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REVIEW

Ultrasound evaluation of superficial lesions caused by ectoparasites in children

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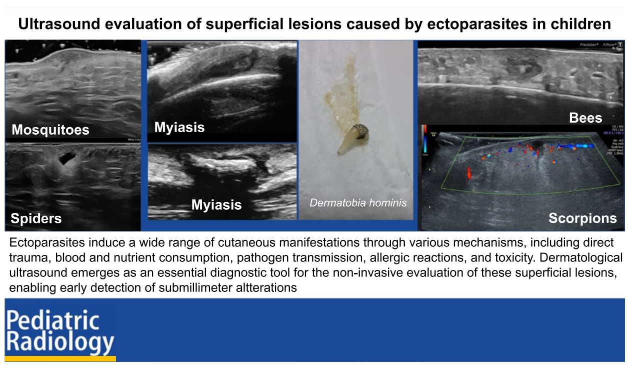
Abstract
Ectoparasites affect the skin, causing different clinical manifestations through direct mechanical damage, blood consumption, pathogen transmission, hypersensitivity reactions, or toxin inoculation. Dermatological ultrasound is the imaging modality of choice to evaluate these superficial lesions, detecting submillimetric alterations in a non-invasive and innocuous way. This review helps the radiologist describe the imaging findings of lesions caused by mosquitoes, myiasis, bees, spiders, and scorpions, with suggestive ultrasound patterns.

Graphical Abstract



Keywords Bees · Child · Culicidae · Myasis · Spiders · Scorpions · Ultrasonography

Introduction

Ectoparasites are pathogens that infect only the surface layers of the skin, including parasitic flies and temporary hematophagous arthropods such as mosquitoes. Humans can be obligated hosts of several types of ectoparasites and can occasionally function as accidental hosts [1]. Other insects, like Hymenoptera (including bees) and arachnids (like spiders and scorpions), can accidentally inject poisonous

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secretions [2]. These organisms can cause direct mechanical damage, consume blood or nutrients, induce hypersensitivity reactions, inoculate toxins, and send pathogens [3].

Ultrasonography has proved itself as an essential tool for assessing skin lesions caused by these insects, as it can detect submillimeter alterations that are difficult to detect on computed tomography and magnetic resonance imaging [4]. It is non-invasive in nature and its high resolution makes it a safe and accurate technique for visualizing tiny anatomical details, making it especially attractive when working with children [5]. By employing high-frequency transducers and Doppler mode, ultrasound provides high-resolution images allowing detailed soft tissue characterization and right quantification of blood flow in lesions [6–8]. This non-invasive technique is invaluable for the differential diagnosis of skin lesions, as it allows the clear visualization of the different layers of the skin and subcutaneous tissues. The epidermis is seen as a hyperechoic line, while the dermis presents a slightly less echogenic appearance. The papillary dermis is sometimes visualized as a superficial hypoechoic zone. Subcutaneous cellular tissue, on the other hand, is characterized by a network of hyperechoic lines that delimit the adipose lobules [6, 9–11].

Despite the relatively sparse literature on ultrasound's application in ectoparasite-induced skin lesions, recent technological advancements have underscored its utility as an adjunct diagnostic modality. Ultrasound can help therapeutic decisions and improve diagnostic accuracy, especially in the context of imported tropical and parasitic diseases [8, 9, 12]. The surges in tourism and global migration have necessitated sonographers to possess a comprehensive understanding of the sonographic manifestations of these pathologies [12].

This manuscript aims to provide a pictorial ultrasound review of lesions caused by mosquitoes, including *Aedes aegypti*, and myiasis caused by *Dermatobia hominis*, bees, spiders, and scorpions where we present the ultrasonographic features of palpable and non-palpable lesions, providing an overview of how ultrasound can individualize, advise, and serve as an adequate guide for further treatment.

Mosquitoes

Mosquitoes are the insects that bite children the most, especially in high-temperature conditions [3]. Unlike males, females bite humans and animals to complete their life cycle, being the main cause of pruritic manifestations. They are attracted to specific properties of the skin and sweat and prefer to bite on the arms, legs, and head [13].

Mosquito bites usually induce local skin reactions through the classic pruritic and inflammatory pathways, triggered by salivary components, IgE-mediated hypersensitivity, and modulations of the host immune response. The spectrum of manifestations can vary depending on the individual's susceptibility. Bites are usually solitary, without significant swelling, or can cause a local skin reaction and hives, with rashes peaking within 20 min, to blistering reactions. Itchy, indurated papules may appear 24 h to 36 h later and disappear within the next few days or weeks. Many of these reactions are transient and self-limiting [3, 13, 14]. Secondary lesions, such as excoriations, scarring, and hyperpigmentation can develop from scratching and may obscure the underlying primary skin findings. Furthermore, mosquito-borne diseases like Zika, Chikungunya, and dengue, as well as their treatments, can induce pruritus and lead to a generalized maculopapular rash [15]. Desensitization to mosquito bites can develop during childhood or through repeated exposure to mosquito antigens. It should be noted that there is no cross-reactivity between different mosquito species. Individual susceptibility to mosquito bites varies depending on the frequency of bites and specific species or population of mosquitoes to which they have been previously exposed [16].

Ultrasound findings

To characterize mosquito bite lesions, we propose an ultrasound analysis in at least two orthogonal planes. The location, size, echogenicity, and margins of focal lesions will be evaluated and compared to the contralateral or adjacent unaffected skin to aid in identification [4, 5, 17]. Ultrasound can identify focal dermal edema within the dermis caused by mosquito bites. This edema is characterized by thickening and altered echogenicity, which is a key finding to differentiate local reactions from generalized inflammatory processes like urticaria. The presence of hyperemia on color Doppler ultrasound further supports the acute phase of inflammation [18] (Fig. 1). Ultrasound can also aid in the diagnosis of cellulitis, which typically presents with thickening of the subcutaneous fat, "cobblestone" pattern, and obliteration of the dermohypodermal interface [19] (Fig. 2). Secondary bacterial superinfection can lead to skin abscess formation, characterized by rounded or irregular lesions with well-defined or poorly defined borders. The contents of these abscesses can vary from liquid to purulent, resulting in a range of echogenicities, from anechoic to hyperechoic. Internal echoes, septations and debris are common findings. Posterior acoustic reinforcement is another frequent finding. Importantly, the ultrasound appearance of an abscess can mimic cellulitis, especially when the content is isoechoic or hyperechoic (Fig. 3). In these cases, the presence of mass effect and the identification of a well-defined wall can help to differentiate both processes [17–19] (Fig. 4).

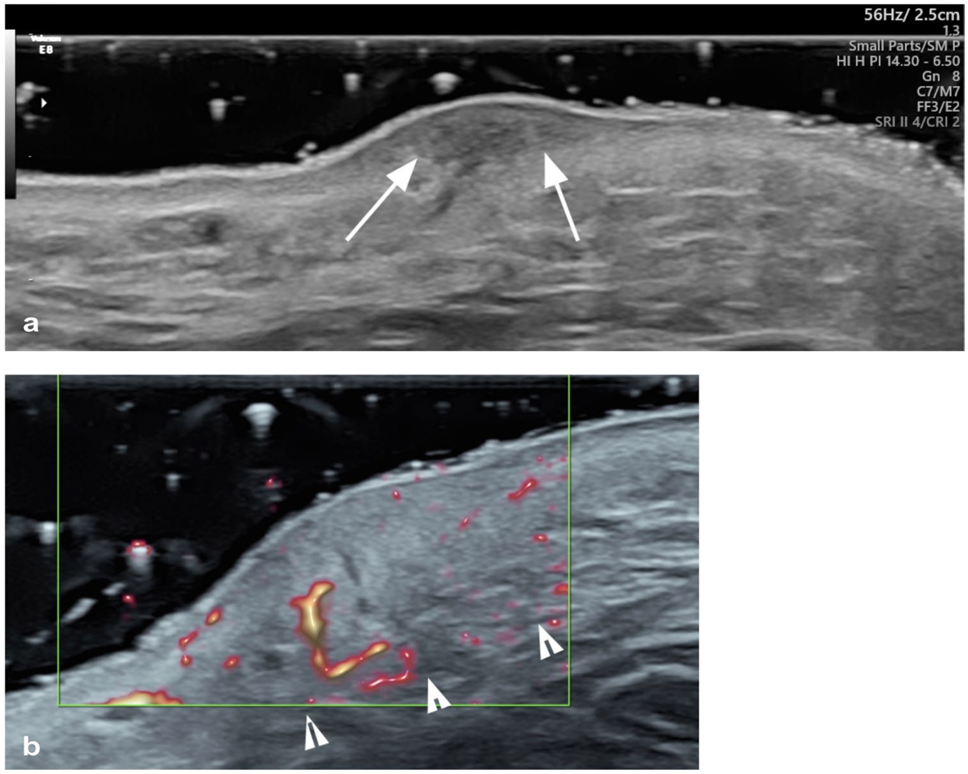

Fig. 1 A 7-year-old girl with an itchy lesion on her right cheek after a mosquito bite. **a** Transverse ultrasound with a high-frequency (56 Hz) linear transducer shows a dermal collection that displaces and protrudes the epidermis. The dermis is thickened with decreased echogenicity, and minimal involvement of the hypodermis (*arrows*). **b** Significant increase in vascularity on the power Doppler examination, especially in the dermohypodermal border (*arrowheads*)

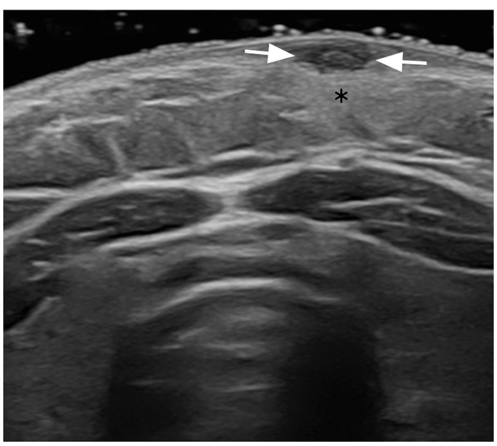

Fig. 2 An 11-year-old girl developed an *Aedes aegypti* bite on the anterior part of the neck. Transverse grayscale ultrasound, performed with an 18-MHz linear transducer, shows a small hypoechoic dermal accumulation extending into the hypodermis (*arrows*). Subcutaneous fat shows increased echogenicity (*asterisk*)

Myiasis

Myiasis is an infection caused by the development of larvae of various flies of the order Diptera, which are characterized by having two wings in their adult form [20]. *Dermatobia hominis* is a Diptera twice in size as a common housefly, with a deep metallic blue abdomen. Its larvae are the most common cause of subcutaneous, tumorous, and furunculous myiasis in these regions, often causing significant pain in the final stages of infection [21].

This infection has a worldwide distribution, with seasonal variations depending on the geographical latitude and life cycle of the distinct species of flies, which require a warm and humid environment for their development. The highest incidence of myiasis occurs in the tropics and subtropics of Africa and the Americas throughout the year and in temperate zones during the summer [20].

During flight, adult female flies deposit and attach their eggs to the abdomen of hematophagous arthropods that function as mechanical vectors called phoretic. This transport phenomenon is known as phoresis. Eggs with larvae can remain for 7 days to 30 days in the abdomen of these insects, waiting for a host [20, 21].

When blood-sucking insects land on the skin to suck blood, the body heat triggers the hatching of the small larvae, which are introduced through the microwound left by their transporter. This condition is not exclusive to humans and can affect other vertebrates.

Once the fly larva penetrates the subcutaneous tissue, it induces an inflammatory response that culminates in the formation of a nodule. This nodule has a small opening, known as a blowhole, through which the larva exchanges gases. During its larval development, which can last approximately 2 months, the larva undergoes several molts and increases its size considerably. To avoid secondary bacterial infections,

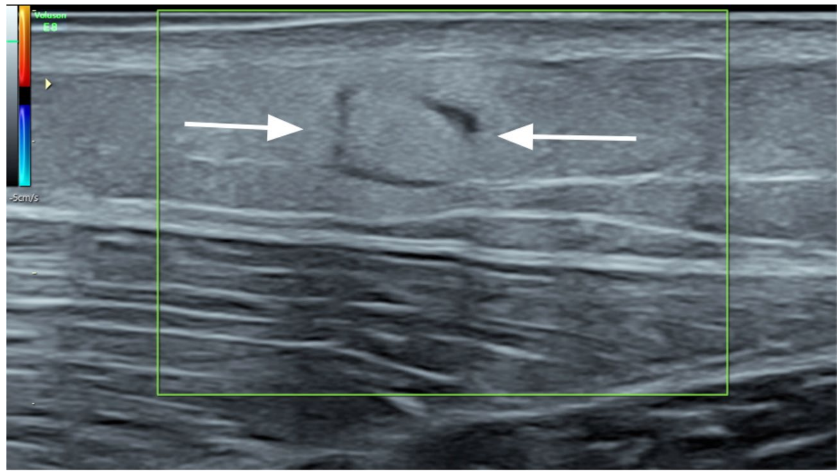

Fig. 3 A 5-year-old boy with a mosquito bite on the anterior left thigh underwent an ultrasound. The longitudinal view shows thickening, increased echogenicity, and cobblestone appearance of the hypodermis. Also, note the small layer of fluid inside the subdermal fat, with no color Doppler flow inside (*arrows*)

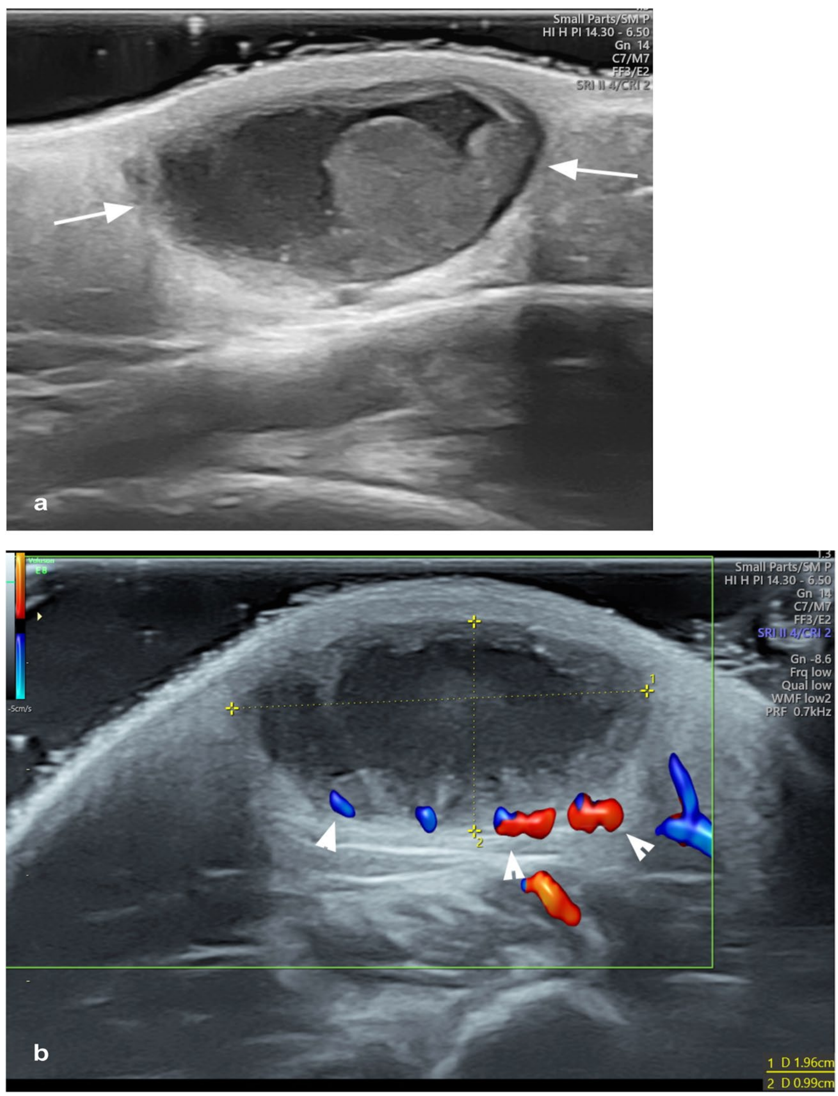

Fig. 4 Mosquito bite on the arm of a 5-year-old boy, with superinfection due to scratching. **a** Transverse view of ultrasound of the right thigh showing a heterogeneous dermohypodermic collection, with precise margins and heterogeneous content, producing a mass effect on the muscular serosa and increasing the echogenicity of the hypodermic fatty tissue (*arrows*). **b** Color Doppler examination shows a significant increase in flow in its periphery, especially at its base (*arrowheads*)

it secretes substances with antibiotic properties that allow it to feed on necrotic and devitalized tissue, without microbial competition. At the end of its development, the mature larva, or third stage, leaves the host through the entry hole, falling to the ground to pupate and complete its life cycle.

Cutaneous myiasis can manifest itself in many ways. Furunculous cutaneous myiasis: The larva excavates a cavity in the subcutaneous tissue, generating an inflammatory nodule like a boil. Cutaneous myiasis migrans: The larva moves through the tissue planes, creating sinuous paths that can be palpable and painful. Cavity myiasis: Larvae can invade natural cavities such as the eyes (ophthalmomyiasis), ears, nose, mouth, urogenital tract, and, in rare cases, the central nervous system (cerebral myiasis) or gastrointestinal tract [22] (Fig. 5). On physical examination, it may present as a persistent skin infection, abscess, or insect bite, or a combination of these. It usually begins as an erythematous papule that progresses to a pustule and can drain fluid. In severe cases, painful subcutaneous nodules may be seen [23].

Ultrasound findings

Cutaneous myiasis generally affects the scalp, arm, and forearm and manifests sonographically as a well-defined oval, subdermal, hyperechogenic mass of 1–1.5 cm in length with posterior acoustic shadow and internal blood flow seen with color Doppler evaluation. The spontaneous movement of the lesion, as observed in real-time ultrasound examinations, aids in the identification and quantification of larvae. These lesions typically present with an anechoic or hypoechoic center, where the larva is located [22, 23].

The echogenicity of the lesion can vary, but it often presents with a peripheral hypoechoic halo caused by the inflammatory reaction and a hyperechoic center corresponding to the larva (Fig. 6). Color Doppler ultrasound shows in addition to spontaneous larval movement, spiracles, and intralarval fluid transport [12].

These findings enable us to differentiate myiasis from other lesions, such as abscesses or cysts, which typically show a heterogeneous echostructure and lack internal movement [24] (Fig. 7). Following the removal of larvae, the lesion often resolves spontaneously, leaving minimal scarring. However, it is crucial to carefully examine the cavity to exclude the possibility of any remaining larvae or residual collections that may require drainage [25] (Fig. 8).

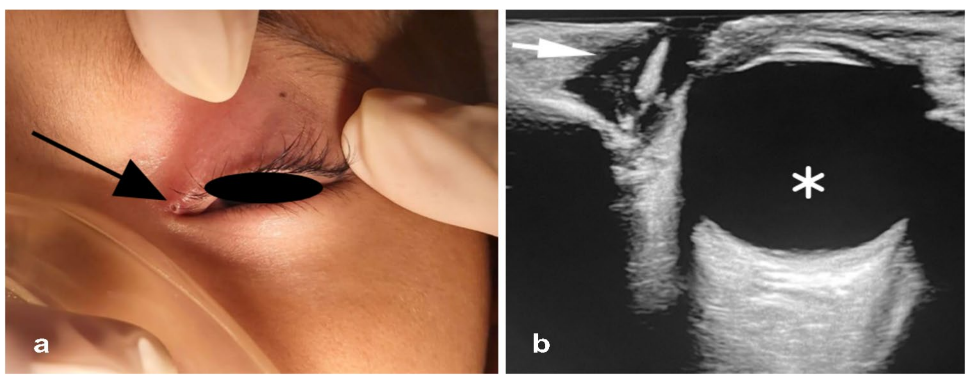

Fig. 5 **a** A 6-year-old girl with edema and redness of the left upper eyelid, increased swelling in the region of the tear duct, with an opening in the skin at that location (*arrow*). **b** Transverse view of ultrasound performed with a 15-MHz linear transducer, showing the eyeball (*asterisk*) and, in the region of the tear duct (*arrow*), a linear echogenic image surrounded by a hypoechoic halo

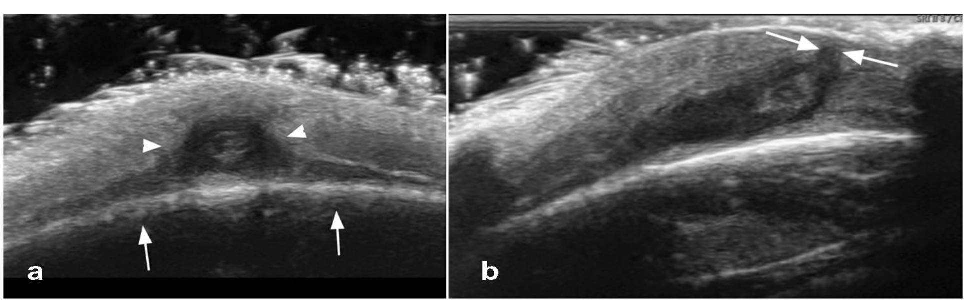

Fig. 6 A 4-year-old boy with myiasis on the right parietal region underwent ultrasound with a high-frequency linear transducer. **a** The transverse view of the ultrasound shows a cystic lesion containing a larva within the subcutaneous tissue (*arrowheads*). The overlying skin appeared normal with minimal dermal thickening. A free space was seen between the subcutaneous fat and the aponeurotic galea, with no abnormalities in these layers or in the epicranium (*arrows*). **b** Longitudinal ultrasound shows a pseudocystic structure of approximately 8 mm directed toward the blowhole, found on the surface of the skin (*arrows*)

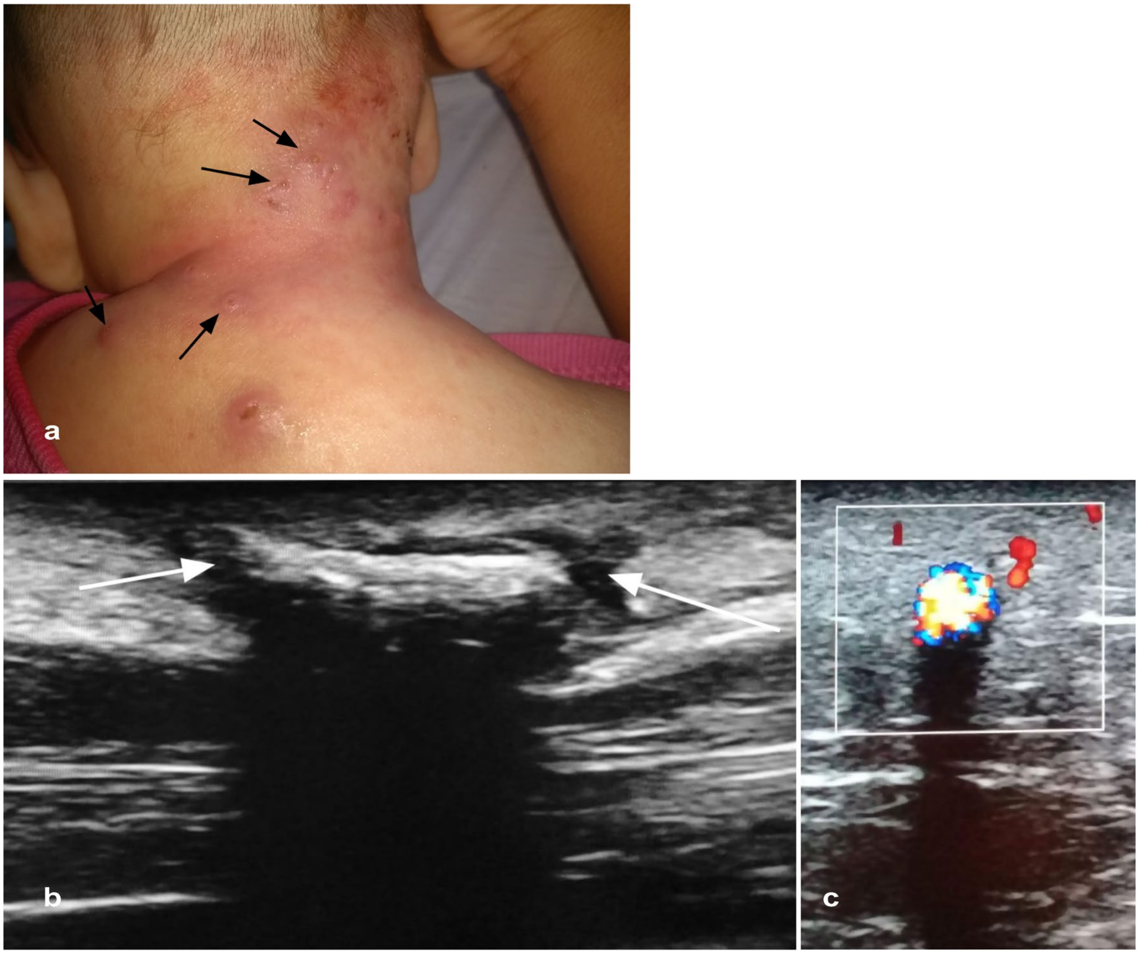

Fig. 7 **a** An 8-month-old girl presented with multiple serosanguinous maculopapular lesions in exposed areas of the neck and upper back, present for 1 month (*arrows*). **b** Longitudinal view of the ultrasound of one of the lesions with a 7.5-MHz linear transducer shows a linear echogenic structure within the hypodermis with a surrounding hypoechoic halo (*arrows*) and posterior acoustic shadowing. **c** Color Doppler in the transverse view shows a marked increase in blood flow during larval movement

Bees

Bee (*Apis mellifera*) stings are a major public health concern, especially in regions with high hive density. Bee venom induces local inflammation and, in allergic individuals, may trigger systemic reactions including urticaria, angioedema, and, in severe cases, anaphylactic shock. The severity of reactions can vary significantly. Mass poisoning, defined by more than 50 stings, can lead to hemolysis, rhabdomyolysis, and acute kidney damage.

Local reactions to bites are usually self-limiting and consist of erythema, edema, and pain. The presence of a stinger at the sting site confirms the etiology [26]. Additionally, a shorter interval between the sting and the onset of systemic symptoms indicates a more severe allergic reaction [27].

In children, Hymenoptera bites are common and mostly cause mild local reactions. However, systemic allergic reactions can also occur [28].

Ultrasound findings

Ultrasound imaging is a valuable diagnostic tool for assessing bee stings. Stingers appear as small highly echogenic structures with a characteristic posterior acoustic shadow. Surrounding the stinger, hypoechoic halos represent reactive tissue changes, such as hematoma, edema, and granulation tissue [29]. Color Doppler ultrasound can further delineate the inflammatory response by demonstrating hyperemia surrounding the affected area. Ultrasound evaluation can provide immediate imaging guidance for removal, minimize complications, and improve clinical outcomes [29, 30] (Fig. 9).

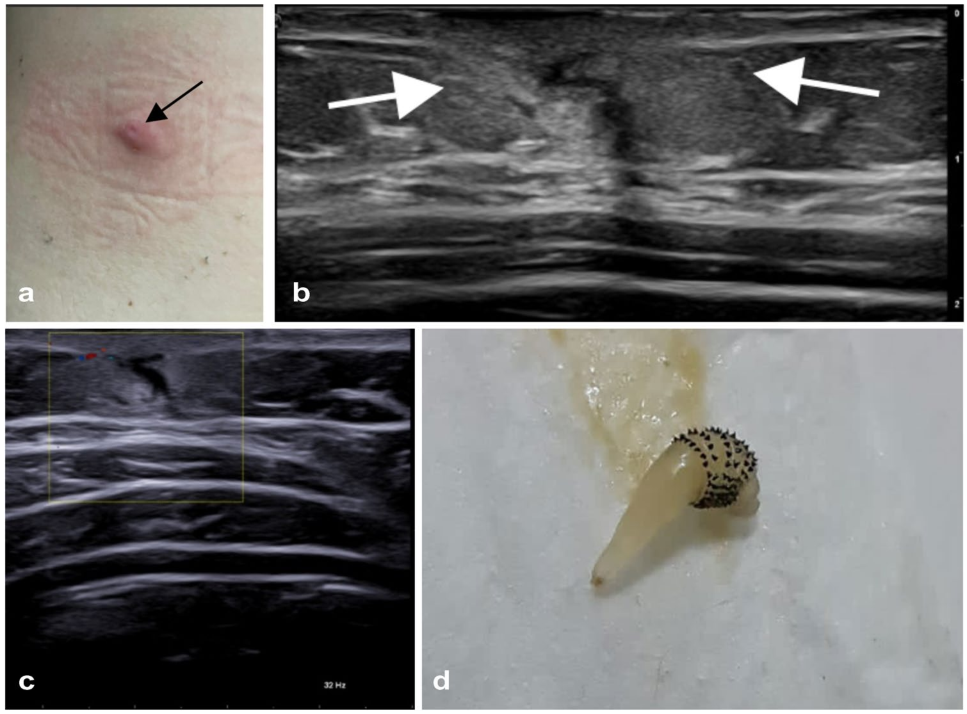

Fig. 8 A 15-year-old girl presented with a painful nodular lesion on the right flank, which had been present for more than a month. Drainage was performed and a larva of approximately 2 cm was removed. **a** Extraction site with a central cavity (*arrow*). **b** Longitudinal view of the ultrasound performed with a 15-MHz linear transducer revealing a cystic hypodermic lesion, compatible with the larval nest, surrounded by an inflammatory halo (*arrows*). **c** Transverse view where color Doppler shows no blood flow within the lesion. **d** The larva, in its third stage of development, had a characteristic appearance with multiple rows of black spines

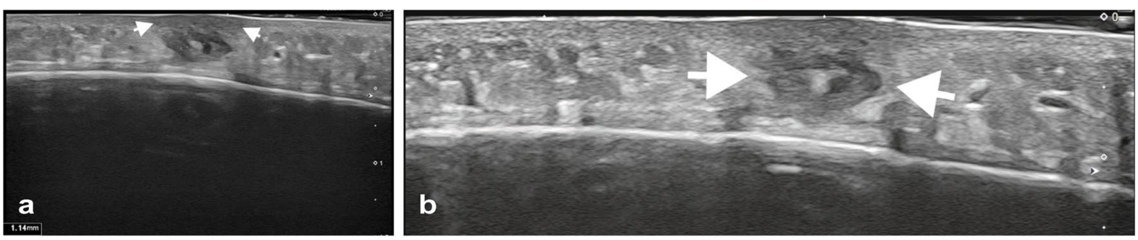

Fig. 9 A 2-year-old boy with a history of bee sting. **a** Transverse view of the ultrasound of the right forehead shows the dermis with slight thickening and decreased echogenicity, which is compatible with edema (*arrows*). No fistulous tract was found on the skin surface. **b** The longitudinal view shows the granulation tissue as a hypoechoic halo in the hypodermis containing a 1.1-mm hyperechoic linear structure corresponding to part of the stinger (*arrows*)

Spiders

Loxosceles spiders, commonly known as recluse spiders, inflict a clinical syndrome termed loxoscelism [31]. This condition can manifest in two forms: cutaneous loxoscelism, characterized by localized skin lesion; and cutaneous-visceral or systemic loxoscelism, a more severe form involving systemic complications, with the latter being less frequent. The characteristic skin lesion typically begins as an erythematous macula that progresses to a livedoid plaque and, ultimately, a necrotic eschar. Bites commonly occur on the extremities, face, thorax, and neck [32]. Systemic complications, such as hemolysis, thrombocytopenia, and disseminated intravascular coagulation, may arise [33]. The venom of *Loxosceles* spiders contains sphingomyelinases, which induce cell damage and tissue necrosis, underlying the pathogenesis of loxoscelism. Bites usually occur when spiders feel threatened.

The severity of loxoscelism varies widely, ranging from localized skin necrosis to severe multi-organ involvement, including kidney damage and coagulation disorders. Initial symptoms are often non-specific and include local pain, fever, and malaise [34]. The severity and progression of the disease are influenced by factors such as the patient's age, immune status, and venom dose [35].

Ultrasound findings

Contrary to what is mentioned in the literature [32], ultrasound findings in *Loxosceles* lesions can clearly prove acute inflammation of all skin layers, characterized by dermal and hypodermic thickening with increased echogenicity and distinctive cobblestone pattern, resulting from edema and fluid accumulation within the interlobular septa [16, 17]. Ultrasound examination demonstrates the gradual incorporation of hypoechogenic strands within the superficial layers of the skin, along with fluid accumulation. These findings suggest severe vascular alterations, including areas of vasoconstriction and hemorrhages that will lead, if not diagnosed in time, to local ischemia and some cases, gangrenous plaque formation [36] (Fig. 10).

The differential diagnosis in the case of cutaneous loxoscelism should be made with bites from other insects and arachnids, herpes simplex, herpes zoster, erysipelas, anthrax, cutaneous lupus erythematosus, angioneurotic edema, and vasculitis [32].

Scorpions

Scorpion poisoning, a major public health problem in tropical and subtropical regions, can induce a spectrum of clinical manifestations ranging from localized pain to life-threatening organ failure [37]. The toxicity of venom varies according to the species of scorpion and individual susceptibility, with populations of children and elderly populations particularly vulnerable [38].

Scorpion stings, which usually affect the lower extremities, initially cause severe pain, erythema, edema, and paresthesia. The Isbister and Bawaskar classification helps assess the severity of the poisoning and guides treatment [39]. Within 24 h, cutaneous manifestations may progress rapidly, encompassing urticarial plaques, hemorrhagic blisters, and, in severe cases, tissue necrosis, reflecting venom-induced vasculopathy and coagulopathy.

Systemic complications can be severe, including fever, jaundice, generalized edema, disseminated intravascular coagulation, anaphylaxis, acute organ failure (pancreatitis, liver, kidney), metabolic acidosis, neurological sequelae (demyelinating polyneuropathy, stroke, cerebral edema), and even death [40]. Comprehensive clinical evaluation is essential to assess the severity of the poisoning and direct proper treatment.

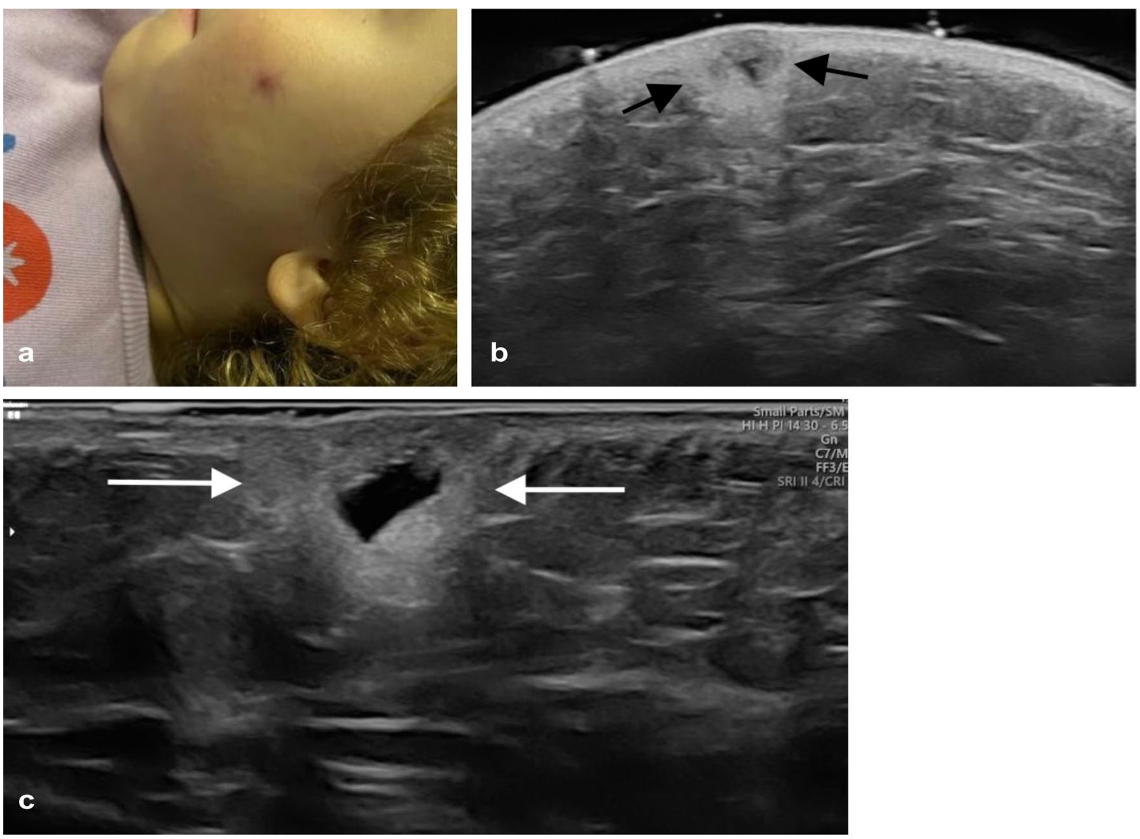

Fig. 10 A 2-year-old girl presented to the emergency department accompanied by her mother, who brought the presumed attacking spider for identification. **a** Physical examination revealed an erythematous lesion on the left cheek. **b** Longitudinal view of ultrasound at the indicated site shows a small anechoic collection at the dermo-hypodermal junction surrounded by a hyperechoic fat layer (*arrows*). **c** Transverse view of follow-up ultrasounds at the lesion site reveals an increase in the size of the anechoic collection hours after the first examination (*arrows*)

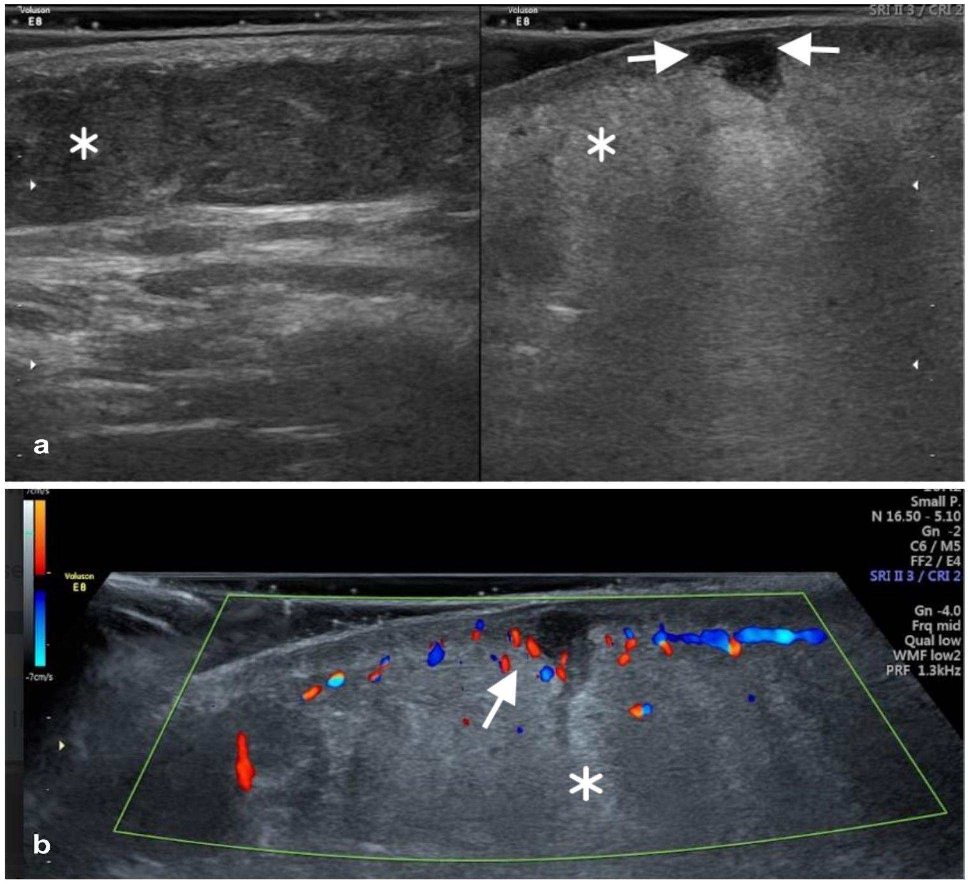

Fig. 11 A 14-year-old boy presented with a scorpion sting on the left buttock. **a** Split-image sonography demonstrates marked subcutaneous thickening, increased echogenicity, loss of fatty septa, and central anechoic fluid collection (*arrows*) in the affected left buttock compared to the normal right buttock (*asterisk*). The overlying dermis is diffusely hypoechoic. **b** Doppler sonography reveals increased vascularity at the dermohypodermal junction (*arrow*) with associated subcutaneous edema (*asterisk*)

Ultrasound findings

Ultrasound is a crucial tool for evaluating scorpion sting injuries, accurately measuring lesion size, depth, and tissue damage [41]. Typical findings include skin and subcutaneous tissue thickening, superficial or deep collections, and increased peripheral vascularization, as demonstrated by color Doppler. A meticulous ultrasound technique is required to prevent the compression of the superficial fluid collections at the painful site following a scorpion's sting, as this can obscure underlying tissue changes [42] (Fig. 11). Ultrasound can differentiate scorpion sting edema from lymphedema or venous insufficiency by evaluating the distribution pattern of edema; localized edema is more suggestive of a scorpion sting, while diffuse edema may indicate other underlying conditions [10].

Summary

To streamline the ultrasound approach to skin lesions associated with ectoparasites and insect poisoning, we present a table (Table 1) that compiles the most characteristic ultrasound findings based on our observations. We believe that this tool will be especially useful for differential diagnosis, easing the identification of these clinical entities in daily practice.

Conclusion

While clinical diagnosis is typically sufficient for skin lesions caused by ectoparasites and insect bites, ultrasound can serve as a valuable adjunct in managing these patients. Our findings demonstrate that ultrasound provides distinctive images that help differentiate these conditions, facilitating an accurate diagnosis. The ability to dynamically and comprehensively evaluate lesions, combined with its non-invasive and accessible nature, makes ultrasound a valuable tool for guiding more targeted therapy, particularly in pediatric populations.

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Author contribution MG, MP, AGB: conceived the idea.

MG: drafted the article.

MG, RP: conducted the bibliographic search.

Table 1 A practical ultrasound guide for diagnosing skin lesions from ectoparasites and insect bites in children

Skin layer	Lesions by				
	Mosquitoes	Myiasis	Bees	Spiders	Scorpions
Epidermis	Thickening and increased echogenicity Irregular edges due to transient reactions or scratch marks	Respiratory opening Erythematous papule that can evolve into a furuncle with drainage of fluid	Very painful erythematous papule	Erythematous macula that evolves into a livedoid plaque, forming a necrotic eschar	Irregular and erythematous macula, possible next tissue disruption in the affected area
Dermis	Thickening and decreased focal echogenicity	Cavity with anechoic or hypoechoic center that houses the larva	Hypoechogenic thickening close to the lesion	Localized thickening and increased echogenicity	Diffuse thickening and increased echogenicity Superficial or deep fluid buildups
Hypodermis	Thickening Cobblestone pattern Obliteration of the dermohypodermal junction	Subdermal peripheral hypoechoic halo surrounding a central hyperechoic focus Spontaneous movement of the larva and acoustic shadowing below	Immobile hyperechoic foreign body with posterior acoustic shadow (stinger) and surrounding hypoechoic halo	Cobblestone pattern Superficial or deep fluid collections within the interlobular septa	Thickening and greatly increased echogenicity Superficial or deep fluid buildups
Color Doppler	Acute hyperemia	It can show spontaneous larval movement and intralarval fluid transport	Peripheral hyperemia that eases the precise location of the stinger	Peripheral hyperemia to the injury	Hypervascularity at the dermohypodermal junction
Differential diagnosis	Erysipelas Skin abscesses	Furunculosis, abscess, insect bite, prurigo, skin cyst, tungiasis	Erysipelas, cellulitis, contact dermatitis	Bites from other insects and arachnids, zoster, herpes simplex, anthrax, angioneurotic edema, vasculitis, erysipelas, cutaneous lupus erythematosus	Lymphedema Venous insufficiency
Comments	Bacterial superinfection may occur at the site of the bite	Larvae can invade natural orifices, such as the eyes, ears, nose, mouth, urogenital tract, and, in rare cases, the gastrointestinal tract and central nervous system	Ultrasound-guided removal minimizes complications and improves clinical outcomes	Prompt evaluation of the lesion's extent is crucial: local, regional, extensive, systemic, anaphylactic, and toxic	Cutaneous manifestations can rapidly progress within 24 h, including urticarial plaques, hemorrhagic blisters, and tissue necrosis, due to venom-induced vascular damage and clotting disorders

MG, MP, LR, RP, AGB: contributed to the provision of cases and their images.

All authors contributed, read, and approved the manuscript versions.

Data availability No datasets were generated or analyzed during the current study.

Declarations

Conflicts of interest We, the authors, declare that there are no potential conflicts of interest that could be construed as influencing the results or interpretation of this study.

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