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RESEARCH

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Lymphatic malformations: a 9-year experience at the vascular anomaly clinic

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Abstract

Purpose To share our experience in the management of a specific type of vascular malformations (lymphatic) at a specialized multidisciplinary clinic for vascular anomalies.

Methods Data of patients attending the vascular anomaly clinic during the period 2015 through 2023 were retrospectively analyzed. The study included cases diagnosed primarily as lymphatic malformations (LMs). We excluded cases associated with complex/syndromic vascular malformations. Available data included regional distribution of the LMs, age at presentation, sex, imaging studies, and different modes of treatment.

Results The study included 131 cases of LMs whose data were available for retrospective analysis. Generally, LMs had a benign course with good prognosis apart from two recorded mortalities (1.5%) during the 9-year period of the study. In this series, 93 cases were managed by injection sclerotherapy (Bleomycin). About 57 cases showed satisfactory response to injection sclerotherapy alone without the need to add other treatment modalities. Forty cases underwent surgical excision/debulking. Postoperative wound complications were recorded in 5 cases (12.5%). Sirolimus was offered for patients with LMs after the failure of conventional treatment (injection/surgery) to control associated significant complications.

Conclusion Lymphatic malformations represent a common presentation at the vascular anomaly clinic, which usually have a benign course. Complications are mainly cosmetic especially when involving the face, and sometimes superadded infections may occur. Airway compromise is a potential serious complication with submandibular lymphatic malformations in the neck.

Keywords Sirolimus, Vascular malformations, Macrocystic, Surgery, Bleomycin, Sclerotherapy

Background

Vascular malformations represent a puzzling field in medicine [1]. Its management is distributed among different specialities that it may be described as an "orphan disease in the medical world" [2]. A modern classification for vascular anomalies helped to better understand the disease spectrum and improve outcomes [3–5]. Another advance in this field was related to the development of multidisciplinary teams/clinics to manage such cases requiring the collaboration of different specialities [6]. In this report, we would share our experience in the management of a specific type of

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vascular malformations (Lymphatic) at a specialized multidisciplinary clinic for vascular anomalies.

Lymphatic malformations (LMs) are the second most common vascular malformation after the venous [7]. LMs are typically formed of lymph-filled cysts not communicating with the normal lymphatic channels (extra-truncular vascular malformations) [8]. The cysts are variable in size: large, medium, or small (microscopic). According to the size of the cysts, LMs are broadly classified into macrocystic and microcystic types, or sometimes a mixture of both [9]. Less commonly, LMs may present as a part of complex and syndromic vascular anomalies associated with other soft tissue and skeletal overgrowth [10]. A famous example for these complex vascular anomalies is Klippel-Trenaunay syndrome, which is a combination of venous, lymphatic, and capillary malformations [11]. The complex/syndromic vascular malformations are beyond our scope in this report.

In this report, we would share our experience in the management of a specific type of vascular malformations (lymphatic) at a specialized multidisciplinary clinic for vascular anomalies.

Methods

Data of patients attending the vascular anomaly clinic during the period 2015 through 2023 were retrospectively analyzed. The study included cases diagnosed primarily as lymphatic malformations (macro-/micro-cystic types) [10]. We excluded cases associated with complex/syndromic vascular malformations (Klippel-Traunany syndrome; generalized lymphatic malformations, tissue overgrowth syndromes). Also, we excluded cases of congenital lymphedema that represent a special category with different plans of management [8]. Available data that were retained by the author included regional distribution of the LMs, age at presentation, sex, imaging studies, and different modes of treatment.

Multidisciplinary approach

At our institution, the idea of a multidisciplinary clinic for vascular anomalies was first introduced by the late Professor Alaa Hamza in 2008. Currently, the vascular anomaly clinic is held once weekly. Pediatric surgeons and pediatricians (hematology/oncology) routinely attend the clinic to manage cases in an integrated manner. Paediatric radiologists review imaging studies to be discussed with the clinical team highlighting the differential diagnoses and significant anatomical findings. Injection sclerotherapy (bleomycin) is usually performed by pediatric surgeons; however, for deep lesions, the procedure will need to be performed under radiological control by interventional radiologists. When indicated, lesions in the face are excised by surgeons with special training in plastic surgical procedures. Other specialties may be independently counseled when necessary (ENT, ophthalmology, etc.).

Imaging

Imaging is usually needed to confirm clinical diagnosis and identify deep extension of lesions before intervention. Ultrasound is readily available, which can confirm the multi-cystic nature of LMs without internal vascularity (Fig. 1b). More advanced cross-sectional imaging modalities better demonstrate the deep relations to important nearby structures (Figs. 2 and 3). Magnetic resonance imaging (MRI) is superior for its high soft tissue resolution and multiplanar capabilities. In the pediatric age group, MRI is usually performed under general anesthesia/sedation. When indicated, the study is performed with contrast-enhanced T1-weighted images (Fig. 4) to differentiate between other types of vascular anomalies (venous malformations) [12]. The technique of MRI for vascular anomalies has been described in previous reports in detail [12, 13]. Lymphatic malformations typically appear as multiple cysts of variable size. The cysts are usually hyperintense in T2WI, isointense in T1WI, and with no appreciable post-contrast enhancement except for the capsule and intervening septa (Fig. 4). Fluid–fluid levels may be seen inside the cysts (Fig. 5); this is related to the sedimentation of the variable protein content of the fluid within the cysts (maybe hemorrhage). Microcystic LMs are a special type with very small (microscopic) cysts (Fig. 6). Although computed tomography (CT) may be less informative than MRI, yet CT may be more readily available and easier to perform in emergency situations (no need for anesthesia) (Fig. 3).

Treatment

It is important to make it clear while discussing treatment options with the parents that LMs are benign lesions. It may be unnecessary and sometimes not feasible to completely eradicate the lesions; the goal of treatment is rather to decrease the effect of these lesions as much as possible [5]. This can be achieved through different ways: sclerotherapy, surgery, and medical treatment. Generally, the cosmetic outcome is a main concern; documentation by digital photography before and after treatment (as shown in figures) was of great help to assess the response more objectively by the attending staff of the clinic, in addition to the degree of parental satisfaction.

Macrocystic LMs usually show good but variable responses (decrease in size) to injection sclerotherapy (Figs. 4 and 5). At our center, we use bleomycin as a sclerosing agent for LMs. The procedure is performed

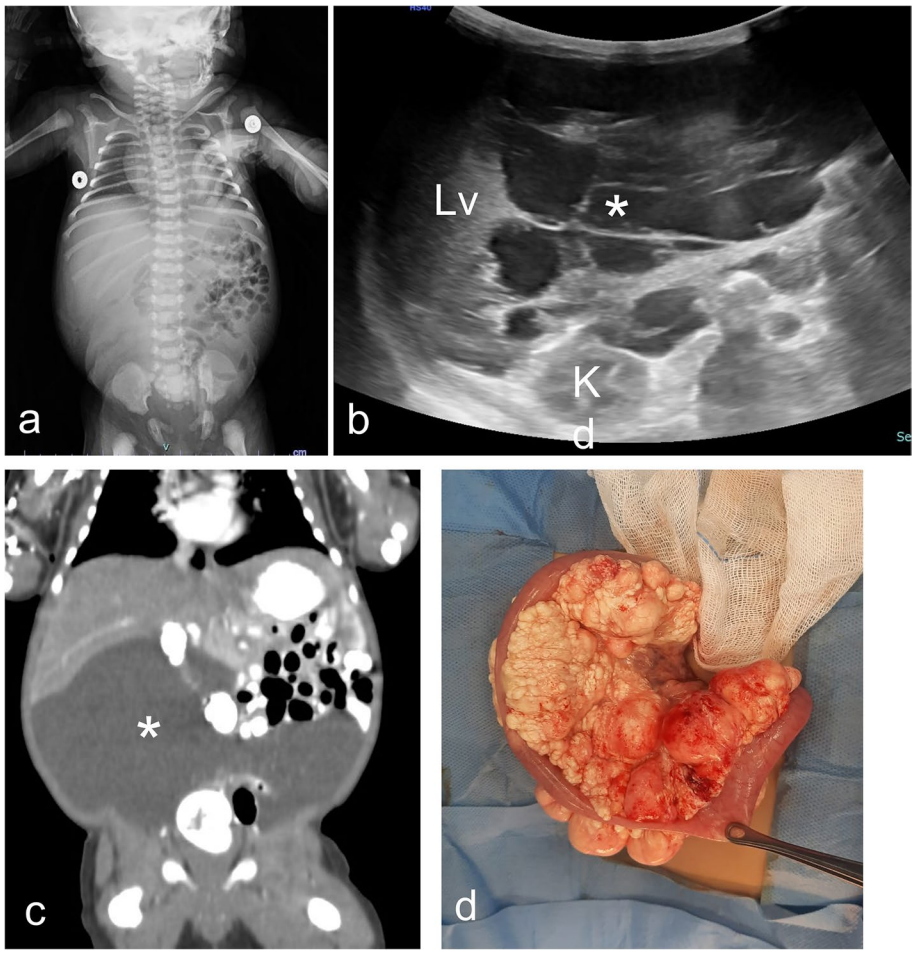

Fig. 1 Mesenteric lymphatic malformation (LM) in a neonate presenting with marked abdominal distension and vomiting. **a** Plain X-ray showing displacement of the bowel to the left side by the large multi-cystic LM. **b** Abdominal ultrasound showing intra-abdominal multi-cystic lesion (asterisk) (Lv: liver, Kd: kidney). **c** Same findings at CT. **d** Intra-operative findings: mesenteric lymphatic malformation

under general anesthesia. At first, the cysts are aspirated and then we inject bleomycin; the dose is 0.2–0.5 mg per kg body weight of bleomycin aqueous solution (1 mg/ml) with a maximum dose of 10 units per session in children less than 2 years of age and 15 units per session in children older than 2 years [14]. Sometimes, there may be an initial increase in the size of LM following injection when we have to wait a few weeks to judge on the final result. Occasionally, with large/diffuse lesions, the procedure may need to be repeated once or twice at 3- to 6-month intervals. The dose of bleomycin injected each time should be documented to avoid reaching the total cumulative toxic dosage that has been estimated as 5 mg/kg [14]. Surgical excision remains a valid way for treating LMs. The location of LMs and the degree of trans-spatial and deep extension is one major decisive factor on the feasibility of surgical excision. Considering the benign nature of LMs, surgical excision should not leave disfiguring scars nor functional disability resulting from injury to important structures and nearby nerves. Partial excision (debulking) may be the only feasible solution for large lesions with deep trans-spatial extensions. Postoperative fluid collections and surgical site wound infections are not uncommon after the excision of LMs [15]; it is recommended to leave drains in the surgical wounds for several days postoperatively [16].

Medical treatment may be as simple as short/protracted courses of antibiotics to control sudden increases in the size of lesions secondary to infection. Sirolimus is a recently introduced drug opening a new era of biomedical genetic therapy with promising results in the treatment of extensive or complicated cases of LMs [17, 18]. The dose of sirolimus is calculated according to body surface area and is further

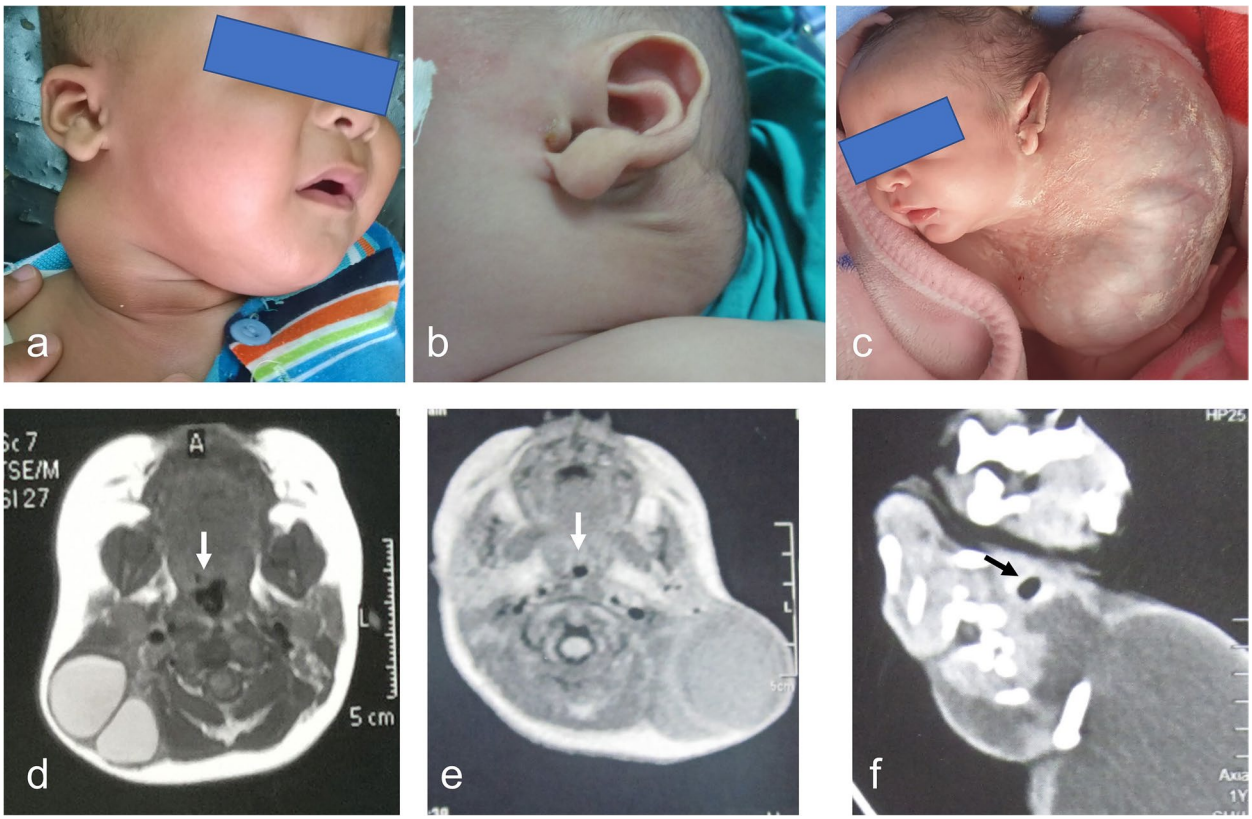

Fig. 2 Lymphatic malformations (LMs) in the posterior triangle of the neck (type 1) in three different cases (**a**, **b**, **c**) and their corresponding cross-sectional imaging (**d**, **e**, **f**), respectively. Note that in this location there is no compromise to the airway (arrow) even when lesions (LMs) are very large in size (**c**, **f**). Our standard practice would be to offer injection sclerotherapy for such cases as a first line, which is usually delayed after the neonatal period (3–6 months of age). However, the third case (**c**) was an exception; the lesion was so huge in size making it difficult to discharge the patient in such condition, when we offered partial excision in the neonatal period and the patient was successfully discharged

adjusted after measuring drug trough level in blood. Sirolimus is administered orally on a continuous dosing schedule at a starting dose of 0.8 mg/m^2, and its level is maintained between 5 and 15 ng/ml.

Results

The study included 131 cases of LMs whose data were available for retrospective analysis. Generally, LMs had a benign course with good prognosis apart from two recorded mortalities (1.5%) during the 9-year period of the study (2015 through 2023).

Regional distribution

About half of cases of LMs were in the head and neck region (74 cases, 56.5%) (Table 1). Table 2 summarizes the regional distribution of LMs in the rest of the body.

Sex distribution

LMs had nearly equal distribution among both sexes (male = 70 cases; female = 61 cases).

Age at presentation

LMs may be diagnosed ante-natally or more commonly at birth. However, many cases were referred to our clinic on an elective basis later in life during infancy or childhood. Even when large, LMs usually have a tendency to grow externally exerting less compression on internal structures (Fig. 2). An exception is submandibular (supra hyoid) neck lesions with deep midline extensions that may compromise the upper airway (Fig. 3). Airway compromise may be noticed after a rapid increase in the size of the lesion secondary to superadded infection or intra-cystic hemorrhage. In this series, only two cases presented with acute severe obstruction necessitating immediate intervention to secure the airway; both cases had submandibular (supra hyoid) LMs. The first case presented with acute respiratory distress at the age of 3 months. A tracheostomy was performed to secure the airway, but unfortunately, the patient died a few days later. The second case presented with airway obstruction at the

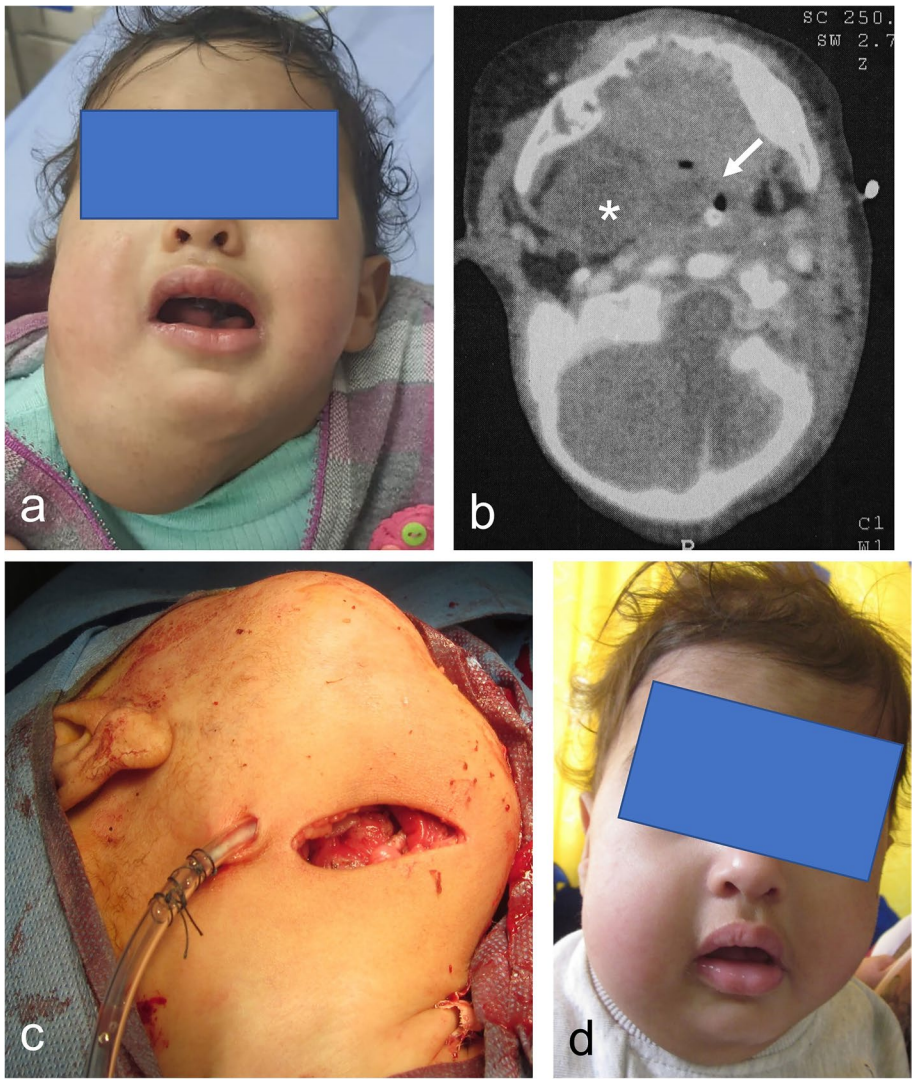

Fig. 3 Eleven-month-old girl with a submandibular lymphatic malformation in the neck (type 2). **a** The patient presented with upper airway obstruction. **b** CT showed the cystic lesion (asterisk) with deep midline extension displacing the airway (arrow). **c** Surgical excision. **d** The patient was successfully discharged after the operation

age of 11 months. The airway was secured by endotracheal intubation; a trial of sclerotherapy was followed by surgical excision and the patient was successfully discharged (Fig. 3). Another example of compressive manifestations by LMs is the closed retro-orbital space when patients present with proptosis. Occasionally, LMs may present with huge size at birth; the other mortality in this series belonged to this group. This was a case that presented in the neonatal period with a huge LM in the axilla; unfortunately, this case died shortly after birth with signs of hypovolemic shock mostly resulting from severe intralesional hemorrhage. Retroperitoneal LMs were discovered accidentally during imaging of the abdomen in two children that were managed conservatively (Fig. 7). This contrasts with mesenteric LMs that commonly presented with marked abdominal distension and signs of intestinal obstruction in the neonatal period (Fig. 1).

Injection sclerotherapy

Injection sclerotherapy was usually the first line of treatment especially for macrocystic lesions in the head and neck to avoid sightful scars (Figs. 4 and 5). We prefer to delay the procedure beyond the neonatal period (3–6 months of age). However, large-sized lesions may be so distressing to the parents and occasionally compromising the airway (submandibular LMs) representing an indication for early intervention

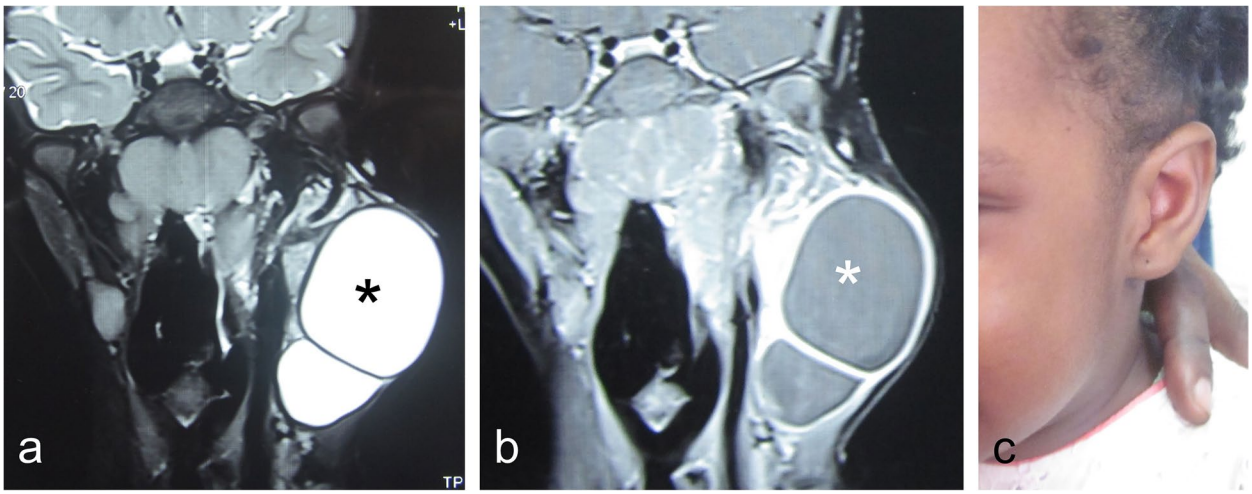

Fig. 4 Three-year-old girl presenting with lymphatic malformation (LM) in the posterior triangle of the neck (type 1). The cysts (asterisk) appear hyperintense on T2-weighted image (**a**), while it appear hypointense on T1-weighted image (**b**) with marginal contrast enhancement. **c** Follow-up showing good response (marked decrease in size of LM) after two sessions of bleomycin injection

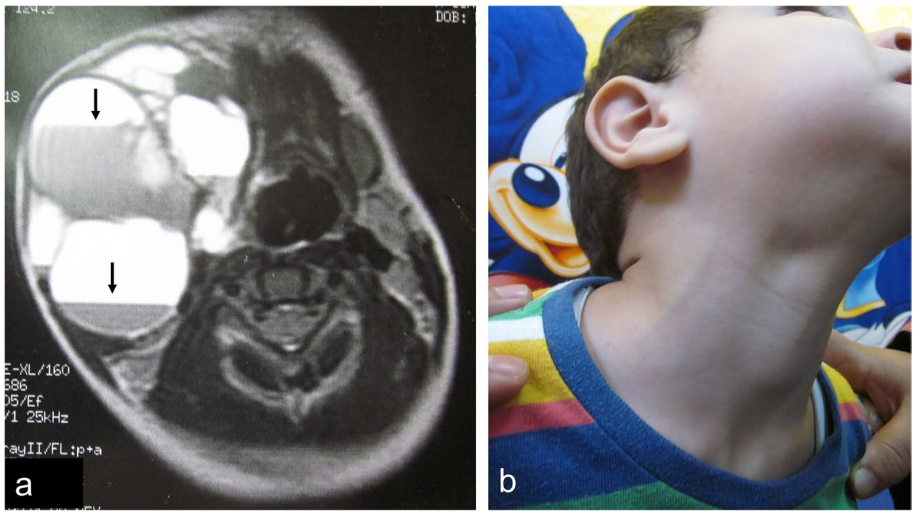

Fig. 5 Eleven-month-old boy presenting with lymphatic malformation (LM) in the submandibular region of the neck (type 2). **a** Axial MRI T2-weighted image demonstrating characteristic fluid–fluid levels (arrows) seen inside the cysts. **b** Follow-up showing good response (marked decrease in size of LM) after two sessions of bleomycin injection

(injection and/or surgery) (Fig. 3). Under general anesthesia, the fluid is aspirated from the lesion followed by an injection of bleomycin solution (0.2–0.5 mg/kg). In this series, 93 cases were managed by injection sclerotherapy (Tables 1 and 2). Partial response (especially with large/diffuse lesions) would encourage repeating the procedure a few months later. However, poor response has been noticed in cases of microcystic LMs, which would favor shifting to another mode of treatment (surgery/medical treatment) (Fig. 6). About 57 cases showed satisfactory response (good cosmetic outcomes) to injection sclerotherapy alone without the need to add other treatment modalities (Figs. 4 and 5).

Surgical treatment

Peripheral localized lesions in limbs and trunk can be best managed primarily by surgical excision (Table 2)

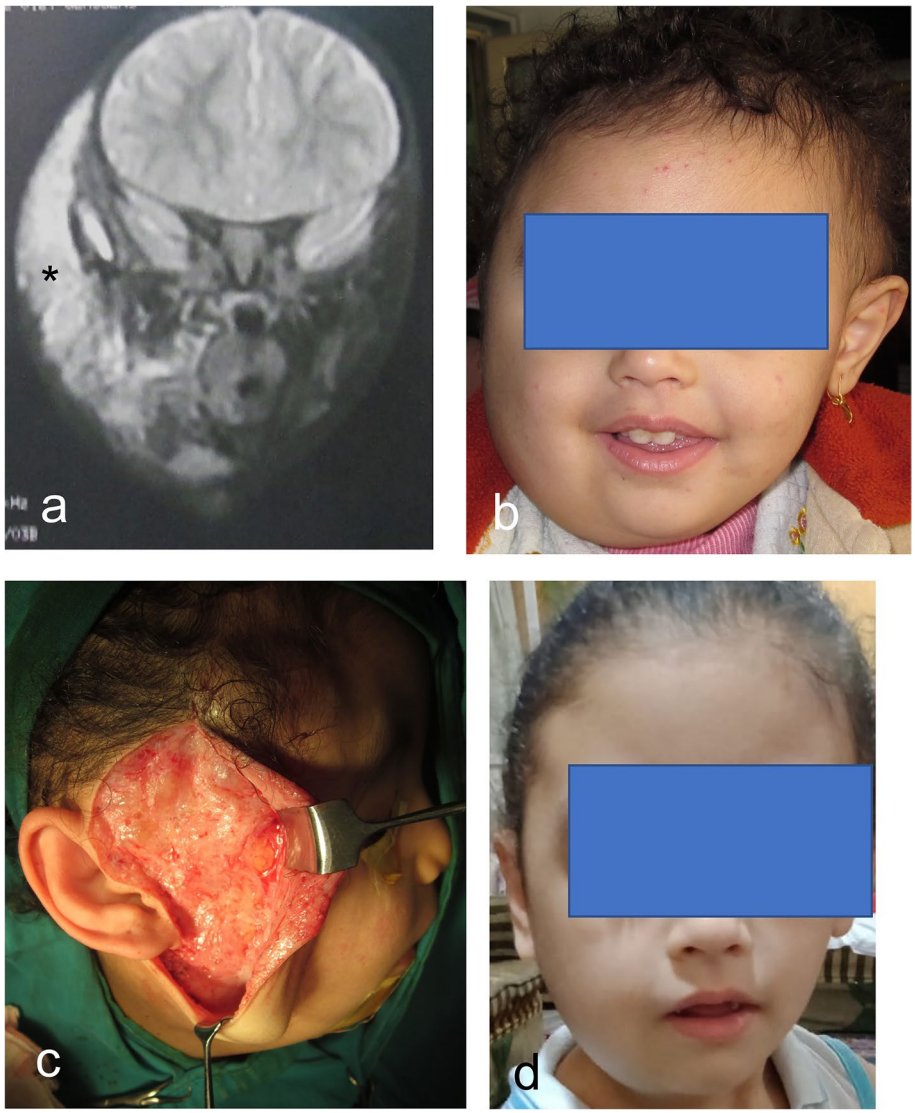

Fig. 6 One-year-old girl with microcystic lymphatic malformation in the right face. **a** Coronal MRI (fat-saturated T2-weighted image) to show the extension of the lesion (asterisk). **b** Poor response to bleomycin injection. **c** Surgical excision through the hidden scar. **d** Follow-up after surgery

(Fig. 8). Also, very large and bulky lesions usually will need some sort of surgical reduction. In the neck region, partial (unsatisfactory) response to injection sclerotherapy or sometimes parent preference were indications for surgery (Table 1). In this series, 40 cases underwent surgical excision/debulking. Postoperative fluid collections and surgical site wound infections were recorded in 5 cases (12.5%): two cases with lesions in the neck, one in the groin, one gluteal, and one postauricular. Microcystic LM was commonly located in the cheek and forehead with a known poor response to injection sclerotherapy; these were best excised through hidden scars (Fig. 6). Regarding tongue lesions, reduction glossectomy can be used to manage persistent significant macroglossia (two cases). Mesenteric LMs were excised by resection and anastomosis of the affected part of the small intestine (Fig. 1).

Sirolimus

This drug was offered for patients with LMs after the failure of conventional treatment (sclerotherapy/surgery) to control associated significant complications. Good examples were cases with bilateral submandibular neck lesions with a high risk of upper airway obstruction (Fig. 9), retro-orbital lesions, large extensive lesions (Fig. 10), and lesions in the face causing significant disfigurement

Table 1 Distribution of cases of LMs in the head and neck region and corresponding mode of treatment

Region	Number of cases	Sex	Affected side	Mode of management		
		Male/female	Right/left/bilateral	Excision	Bleomycin injection	Sirolimus
Posterior triangle of the neck (Type 1)	18	11: 7	9: 9: 0	3	18	0
Submandibular (Type 2)	24	11: 13	9: 9: 6	9	20	6
Parotid	8	5: 3	5: 3: 0	0	8	0
Cheek	8	4: 4	7: 1: 0	4	8	3
Tongue	7	5: 2	N/A	3	0	2
Orbit	5	3: 2	2: 3: 0	0	2	3
Lip	2	1: 1	N/A	1	1	0
Forehead	1	0: 1	0: 1: 0	1	1	0
Post-auricular	1	0: 1	1: 0: 0	1	0	0
Total	**74 cases**	**40: 34**		22	58	14

A single case may receive more than one mode of treatment

Table 2 Distribution of cases of LMs in the rest of the body and corresponding mode of treatment

Region	Number of cases	Sex	Affected side	Mode of management		
		Male/female	Right/left	Excision	Bleomycin injection	Sirolimus
Trunk	14	7: 7	N/A	5	7	1
Axilla	12	3: 9	3: 9	3	10	0
Upper limb	5	3: 2	4: 1	2	3	0
Supra-clavicular	4	4: 0	3: 1	0	4	0
Gluteal	6	4: 2	2: 4	2	4	0
Groin	5	2: 3	2: 3	3	2	0
Lower limb	5	3: 2	3: 2	0	5	0
Abdominal (Mesenteric)	4	3: 1	N/A	3	0	1
Abdominal (Retroperitoneal)	2	1: 1	N/A	Expectant treatment; spontaneous involution		
Total	**57 cases**	**30: 27**		18	35	2

A single case may receive more than one mode of treatment

(Tables 1 and 2). Generally, the drug was well tolerated with few and transient side effects (diarrhea, oral mucosal ulcers). Response to treatment was obvious with marked improvement in proportion with symptoms within 2 weeks from the start of sirolimus, which was well-appreciated by parents attending the clinic (Fig. 10).

Based on our retrospective analysis, a summary of the suggested treatment algorithms for LMs presenting in common regions of the body is presented in Table 3.

Discussion

Lymphatic malformations (LMs) are classified under low-flow vascular malformations [7]. LMs are usually present at birth and grow proportionate to the growth of the child. The sudden increase in size may indicate superadded infection or hemorrhage within the cysts; spontaneous involution has also been reported [9]. LMs have a special predilection to appear in the neck and axilla but can involve any other parts of the body except the brain [7, 8]. Generally, LMs are benign lesions causing mainly disfigurement due to disproportionate growth, in addition to some other few complications related to compressive manifestations in specific locations (neck, retro-orbital, mesenteric, etc.) [9].

Airway compromise is a major concern with LMs in the neck region. De Serres proposed a staging system (score of 5) for head and neck LMs to quantify the degree of severity and functional compromise [9]. In our study, we could differentiate between two main types of LMs occurring in the neck. The first type (type 1)

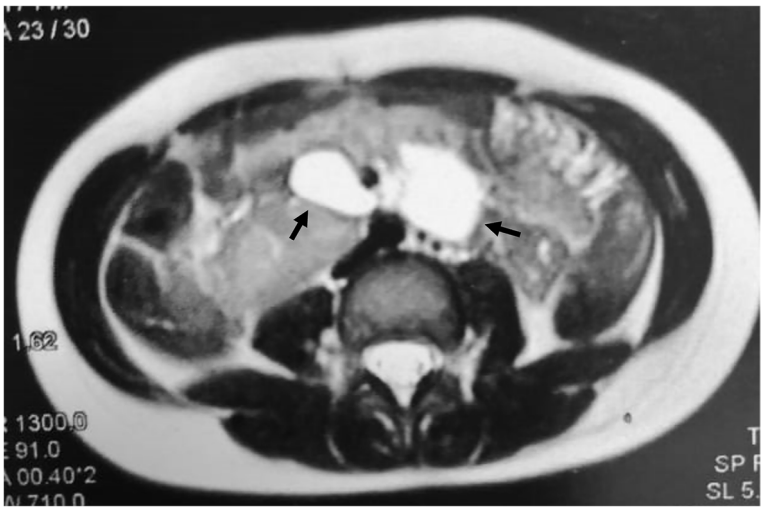

Fig. 7 Retro peritoneal lymphatic malformation in a 13-year-old boy. The cystic lesion was discovered accidentally during an MRI examination of the abdomen (abdominal pain). Note the hyperintense signal of the lesions in T2-weighted images (arrows)

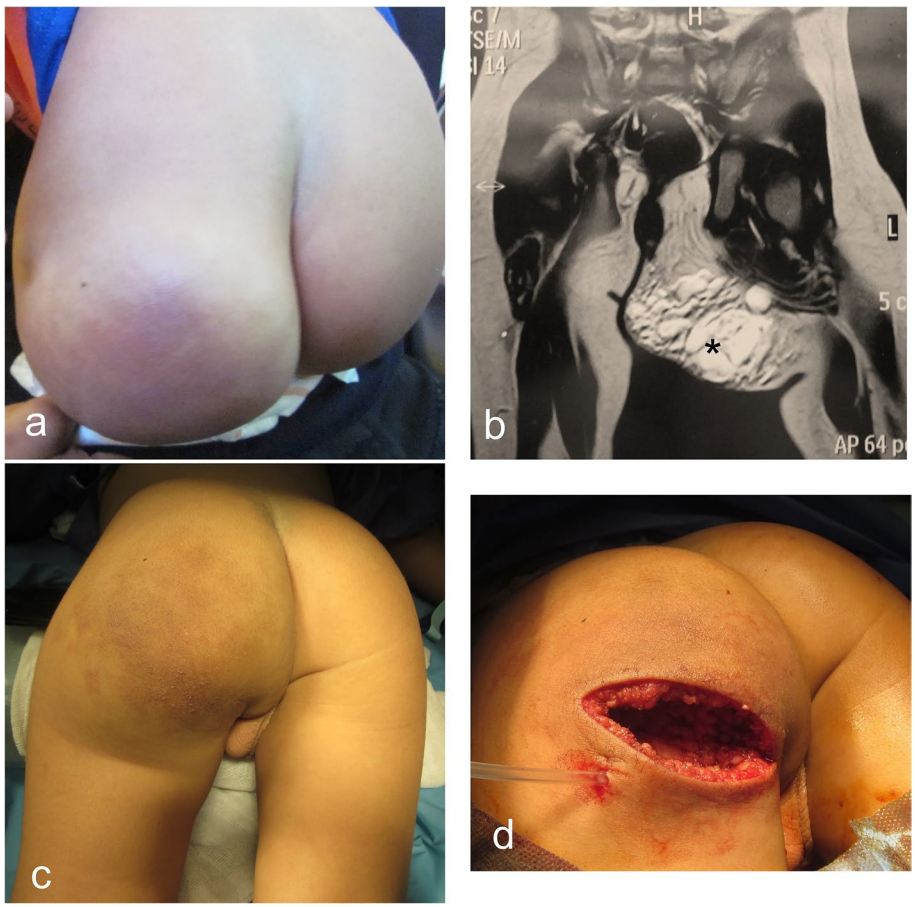

Fig. 8 A 20-month-old boy with left gluteal lymphatic malformation. **a** The patient presented with a sudden increase in the size of the lesion that was present since birth due to superadded infection. **b** Coronal MRI T2-weighted image demonstrating the subcutaneous location of the lesion which was formed of small-sized cysts (asterisk). **c**, **d** After the infection has subsided, the lesion was surgically excised

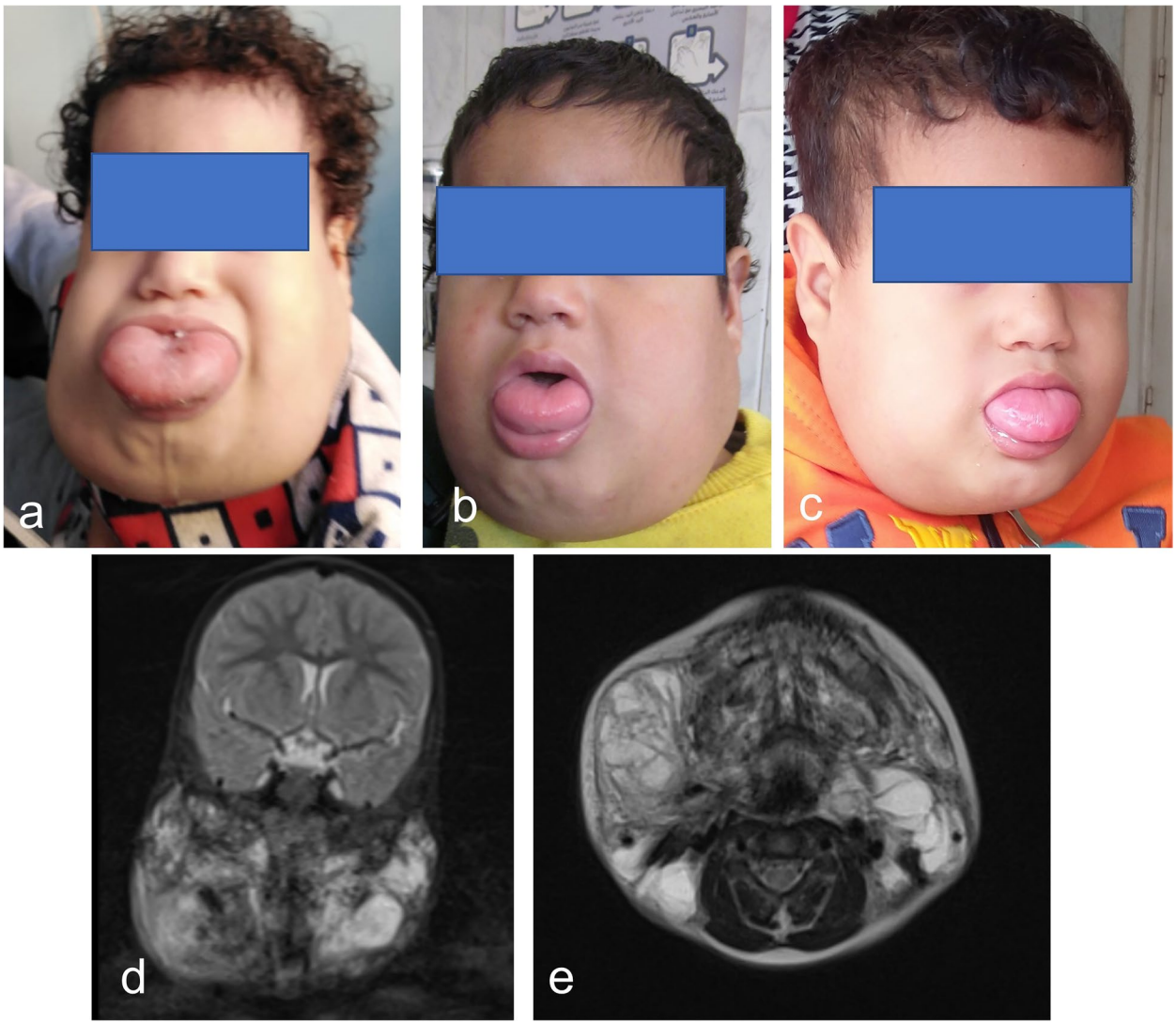

Fig. 9 One-year-old boy presenting with bilateral submandibular lymphatic malformation with involvement of the tongue (macroglossia). Initially, the patient showed poor response to repeated trials of injection sclerotherapy. **a**, **b**, **c** Sequential images of the child showing good response to sirolimus treatment over a period of 15 months. **d**, **e** Coronal and axial MRI (respectively) demonstrating the deep extension of the lesion

was peripherally located in the posterior triangle of the neck, which did not compromise the airway even when lesions were huge in size (Fig. 2). The second type (type 2) located in the submandibular region had an increasing risk of airway compromise (Fig. 3). In the latter type, two cases presented with severe airway obstruction requiring immediate intervention to secure the airway (endotracheal intubation/tracheostomy). Unfortunately, one of these two passed away representing one out of two mortalities in this case series. Occasionally, LMs may present with huge size at birth causing severe disfigurement and posing extra challenges during delivery. Antenatal diagnosis and proper planning for delivery are crucial to avoid unexpected complications [9].

Injection sclerotherapy has been reported to be as effective as surgery for managing macrocystic LMs [5, 9], which have a good prognosis. Different substances may be used for injection sclerotherapy of LMs with comparable results [8]. However, microcystic LMs are much more difficult to treat with a known poor response to sclerotherapy [16, 19]. Moreover, surgery for microcystic LMs may be challenging due to its diffuse trans-spatial extensions, especially in critical areas like the neck (Fig. 9). Pharmacologic treatment has largely been implemented especially with

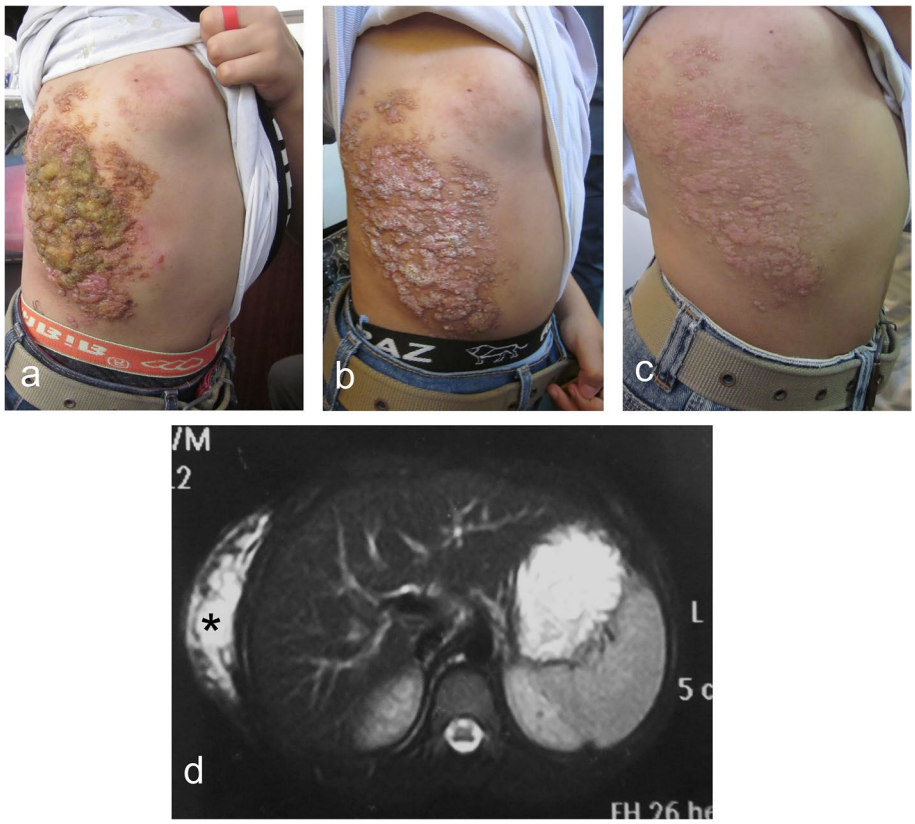

Fig. 10 This boy was referred to us at the age of 11 years with a lymphatic malformation on the right side of his trunk with skin involvement (raised fluid-filled blebs). Due to the diffuse spread of the lesion over a wide area, in addition to severe cutaneous manifestations, we started sirolimus treatment upon referral. Sequential images of the patient at presentation (**a**), 2 weeks after the start of sirolimus treatment (**b**), and 8 months later at follow-up (**c**) (still on sirolimus). **d** Axial MRI fat-saturated T2-weighted image to demonstrate the deep extension of the lesion (asterisk)

the identification of germline and somatic mutations of intracellular signaling pathways in LMs. With the previous targeting of the PI3K-AKT-mTOR and RAS-MAPK pathways in cancer, several treatment options have been used; the commonest used drug is the mTOR inhibitor Sirolimus, yet other targeted treatment has been used in complex LMs with variable results. The introduction of sirolimus has revolutionized the management of these difficult cases by improving outcomes and avoiding morbidity/complications of surgery in critical areas [9]. In a previous study [20], we have reported on improved quality of life scores in such complicated cases after the introduction of sirolimus in their management.

The role of surgery in the management of LMs is still well appreciated [16]. Localized peripheral lesions (trunk, limbs) can be best managed primarily via surgical excision cutting a long story short. Also, mesenteric LMs can be surgically excised by resection anastomosis of affected bowel segments. Furthermore, surgery may be used as a second line after a less satisfactory response to other modes of treatment (injection sclerotherapy, medical treatment) [9]. Significant macroglossia usually show poor response to non-operative management when partial glossectomy (central wedge resection) can offer a relief for such patients [16].

Over the past years, advances in the field of vascular malformations have been achieved thanks to the efforts and cooperation of pioneers from different specialities, in addition to the introduction of new drugs, and new diagnostic and interventional modalities. However, to the best of our knowledge, there is no consensus or guidelines for treatment options. Several factors would affect the choice of treatment depending on the size and location of lesions, degree of trans-spatial spread, proximity to vital structures, and available expertise. Here, we tried to share our experience in the management of a relatively large case series of LMs at a multidisciplinary facility; we proposed a suggested treatment algorithm as an example putting into consideration the variable individual factors in addition to newly introduced medical therapeutic options. More research is

Table 3 Summary for treatment algorithm of lymphatic malformations presenting at common locations

Region	Subtypes	Pathology	Complications/presentation	Treatment
Neck	Type 1: posterior triangle (Figs. 2,4)	Mostly macrocystic; usually unilateral	Mostly disfigurement Infection, pain	1st line: injection sclerotherapy 2nd line: surgical excision
	Type 2: submandibular (Figs. 3,5,9)	Significant microcystic component; may be bilateral + tongue involvement	Potential risk of airway obstruction due to midline extension Disfigurement, infection, pain	May need emergency procedure to secure airway (Fig. 3) 1st line: injection sclerotherapy ± **sirolimus** 2nd line: surgical debulking
Head	Parotid	Macrocystic / mixed	Mostly disfigurement Infection, pain	Injection sclerotherapy
	Face (cheek, forehead)	Microcystic	Mostly disfigurement	Combined treatment: injection sclerotherapy, **sirolimus**, surgery through hidden scars (Fig. 6)
	Tongue (Fig. 9)	Microcystic	Localized painful and bleeding mucosal lesions/vesicles Generalized macroglossia	**Sirolimus** can rapidly control pain and bleeding Injection usually has poor response Surgery for localised lesions or reduction glosso-plasty
	Retro-orbital	Medium sized cysts	Proptosis	**Sirolimus** Injection sclerotherapy
	Lips	Microcystic	Disfigurement	Injection sclerotherapy Surgery to reduce the size
Limbs and trunk	Axilla, chest wall, groin	Mostly macrocystic	Mostly disfigurement Infection, pain	Injection sclerotherapy Surgery (debulking)
	Gluteal	Combined macro-/micro cystic	Mostly disfigurement Infection, pain (Fig. 8)	Surgical excision/ injection sclerotherapy
	Arms, forearms, legs	Macrocystic	Mostly disfigurement Infection, pain	Surgical excision/ injection sclerotherapy

still needed in the field including randomized controlled studies and meta-analysis of data from different centres hoping to reach internationally accepted therapeutic guidelines.

Conclusion

Lymphatic malformations represent a common presentation at the vascular anomaly clinic, which usually have a benign course. Complications are mainly cosmetic especially when involving the face, and sometimes superadded infections may occur. Airway compromise is a potential serious complication with submandibular lymphatic malformations in the neck.

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Authors' contributions
Data acquisition, analysis, and interpretation were performed by all authors (AA, SM, NA, WG, MS, IR, OE, and MA). AA made the drafting of the manuscript. All authors have read and approved the final manuscript.

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Declarations

Ethics approval and consent to participate
All methods were carried out in accordance with relevant guidelines and regulations. Informed parental consent was taken before operation in all cases. Owing to the retrospective nature of the study, an IRB number was not required, and the study was approved through expedited review by the scientific/ethical committee of the Pediatric Surgery Department (Faculty of Medicine, Ain-Shams University).

Consent for publication
Not applicable. Patient identity did not appear in any part of the manuscript; therefore, consent for publication was not required.

Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests
The authors declare that they have no competing interests.

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