Savina Gupta

[1,2]Senior Resident, [4]Professor and Head, Department of Oral and Maxillofacial Surgery, Jaipur Dental College, Jaipur, Rajasthan, India;
[3]Senior Resident, Department of Pedodontics and Preventive Dentistry, India

ABSTRACT:
Vascular anomalies are a group of congenital errors in development of vessels which are more typically referred to as birthmarks. The understanding of the distinction between its two forms, hemangiomas and vascular malformations remain confusing. They commonly involve the head, neck and oral cavity. The most common problem associated with vascular anomalies in oral and maxillofacial region causes psychological distress related to defacement as well as functional defects. The review of this anomaly aims at broady understanding the disease. Vascular anomalies are easily diagnosed by clinical demonstration but choice of treatment for this range of lesions is diverse. This article anticipates the current over view on the classification, diagnosis with suggestions on the management of commonly found vascular tumors and anomalies in maxillofacial region.
Keywords: Vascular anomaly, Maxillofacial region, Hemangioma, Vascular malformation.

Received: 16 November, 2022 Accepted: 22 December, 2022

Corresponding author: Mansha Hassan, Senior Resident, Department of Oral and Maxillofacial Surgery, Jaipur Dental College, Jaipur, Rajasthan, India

This article may be cited as: Hassan M, Hafiz M, Basheer A, Gupta S. Head & Neck hemangiomas and vascular malformations: A Review. J Adv Med Dent Scie Res 2023;11(1):52-58.

INTRODUCTION

Hemangiomas and vascular malformations are innate errors of vascular development, which causes distinguishable birthmarks of the skin and mucosa associated with a fluctuating degree of underlying soft tissue abnormalities.[1] They are usually benign, occurs in children and young adults with a prevalence in head and neck areas.[2]The approximated prevalence is 4.5% and the anomalies are usually diagnosed during infancy or childhood.[3]

The most common problem associated with vascular anomalies in oral and maxillofacial region causes psychological distress related to defacement as well as functional defects.[3]The most affected areas in oral cavity are lips, tongue, buccal mucosa and palate.[2]In the past , patients had been frustrated because of persistent mismanagement and misdiagnosis of vascular anomalies.[1]On reviewing the English literature of past 10 years we have formulated a classification of these vascular anomalies for a comprehensive diagnosis. Following is the brief description of these anomalies and malformations.

CLASSIFICATION

The first to categorize the vascular anomalies by microscopic channel architecture was Karl Virchow (1863), the father of cellular pathology, he called them Angioma simplex, Angiomacavernosum or Angiomaracemosum. Most of these lesions disappear spontaneously within Ist year of life which led to incorrect nomenclature and misconception.[4]

Mulliken and Glowacki, in 1982, gave a simple biological classification based on the clinical, histochemical, and cellular kinetics. In 1996 in Rome, ISSVA classification scheme which is based on the basic separation of vascular anomalies into those with a proliferative unit as vascular tumors with nearly static vascular malformation. Vascular malformations which are inborn errors in vessels are classified depending on the types of vessels involved: capillary, arterial, lymphatic or venous or combined malformations. Then in 1999 this classification was modified based on the depth of the lesion, vessel type and characteristics of the flow of the lesion. The ISSVA society further modified the biological classification in 2014 in Melbourne their continuing

workshop and divided vascular lesions into vascular tumors and vascular malformations.[4,5] (Table1)

Table 1: ISSVA Society 2014 classification (2014 Melbourne)

VASCULAR TUMORS	**VASCULAR MALFORMATIONS**				
	Simple		**Combined**	**Of major named Vessels**	**Associated with other anomalies**
BENIGN					
Infantile hemangioma/ Hemangioma of infancy	Capillary malformations	CM + VM	CVM	Capillary	**Klippel-Trenaunay** Syndrome CM+VM+/-LM + Limb overgrowth
Congenital hemangioma Rapidly Involuting (RICH) Non involuting (NICH) Partially involuting (PICH)	Lymphatic malformations	CM+ LM	CLM	Arterial Lymphatic	**Parkes-Weber syndrome** CM+AVF+ limb overgrowth.
Tufted angioma		CM+	CAVM		**Servelle-Martorell Syndrome** limb VM+ bone
Spindle cell hemangioma		AVM		Venous or a	undergrowth.
Sturge-weber syndrome EpitheloidHemangiomafacial+leptomeningeal CM					
Pyogenic Granuloma.		LM+ VM	LVM	Combination	+ ocular anomalies+/-bone or/soft tissue overgrowth Limb CM+ congenital non
LOCALLY AGGRESSIVE progressive limb **ORBORDERLINE.**					hypertrophy.
CM+ CLVM Kaposiform Hemangioendothelioma.	**Maffuccisyndrome** Venous Malformations	LM+ VM			VM+/-spindle cell hemangioma+enchondroma
Macrocephaly-CM(M-CM Papillaryintalymphatic angioendothelioma**Microcephaly**-CM					/MCAP) (MICCAP)
Dabaska tumor		CM+ LM+	CLAVM		**Cloves syndrome**-LM+VM +CM+/-AVM+ lipomatous overgrowth
Composite Hemangioendothelioma	Arteriovenous malformation	AVM			**Proteus syndrome**-CM, VM and/or LM + asymmetrical somatic Overgrowth.
Kaposi sarcoma					
Others		CM+	CVAVM		**Bannayan-Riley**
VM+ **MALIGNANT VASCULAR TUMORS.**	**-Ruvalcaba syndrome-** AVM			AVM+VM+ macrocephaly	Lipomatous growth.
AngiosarcomaArteriovenous fistula	CM + LM+	CLAVM			
Epitheloid hemangioendothelioma	VM+ AVM				
Others					

CVM: capillary-venous malformation, CLM: capillary-lymphatic malformation, CAVM: capillary-arteriovenous malformation, LVM: lymphatic venous malformation, CLVM: capillary-venous-lymphatic malformation, CLAVM: capillary-lymphatic-arteriovenous malformation. CVAVM:capillary-venous-arteriovenous malformation ,CLVAVM: capillary-lymphatic-venous-arteriovenous malformation.

S.C Nair in his review of 115 cases of surgical management of vascular lesions of head and neck introduced a classification which helps to make decision on diagnostic imaging and treatment planning.[5] (Table 2)

Table 2: Categorization of vascular malformation based on anatomical presentation and treatment planning

Type I	Mucosal/superficial lesions	Excision of skin or mucosa with local Or regional flaps for reconstruction.
Type II	Submucosal/subcutaneous	Complete excision after skin flap elevation.
Type III	Lymphovenous or venous Venous malformations Involving glands of head and neck.	Excision with affected gland.
Type IV	Intraosseous lesions	Excision with involved bone.
Type V	Deep visceral spaces	Skeletal access osteotomy with total excision

VASCULAR TUMORS

HEMANGIOMA

Hemangioma is a benign lesion of a hamartomatous growth of capillaries with a high proliferation index.[6]They are most common vascular tumors and occur in approximately 10% of the population. Predominance is found in female sex, prematurity, low birth weight,advanced maternal age and Caucasians. Hemangiomas growth is connected to hyperplasia of endothelial cells. Hemangiomas are categorized into 2 types, infantile hemangioma (IH) and conginental hemangioma (CH), out of which congenital hemangioma is rare and less understood[7]. IH is further categorized depending on site as focal, segmental and indeterminate and also categorized on the depth of the lesion from the skin surface as superficial (capillary hemangioma) , deep (cavernous hemangioma) and mixed (capillary cavernous hemangioma). CH are also further classified as Rapidly Involuting congenital hemangioma (RICH) and noninvoluting congenital hemangioma (NICH).[6]

The pathogenesis of infantile hemangiomasremains unclear although two theories dominate current thought. First suggest that hemangioma endothelial cells arise from disrupted placental tissue imbedded in foetal soft tissues during gestation and birth. A second theory arose from the discovery of endothelial progenitor and stem cells in the circulation of patients with hemangiomas.[7]

Diagnosis: Clinical examination of hemangiomas generally arises from a thorough physical examination. They are seen as flat, well demarcated, and erythematous red patches.[1]Their vertical growth and rapid proliferation will trigger the diagnosis. It follows 3 developmental phases: proliferation, quiescence and involution. In most of hemangiomas, 80% of proliferation occurs by 3 months of life and in this phase rapid growth can lead to depletion of blood supply with resulting ischemia, necrosis, ulceration & bleeding. After proliferation, hemangiomas enter a slower or no growth phase, lasts from 9 to 12months of age known as quiescence. Then the final stage is involution in which greying of the overlying skin & shrinking of the deeper components usually occurs,the involution of 50%, 70% & 90% occurs by 5, 7 & 9 years of age with some variableness. Therefore, the best diagnosis is made by clinical history and thorough physical examination. If diagnosis is still not clear then best radiographic modalities used are Doppler, ultrasound or MRI (Magnetic resonance imaging).[7]

Management: Hemangiomas have been managed with close monitoring over their lifecycle.[7]The lesions which are not easily noticeable are best treated with close observation during its proliferative phase.[2] According to research almost 40% of children require further treatment after involution phase because of bleeding, ulceration, airway obstruction, visual axis obstruction, high-output cardiac failure or permanent defacement and for these type of hemangiomas medical & surgical options are avalaible. [7]

Medical management includes one or more systematic therapies. Prednisolone is the first line of drug used in life threatening hemangiomas[2]or intra-lesionally a mixture of betamethasone 6mg/ml and triamcinolone 40mg/ml in 1:1 ratio is to be injected 1-2ml intra-lesion.Intra-lesion steroid therapy is given in focal hemangiomas of the parotid, nasal tip, sub-glottis and eyelid [8] .Interferon alpha & vincristine have been used for massive and life threatening disease out of which interferon alpha have high risk of neurotoxicity [8]. In recent medical management in 2008 a non-selective β adrenergic antagonist propranolol, was discovered to cause regression of proliferating hemangiomas in new born receiving treatment for cardiovascular disease.[9] Over 90% of patients have reduction in the size in 2 weeks following the first dose. Dosage recommended is 2-3mg/kg separated in 2 or 3 times a day regimen.[10]

Surgical management involves excision, laser treatment or both.[7] Superficial hemangiomas can be treated with pulsed dye laser and in later proliferative and involutive phases potassium-titanyl phosphate (KTP) laser and neodymium: yttrium aluminium-garnet (Nd:YAG) lasers are used.[2] Residual erythema

and telangiectasia frequently remain in involuted hemangiomas and are treated by selective photo-thermolysis using FPDL (Flash pulse dye laser).[7]Resection being the main treatment for deep hemangiomas and excision for localised lesions and in case of compound lesions, the superficial component is treated by photocoagulation and deep component excised.[2]

PYOGENIC GRANULOMA

Pyogenic granuloma (PG) also called as lobular capillary hemangioma is a benign vascular tumor. It occurs in all age groups with no gender predilection. It commonly occurs on hands, mucous membranes such as lower lips and gingiva and sometimes also found subcutaneously or intravascularly that occur spontaneously after trauma or within capillary malformations. During pregnancy, intraoral PGs may occur. It has also been associated with certain medications such as oral contraceptives, Gefitinib, Retinoids. The development occurs in 3 phases as cellular phase, capillary or vascular phase and involutionary phase.

Diagnosis: PGs are clinically small pedunculated reddish exophytic nodules that grow rapidly. It has glistening, moist surface. PGs bleed spontaneously due to presence of large number of blood vessels.

Management: PGs are usually excised as it has lowest rate of recurrence Depending on the area and size other treatment alternatives are electrocautery, radiosurgery, curettage, sclerotherapy or diode lasers of wave length between 808 to 980nm are used. In children, oral therapy with beta adrenergic receptor antagonist propranolol or timolol is effective. Topical therapy with 0.5% timolol is effective for the lesion on ocular surface.[6,11]

VASCULAR MALFORMATIONS (OVERVIEW)/ SLOW FLOW MALFORMATIONS

Vascular malformations were previously called port wine stain.[2] It arises from error in morphogenesis in venous, arterial and lymphatic vascular networks.[6] These are slow flow anomalies composed of ectatic venous channels that continues to grow throughout the lifetime. These malformations commonly occur in the head and neck region with predilection for the oral cavity, muscle group and airway.[1] The most common vascular malformations include lymphatic malformation, venous malformation, capillary venular malformations and arteriovenous malformation.[7]

LYMPHATIC MALFORMATIONS

Lymphatic malformations (LM) are congenital collections of dilated lymphatic vessels with inappropriate communication lined by endothelial cells and filled with lymphatic fluid.[12] Many classification systems have been given to classify these lesions , but only one system, the classification by Mulliken and Glowacki (1982) , which is based on clinicopathologic findings and has a prognostic value and are classified as macrocystic (≥ 2cm), microcystic (<2cm), or mixed. Macrocystic are diffused and do not respect tissue planes thus making it most difficult to eradicate while as microcystic are more localised and respect the tissue planes and are easily excised [1]. In earlier system which is considered obsolete nowadays called them as lymphangioma and cystic hygroma.[7]

Diagnosis: LM can occur anywhere on the body, and symptoms are determined by the extent of disease but most of them are found in cervicofacial region and extend to involve the oral cavity or airway in diffused manner.[13]Expansion and gradual growth is typical. Local infections in the course of lymphatic drainage will cause LM to protrude, swell and painful. This is the particular feature of a LM with other vascular anomalies that do not present in this manner. Macrocystic LMs present as a fluid filled, soft swelling beneath normal or moderately discoloured skin due to intra-cystic bleeding or can be due to mixed lymphatic venous malformation. Microcystic LMs are non-compressible and soft masses involving skin and mucosa with an superficial area of small vesicles that weep and at usually cause pain or bleeding.[7]

Symptoms include, dysphagia, odynophagia, pain, impaired speech or in severe cases airway obstruction. They often cause osseous hypertrophy when involves the skeleton leading to dental or extremity abnormalities. These malformations can usually be diagnosed by physical examination, MRI to determine extent of disease.[14]

Management: Treatment plan is based on the location and type of lesion which includes excision, sclerotherapy and laser therapy. Pinyagmycin (1.0 mg/mL) and Laser therapy is given for superficial oral mucosal microcystic lymphatic malformations. After treatment the cystic lesions will slowly disappear with resurfacings of the oral linings. If the lesion is extensive and multiple, excision can be done to debulk, with residual lesions retreated with laser therapy or sclerotherapy. In deep seated microcystic LMs, the result of surgical resection may lead to secondary oromaxillofacial defects therefore thesclerotherapy and intra-lesioninjections improve the outcomes.[2]

In macrocystic LMs, sclerotherapy is mainstay treatment and ethanol was used earlier followed by doxycycline and sodium tetradecyl sulphate. Response varies with the type of lymphatic malformation. Complications include swelling, skin breakdown, pain, and temporary loss of function. CO2 laser therapy may also be employed in limited disease of the airway and oral mucosa. Recently OK 432 (lyophilised Streptococcus pyogenes treated with benzyl penicillin) has been used for macrocystic lesions. When Overall elimination of lesion is not feasible, various treatment modalities are combined to control disease to provide satisfactory functional outcomes.[15]

CAPILLARY MALFORMATIONS

Capillary malformations (CM) are dilated capillary like channels with sporadic lesions. They occur in approximately 0.3% of children and can present on any part of the body, but are mostly found in the head and neck region. They are categorized as medial or lateral lesions. Medial CM usually lightens with time and eventually disappears. Unofficially they are referred to asangel kisses on the forehead and stroke bites on the nape of the neck and. Lateral lesions , commonly referred to as port wine stains, have a more prolonged course.[16]

Diagnosis: CMs present at birth as red, flat or purple, cutaneous patches with irregular borders. They do not bleed spontaneously and are painless. Lateral ones usually involve the face and present along the distribution of the trigeminal nerve. They tend to progress with time as the vessel ectasia extends to involve deeper vessels. This causes lesion to become darker in colour, as well as more raised and nodular.[17]

CMs may exist as a part of syndrome, most common of these is Sturge Weber Syndrome and is characterised by a CM in the region of the ophthalmic branch of the trigeminal nerve, choroid angioma and leptomeningeal angiomatosis. CM may also be present in Klippel Trenaunay Syndrome which consists of combination of multiple lymphatic, capillary and venous abnormalities. Diagnosis is usually made by physical examination. If there are findings inconsistent with CM exist, e.g. pain and bleeding, an MRI may be performed.[7]

Management: The choice of treatment depends upon on the degree of the diameter of the vessel.[18]The mainstay of treatment for CM is pulsed dye laser therapy using wavelengths of 577 and 585nm recently [19]. The laser slowly causes the redness of the lesion to fade.[7] For vascular lesions the target chromophore is oxyhaemoglobin.[2]Lesions resistant to pulsed dye laser may respond to KTP, copper vapour, argon and other new lasers.[20] The complications of scarring and hypopigmentation/hyperpigmentation are more common with copper and KTP lasers.[2]In patients with associated soft tissue or bony hypertrophy , surgical management can be helpful in restoring the normal anatomy and in re-establishing a symmetric contour.[7]

VENOUS MALFORMATION

Venous malformations (VMs) are slow- flow vascular anomalies composed of abnormal venous channels which lack a uniform smooth muscle layer and thus lead to venous congestion, thrombosis and gradual expansion of these lesions.[7 &18] These are common vascular deformities of the head and neck region with predilection for oral cavity, airway and muscle groups.[1]VMs more commonly occur sporadically, but research into familial pattern and multifocal disease has helped discover suspected genetic loci involved in their development.[2]. They tend to grow rapidly during hormonal changes as progesterone receptors have been discovered in venous malformations.[22]

Diagnosis: Venous malformations are often present at birth but may present as a deep mass. Protrusion may be the only presenting symptom. Rapid growth may occur during puberty, pregnancy, or traumatic injury. The overlying skin may appear normal or possess a bluish discoloration. With more cutaneous involvement, the lesions appear dark blue or purple. Upper aerodigestive involvement is common and VM are particularly evident when mucosa is affected. VMs are compressible and swell when the region is dependant or there is an increase in hydrostatic pressure such as during a Valsalva Manoeuvre which helps to distinguish them from LMs on physical examination.[23]

Management: No single treatment method is favoured in the treatment of VMs and often more than one modality is utilised.[24]Nd:YAG laser therapy, surgery and sclerotherapy are various options for its treatment.[7]This is largely dependent on the fluid dynamics of the lesion. Prelimnary imaging with US Doppler will differentiate a high flow from low flow lesion.

Sclerosants commonly used are ethanol and sotradecol.[25]Acquired adult venous malformations are common in face and lower lip and are treated by excision or laser photocoagulation.[26]Cryotherapy with nitrous oxide is used for the treatment of small intraoral lesions.[27] Nd:YAG laser is used for treatment of superficial lesion or superficial component of a compound lesion. Larger lesions are managed by combination sclerotherapy and excision or sclerotherapy alone.[14]

ARTERIOVENOUS MALFORMATIONS

Arteriovenous malformations(AVFs) are congenital rare vascular malformations.[18] It involves the midface, particularly cheek and ear are most common sites.[28] It results due to trauma and puberty, initially consist of one or several shunts between veins and arteries.[29]They are infiltrative causing destruction of local tissue and life threatening secondary to massive bleeding.[7]

Diagnosis: AVM is present at birth but may not become evident until childhood. It has a pink red cutaneous stain with a palpable thrill andit is important to distinguish AVM from a CM or hemangioma. The underlying tissue is usually thickened and is not fluctuant or compressible but can be pulsatile .Lesion looks ischaemic with common complications pain, ulceration, bleeding and congestive heart failure. It can cause disfigurement, compression or destruction of adjacent tissues. Imagining studies are essential for the diagnosis and evaluation of AVMs. MRI with T2 weighted processing will typically reveal a hypertense, irregular lesion with numerous flow voids.[1]

Management: Treatment of AVMs consists of embolization, resection, or a combination.[14] Embolization is done for larger malformations; absolute ethanol, polyvinyl alcohol and Onyx are used

as embolization materials. These agents selectively obstruct and destroy the arteries. Complications due to embolization include local skin ulceration, soft tissue necrosis, mucosal sloughing or nerve injury.[30] It provides temporary control of disease, but recurrence is high due to collateralization and recruitment of new vessels to support an undetected portion of the nidus.[31]Surgical management of AVMs requires pre-operative selective embolization, judicious removal of tissue and complex reconstructive techniques. Excision is performed 24-48 hours after embolization. This helps control blood loss and definesurgical margins of the lesion.[32 &33]

CONCLUSION

Vascular anomalies embody a myriad of blood vessels abnormalities that are thought to occur prenatally. Correct diagnosis is imperative for appropriate treatment. The most common vascular anomalies in order of presentation include hemangiomas, lymphatic malformations, capillary malformations (port-wine stains), venous malformations, and arteriovenous malformations. Treatment of vascular anomalies is complex and often involves multiple disciplines and therapeutic options. Referral to a vascular anomalies team is recommended when considering therapy for "problematic" hemangiomas and vascular malformations.It isimportant to remember that vascular anomalies of the head and neck can be divided into vascular tumours and vascular malformations; the former representing trues proliferative neoplasms and the latter defects of vascular morphogenesis. These lesions can present in a variety of locations in the head and neck. Imaging plays a role for many of these lesions, and therefore, knowledge of the classification of these lesions based on the updated 2018 International Society for the Study of Vascular Anomalies, as well as characteristic imaging findings are key to diagnosis and subsequent appropriate treatment.

REFERENCES

1. Buckmiller LM, Richter GT, Suen SY. Diagnosis and managementof hemangiomasand vascular malformations of head and neck. Journal of oral diseases 2010 Jul; 16 (5): 405-418.
2. Dr. Sri VarshiniPoojithaSenapathi,Dr.Pradeep. Vascular Lesions of Oral and Maxillofacial Region. JMSCR 2014 March; 2 (3): 524-531.
3. Jeong Woo Lee, Hoyun Chung. Vascular anomalies of head and neck. Arch Craniofacsurg2018 Dec; 19(4): 243-247.
4. Michel Wassef MD, Francine Blei MD, Denise Adams MD et al.Vascular Anomalies Classification: Recommendations from the international society for the study of vascular anomalies. American academy of Pediatrics2018 Oct;136 (1)
5. Nair S.C. Vascular Anomalies of the Head and Neck region. J. Maxillofac. Oral Surg (Jan-Mar 2018); 17(1): 1-12.
6. Syed NaziaMasoom. Vascular lesions of Head and neck: A Literature Review. Indian Journal of Dental Sci 2016; 8:176-82.
7. Gresham T. Richter and Adva B. Friedman.Hemangiomas and Vascular Malformations. Current theory and management. Intl Journal of Paediatrics Jan 2012;
8. Bauman N.M, Burke D.K, and SmithR.H.J. Treatment of massive or life threatening hemangiomas with recombinant α_{2a} interferon. Otolaryngology- Head and Neck Surgery 1997; 117:99-110.
9. Leaute-Labreze J.C, de la Roque E.D, Hubiche .T, Boralevi .F, Thambo J.B, and Taieb .A.Propranolol for severe hemangiomas of infancy. The New England Journal of Medicine 2008; 358(24): 2649–2651.
10. Bagazgoitia. L, Torrelo. A, Gutierrez et al J.C.L. Propranolol for infantile hemangiomas. Pediatric Dermatology 2011; 28(2):108–114.
11. WollinaUwe, Dana Langner. Pyogenic granuloma- a common benign vascular tumor with variable clinical presentation: new findings and treatment options,.Maced J Med Sci 2017 jul; 5(4): 423-426.
12. Bagazgoitia .L, Torrelo .A, Gutierrez et al J.C.L.Propranolol for infantile hemangiomas.Pediatric Dermatology 2011; 28 (2):108–114.
13. Perkins J.A, Maniglia .C,Magit .A, Sidhu .M, Manning S.C, and Chen E.Y.Clinical and radiographic findings in children with spontaneous lymphatic malformation regression". Otolaryngology-Head and Neck Surgery2008;138(6): 772–777.
14. Ethunandan .M, Timothy K. Mellor. Hemangiomas and vascular malformation of the maxillofacial region-a review. British Journal of oral and maxillofacial surgery 2006; 44: 263-272.
15. Arin K. Greene MD, Chad A.Perlyn. Management of Lymphatic Malformations. clin Plastic Surg2011; 38 :75-82.
16. Eerola .I, Boon L.M, Watanabe. S, Grynberg .H, Mulliken J.B, and Vikkula .M.Locus for susceptibility for familial capillary malformation ("port-wine stain") maps to 5q. European Journal of Human Genetics 2002; 10 (6):375–380.
17. TarkKC ,Lew D.H and Lee D.W.The fate of longstanding port-wine stain and its surgical management. Plastic and Reconstructive Surgery 2011;127(2):784–791.
18. Waner M, Suen JY. Hemangiomas and vascular malformations of the head and neck. 1999.New York: Wiley-Liss.
19. Namba Y, Mae O, Ao M. The treatment of portwine stains with a dye laser: a study of 644 patients.Scand J PlastReconstrSurg Hand Surg 2001;35:197–202,.
20. Lanigan SW. Port-wine stains unresponsive to pulsed dye laser: explanations and solutions. Br J Dermatol 1998;139:173–7.
21. Boon L.M, Mulliken J.B, Vikkula.M et al.Assignment of a locus for dominantly inherited venous malformations to chromosome 9p. Human Molecular Genetics 1994;3(9) 1583–1587.
22. Duyka L.J, Fan C.Y, Coviello-Malle J.M,Buckmiller .L and Suen J.Y. Progesterone receptors identified in vascular malformations of the head and neck. Otolaryngology—Head and Neck Surgery 2009 ;141(4) :491–495.
23. Dompmartin .A, Vikkula .M, and Boon L.M. Venous malformation: update on aetiopathogenesis, diagnosis and management. Phlebology 2010;25(5):224–235.

24. Glade R.S, Richter G.T, James C.A, Suen J.Y, and Buckmiller L.M. Diagnosis and management of pediatric cervicofacial venous malformations: retrospective review from a vascular anomalies center. Laryngoscope 2010 ;120(2):229–235.
25. Wang Y.A , Zheng J.W, Zhu H.G, Ye W.M, He.Y, and Zhang Z.Y. Sclerotherapy of voluminous venous malformation in head and neck with absolute ethanol under digital subtraction angiography guidance.Phlebology 2010; 25(3):138–144.
26. Landthaler. M, Haina .D, Waidelich W, BraunFalco O. Laser therapy of venous lakes (BeanWalsh) and telangiectasias. PlastReconstrSurg 1984;73:78–83,
27. Gongloff RK. Treatment of intra oral hemangiomas with nitrous oxide cryosurgery. Oral Surg Oral Med Oral Pathol 1983;56:20–24.
28. Kahout MP, Hansen M, Pribaz JJ, Mulliken JB. Arteriovenous malformations of the head and neck:natural history and management. PlastReconstrSurg 1998;102:643–54.
29. Kohout M.P, Hansen .M, J Pribaz J.J, and Mulliken J.B. Arteriovenous malformations of the head and neck: natural history and management. Plastic and Reconstructive Surgery 1998; 102(3):643–654.
30. Arat .A,Cil B.E, Vargel .I et al. Embolization of high-flow craniofacial vascular malformations with Onyx. American Journal of Neuroradiology 2007;28(7):1409–1414.
31. Burrows PE, Lasjaunias PL, TerBrugge KG, Flodmark O. Urgent and emergent embolisation of lesions of the head and neck in children: indications and results. Pediatrics 1987;80:386–94.
32. Bradley J.P, Zide B.M, Berenstein .A, and LongakerM.T.Large arteriovenous malformations of the face: aesthetic results with recurrence control. Plastic and Reconstructive Surgery 1999; 103(2): 351–361.
33. Visser .A, Fitzjohn .T, and Tan S.T. Surgical management of arteriovenous malformation. Journal of Plastic, Reconstructive and Aesthetic Surgery 2011; 64(3):283–291.