

Perioperative Management of Patients with Mastocytosis

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MASTOCYTOSIS may be associated with the occurrence of perioperative immediate hypersensitivity reactions. Hypersensitivity corresponds to the *reproducible signs or symptoms, initiated by exposure to a defined stimulus at a dose tolerated by normal subjects*.¹ It is generally accepted that immediate reactions may be delayed for up to an hour.² Two phenotypes of immediate-type hypersensitivity may occur during the perioperative setting. Although immediate nonallergic hypersensitivity refers to clinical reactions where an immune mechanism can be ruled out (*e.g.*, histamine release belongs to nonallergic hypersensitivity), immediate allergic hypersensitivity refers to those where an immune mechanism can be demonstrated (usually immunoglobulin E [IgE]-mediated).¹ Basophil and mast cell degranulation and corresponding inflammatory mediators release occur through a specific IgE-mediated mechanism with subsequent clinical features.³ Mastocytosis is not an allergic disorder but a rare clinical condition with an estimated incidence of 1:150,000.⁴ In mastocytosis, immediate hypersensitivity usually arises after mast cell degranulation elicited by various nonspecific triggers including psychological, pharmacological and mechanical factors, and temperature changes (table 1). Nevertheless, a concurrent drug-induced IgE-mediated reaction may also occur in patients with mastocytosis. The overall incidence of perioperative IgE-mediated anaphylaxis is estimated at 1 in 10,000–20,000 anesthesia procedures.^{2,5,6}

Little is known about the perioperative management of patients with mastocytosis. It remains poorly understood by anesthesiologists, as existing information consists of single-case reports and a few case series. Moreover, there are currently no

European or North-American guidelines regarding its perioperative management. The main anesthetic concern is the avoidance of release of histamine and other mast cell mediators.

This review seeks to discuss: (1) the various nonspecific triggers that may cause perioperative mast cell degranulation in mastocytosis; (2) a preemptive strategy that allows for a safe perioperative management; (3) the management of immediate hypersensitivity in mastocytosis; and (4) the diagnostic pathway necessary to distinguish nonspecific mast cell degranulation in mastocytosis from other clinical entities.

What Is Mastocytosis?

Mastocytosis consists of a heterogeneous group of disorders with diverse clinical presentations. It is characterized by an abnormal increase in tissue mast cells, which can be limited to the skin (*cutaneous mastocytosis [CM]*) or infiltrate the bone marrow and other organs with or without skin involvement (*systemic mastocytosis [SM]*).^{7,8} Somatic mutations of c-kit, which is a transmembrane protein involved in mast cell survival and activation, with intrinsic tyrosine kinase activity, are associated with mastocytosis. The mutation at codon D816V induces its constitutive activation and is found in 50% of cases of CM and over 90% of cases of SM. Mastocytosis is classified into seven categories according to the *World Health Organization* consensus. The categories differ by the age of onset (pediatric *vs.* adult), the phenotype (cutaneous *vs.* systemic), and the clinical characteristics (indolent *vs.* aggressive) of the disease.⁸ CM is the most frequent phenotype. It is limited to the skin, and the most common form is characterized by small reddish-brown hyperpigmented

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Table 1. Differences between Mast Cell Activation in Mastocytosis and during IgE-mediated Allergic Hypersensitivity

	Mastocytosis	IgE-mediated Allergic Hypersensitivity
Key cell	Mast cell	Mast cell and basophil
Receptor	C-kit receptor (D816V mutation)	FcεRI
Mechanism	Non IgE-mediated	IgE-cross-linking by allergen
Triggers	Nonspecific (psychological, pharmacological, mechanical factors, and temperature changes)	Specific (IgE-antibody)
Serum tryptase after the clinical reaction	Increased	Increased
Basal serum tryptase	Usually increased (>20 µg/l) in SM Less than 20 µg/l in CM	Not increased
Skin tests	Negative	Positive

Median serum tryptase in healthy adults is ≈5 µg/l.

CM = cutaneous mastocytosis; IgE = immunoglobulin E; SM = systemic mastocytosis.

maculopapular lesions (also called *Urticaria Pigmentosa*). Other types, such as CM with bullous forms, are also described. CM is mainly observed during childhood and can resolve at or shortly after puberty. In contrast, SM is observed primarily in adulthood. Six forms of SM have been described including indolent SM, which is the most common form with a good prognosis. However, aggressive SM with severe organ infiltration, SM with an associated hematologic disease, mast cell leukemia, and mast cell sarcoma have a worse prognosis. The clinical features and symptoms depend on the involved organs or tissues and result from tissue response to mediator release from mast cells. These mediators include histamine, leukotriens, prostaglandins, and proteases (*e.g.*, tryptase) (fig. 1).

Perioperative Mast Cell Degranulation in Mastocytosis

The incidence of immediate hypersensitivity related to anesthesia and/or surgery in patients with mastocytosis is unknown. We focused our search on English- and French-language studies and case reports published during the last 4 decades, that is, between 1973 and December 31, 2012. Large cohort studies of patients with mastocytosis undergoing surgical procedures have not been published. Uneventful procedures have been reported in two retrospective small case series including 22 and 6 patients with pediatric mastocytosis, respectively.^{9,10} However, most uneventful procedures likely go unreported. A few isolated clinical cases (n = 15) or small case series (n = 3) regarding the perioperative management of adult patients with CM or SM have been published. Perioperative complications were reported in only a few of these patients (n = 4).

How to Stratify the Clinical Features Occurring in Mastocytosis?

The *Ring and Messmer's* four-step grading scale is appropriate to describe the clinical severity of perioperative immediate hypersensitivity occurring in mastocytosis.¹¹ Accordingly,

the diagnosis of immediate hypersensitivity is based on clinical findings, whereas the management is guided by the clinical expression of the reaction. This scale has been modified as follows^{5,6,11}: Although grade I reactions involve only mucocutaneous signs and symptoms, grade II reactions correspond to mild mucocutaneous features that may be associated with cardiovascular and/or respiratory signs. The cardinal sign of grade III reactions is cardiovascular collapse, which may be associated with bronchospasm, mucocutaneous, and/or gastrointestinal signs. Grade IV reactions present with cardiac arrest. Grades I and II are usually not life-threatening conditions, whereas grades III and IV correspond to clinical settings necessitating urgent resuscitation.

What Kind of Perioperative Clinical Features Is Observed in Mastocytosis?

Perioperative clinical features mainly involve the skin and the cardiovascular system. The onset of immediate hypersensitivity usually occurs within minutes of the precipitating event. Although cutaneous signs including generalized erythema, rash, or flushing are commonly reported, they may be absent. Angioedema is not a characteristic of the disease. Cardiovascular signs do not correlate with the cutaneous or systemic phenotype of the disease.⁸ Cardiovascular symptoms may also occur in CM, especially in those with excessive spreading of skin disease (*i.e.*, diffuse CM). Accordingly, clinical features result from tissue response to mediator release from mast cells and local mast cell burden. Thus, mast cell degranulation with subsequent release of histamine and other inflammatory mediators may also result in profound vasodilatation and a life-threatening condition. Bronchospasm does not usually occur, and digestive features (*e.g.*, vomiting, diarrhea) are not reported during the perioperative setting. The perioperative course remained uncomplicated in the majority of the reported cases.

Perioperative Management

Because various nonspecific triggers may cause perioperative mast cell degranulation with subsequent immediate

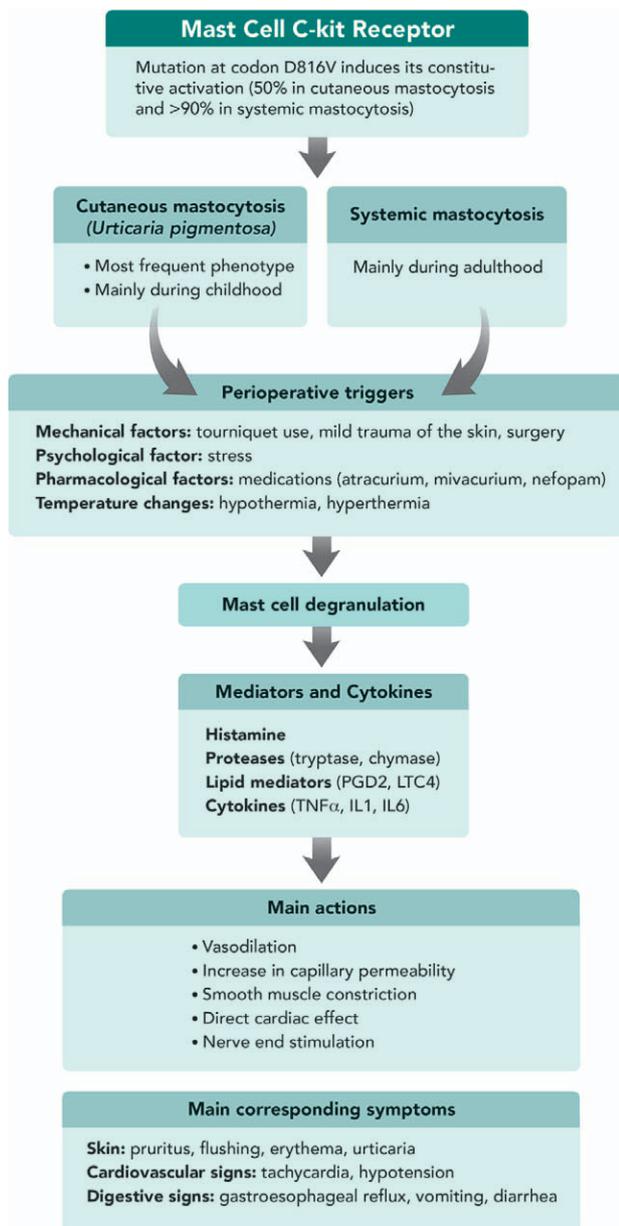


Fig. 1. Pathophysiology of mastocytosis. IL-1 = interleukin-1; IL-6 = interleukin-6; LTC4 = leukotriene C4; PGD2 = prostaglandin D2; TNF- α = tumor necrosis factor- α .

hypersensitivity, prevention of mediator release (*e.g.*, histamine release) constitutes the major therapeutic goal.¹² The perioperative management of patients with mastocytosis implies: (1) an understanding of the disease and its clinical manifestations; (2) a careful preoperative history regarding the phenotype of the disease and its activity (*e.g.*, forming blisters), and any previous immediate reactions; (3) a close communication between the anesthesiologist and surgeon before surgery; (4) the avoidance of known and possible factors triggering acute mediators release; and (5) management of perioperative mast cell degranulation and cardiovascular disturbances.

Psychological Factors

Anxiolysis is recommended,¹¹ because emotional factors including psychological stress and anxiety may precipitate mast cell degranulation.⁷ The case should be scheduled as the first of the day whenever possible. A quiet environment in the operating room during anesthesia induction is likely to reduce preoperative anxiety.

Temperature Changes

Environmental factors such as extremes of temperature (hypothermia and hyperthermia) may induce mast cell degranulation.⁷ The patient's temperature must be monitored during all phases of the surgical procedure. Different ways to avoid perioperative hypothermia include: (1) increase of the operating room's temperature; (2) heat-maintenance devices such as head coverings, warming mattress, and forced-air warming systems; (3) warmed irrigation and infusion fluids/solutions; and (4) warmed anesthetic gases.

Mechanical Factors

Mild trauma (*e.g.*, mechanical irritation, tourniquet use) of skin lesions (*Urticaria Pigmentosa*) may induce mast cell degranulation and the development of a *wheal-and-flare* response leading to urticaria. It intensifies upon rubbing or scratching, a condition known as *Darier's sign*.⁸ Blister formation or bullae may occur in any of the skin lesions in young children and infants with mechanical pressure from a face mask. Chymase, a neutral protease released by mast cells, may weaken the dermo-epidermal junction where separation occurs. Mast cell degranulation may then cause edema. Because the dermo-epidermal junction is relatively poorly formed in young children, it may explain blistering in these patients.¹³ Other mechanical factors, such as surgery itself, have been reported to induce mast cell degranulation. This is more likely to happen in the gastrointestinal tract (*e.g.*, resection of a rectal tumor, needle biopsy of the pancreas), because it is a rich source of mast cells.

Skeletal pathological findings in SM include osteoporosis, osteopenia, and osteolysis. Osteolysis is usually seen in advanced disease, whereas osteoporosis may be seen in any variant.⁸ The main symptom is musculoskeletal pain. Appropriate positioning and manipulations of the patient on the surgical table should be carefully done, to avoid bone fractures.

Pharmacological Factors

Randomized, controlled trials or meta-analyses regarding the use of anesthetics in mastocytosis are not available. Table 2 summarizes common drugs used during the perioperative period. Drugs that can be safely used in patients with mastocytosis and those that are not recommended (essentially histamine-releasing drugs) were compiled according to different published clinical reports, isolated cases, and case series. Many authors advocate avoiding certain classes of drugs (*e.g.*, opioids, neuromuscular-blocking agents) unless specifically indicated. However, this is not supported by

scientific evidence. Histamine-releasing benzylisoquinolins (e.g., atracurium and mivacurium) and nefopam, a non-sedative benzoxazocine analgesic, are not recommended in mastocytosis (table 2). Rapid intravenous administration of histamine-releasing medications should be avoided whenever possible. Perioperative immediate hypersensitivity (including one fatality) was found to be linked to the anesthetic (*i.e.*, atracurium) in only two cases.

Pain

Because pain by itself may induce mast cell degranulation, the use of analgesics, specifically opioids, is indicated for intraoperative and postoperative analgesia.¹¹

Postoperative Course

The postoperative course remained uneventful in the reported clinical cases. Mild adverse effects have been observed during the postoperative period and may be attributed to mechanical factors (tourniquet) or mastocytosis by itself. In another case, the story remained inconclusive.

Management of Perioperative Mast Cell Degranulation in Patients with Mastocytosis

The management must be grade specific and adapted to the severity of the clinical features, (*i.e.*, cardiovascular disturbances).^{3,5,6,11} The following measures should be applied whenever possible: (1) if a drug is suspected, its administration should be discontinued; (2) in cases of unusual severe reactions, discontinue anesthetic agents likely to cause vasodilation and negative inotropic effects whenever possible. In addition, provide early administration of epinephrine in cases of grade III or IV reactions, administer a large volume loading and establish or secure the airway with 100% oxygen.

Epinephrine

Epinephrine should never be injected during grade I reactions, but small titrated boluses (10–20 µg) may sometimes be necessary during grade II reactions. Titrated intravenous bolus administrations of higher doses of epinephrine (100–200 µg) are required during grade III reactions, repeated every 1–2 min as necessary according to the hemodynamic response. This might be followed by a continuous infusion of epinephrine (0.05–0.1 µg kg⁻¹ min⁻¹) to minimize the need for repeated bolus injections.^{3,5,6,11} Grade IV reactions (cardiac arrest) should be treated with higher-doses epinephrine as recommend in the latest guidelines for Adult Advanced Life Support.¹⁴

Fluid Therapy

In cases of cardiovascular disturbances (hypotension and eventual cardiovascular collapse), it is essential to compensate for the peripheral vasodilatation and capillary leakage that might result after the release of mast cell mediators.^{3,5,6,11,15} Fluid therapy should be immediately initiated with either crystalloids (e.g., lactated Ringer's solution, saline) or colloids (gelatine,

hydroxyethylstarch). However, the exact requirement for fluid therapy during an immediate reaction in mastocytosis remains unknown. Thus, a volume of crystalloids and/or colloids titrated to hemodynamic effects should be administered.

Additional Therapy

Although corticosteroids and/or H₁- and H₂-receptor antagonists are often recommended in the management of immediate hypersensitivity in mastocytosis, their effects have never been evaluated in placebo-controlled trials.

Etiological Diagnosis

The etiological diagnosis of a perioperative immediate hypersensitivity reaction occurring in patients with mastocytosis relies on a triad including the clinical history (onset delay and clinical features) and the biological and allergological assessment.

Biological Assessment

Histamine. Histamine is a preformed mediator contained in granules of basophils and mast cells. An increased concentration indicates *in vivo* release and is observed during both allergic and nonallergic immediate hypersensitivity. Its plasma half-life is approximately 15–20 min. Blood samples should be drawn within 15–30 min for grade I and II reactions and within 30–120 min for grade III and IV reactions.⁶ Its use has been abandoned in the United States,⁷ in Scandinavia,⁵ and in the United Kingdom.² The collection of histamine metabolites, such as 24-h urinary methylhistamine, does have some value, as it is not subject to diurnal variations. However, measurement of histamine metabolites seems to be neither more sensitive nor specific than those of serum tryptase.⁷

Serum Tryptase. Tryptases are neutral serine proteases predominantly stored in mast cells. Two major forms can be measured *in vivo*: *pro-α tryptase*, which reflects the mast cell burden and is increased in mastocytosis, and mature *β-tryptase*, which is preferentially stored in mast cells granules and released during mast cell activation such as IgE-mediated anaphylaxis.^{2,3,5,6,11} The total tryptase level measured in serum by fluoroimmunoassay (Phadia ImmunoCAP, Uppsala, Sweden) measures *pro-α tryptase* and mature *β-tryptase*. Serum total tryptase concentrations reach a peak between 30 and 60 min after the onset of immediate hypersensitivity, decline under first-order kinetics with a half-life of approximately 2 h and correlate with the clinical severity of the reaction.^{2,5,6} Although an increase in tryptase can be measured 30–60 min after onset of immediate hypersensitivity in cases of mild reactions, sampling is recommended within 30–120 min in cases of grades III and IV reactions.⁶ Moreover, it is important to compare the tryptase level after immediate hypersensitivity to the patient's baseline level.^{2,5,6,9,11} Recently, a median serum tryptase level was reported to be 5.1 µg/l (range, 1–30.7 µg/l) in a general adult population.¹⁶ However, tryptase levels tend to be higher in patients with a high mast cells burden. In SM, tryptase levels

Table 2. Perioperative Medications Accepted in Clinical Practice and Those Not Recommended in Mastocytosis

Family of Drugs	Accepted	Not Recommended
<i>Intravenous, inhalation, and local anesthetics</i>		
Benzodiazepine	Midazolam	
Hypnotics	Etomidate	
	Ketamine	
	Propofol	
	Thiopental	
Halogenated gases and nitrous oxide	Desflurane	
	Isoflurane	
	Sevoflurane	
	Nitrous oxide	
Local anesthetics	Amide-type	
	Ester-type*	
<i>Neuromuscular blocking agents</i>		
Depolarizing NMBA	Succinylcholine	
Nondepolarizing steroidal NMBAs	Pancuronium	
	Rocuronium	
	Vecuronium	
Nondepolarizing benzylisoquinolin NMBAs	Cis-atracurium	Atracurium
		Mivacurium
<i>Reversal of neuromuscular blockade</i>		
Anticholinesterase agent	Neostigmine	
Cyclodextrin	Sugammadex*	
<i>Intravenous analgesics</i>		
Opioids	Alfentanil	
	Fentanyl	
	Remifentanyl	
	Sufentanyl	
Morphine	Requires titration	
Analgesic	Paracetamol (acetaminophen)	Nefopam
<i>Other agents</i>		
Antiseptics*	Chlorhexidine	
	Povidone iodine	
Plasma substitutes*	Albumin	
	Gelatin	
	Hydroxyethylstarch	
Miscellaneous agents	Aprotinin* (topical glue)	
	Atropine	
	Ondansetron	
	Oxytocin	
	Protamine*	

Patients with prior reactions to anesthetics should undergo skin tests with the medications used including antibiotics and latex.

* Although there is no data concerning the use of these agents, there is no reason to avoid them.

NMBA = neuromuscular-blocking agent.

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range from normal to markedly increased (exceeding 20 µg/l). However, tryptase levels are less than 20 µg/l in most patients with CM.⁸ Tryptase can be increased 24–48 h after the initial event in mastocytosis, depending on the severity and the extent of mast cell degranulation.

Allergological Assessment: Skin Tests

Perioperative immediate hypersensitivity occurring in patients with mastocytosis may present as an IgE-mediated

hypersensitivity but may never be diagnosed if not investigated subsequently. Therefore, the etiological diagnosis remains presumptive until skin testing is performed. Skin tests should be performed, according to the clinical history, with all drugs injected just before the occurrence of immediate hypersensitivity as well as latex, to provide a pertinent diagnosis.^{2,3,5,6} A suggestive clinical history (usually severe immediate hypersensitivity) associated with an increased tryptase concentration when compared with the patient's

baseline level and a positive skin test to one of the suspected agents confirm the diagnosis of IgE-mediated allergic hypersensitivity. The absence of an increased tryptase level does not rule out the diagnosis. However, a suggestive clinical history (usually not as severe) that may or may not be associated with an increased tryptase level when compared with the patient's own baseline levels and a negative skin test to given drugs suggest nonallergic immediate hypersensitivity. Skin testing was performed in only three of the published clinical cases and remained each time negative, therefore excluding an IgE-mediated mechanism.

Overall, data are still insufficient to explain whether the frequency of IgE-mediated drug-induced allergic hypersensitivity in mastocytosis is higher in comparison with the general population.¹²

Other Clinical Situations

Pediatric Anesthesia

Children account for approximately 65% of cases of mastocytosis, 15% being congenital. CM is the most common phenotype during childhood, whereas SM is extremely rare.¹³ Although anesthesia experience in pediatric patients with mastocytosis is limited, perioperative outcomes remained uncomplicated in two different series. One report included 22 pediatric CM and SM cases receiving 29 general anesthetics,⁹ whereas the other one consisted of 6 CM cases receiving 7 general anesthetics.¹⁰ This had lead some authors to suggest that *"Combining all available data on the risk of anaphylaxis in children with mastocytosis, the risks of general anesthesia appear to be overstated by mastocytosis websites."*^{10,12}

Obstetric Anesthesia

Mastocytosis has a diverse clinical presentation during pregnancy. Symptoms may improve or worsen in half of the cases, whereas they remain unchanged in the others. Since 2000, less than 50 cases have been published reporting anesthetic management of parturients with either CM (n = 13) or SM (n = 33) giving birth to 65 children.^{17–25} Prophylactic therapy with different combinations of antihistamines and corticosteroids was used in some patients.^{21–25} Sixty-three percent (n = 41) of the infants were born by vaginal delivery^{18,20,22–24} and 20% (n = 13) had a cesarean delivery.^{17,21,23,25} The mode of delivery was not detailed in 17% of the cases (n = 11).¹⁹ Anesthesia procedures for labor and delivery were carried out in 74% of the cases (n = 48). They included neuraxial analgesia (n = 42), general anesthesia (n = 2), and intravenous fentanyl or local anesthesia (n = 4).^{18,19,21,23,24} No analgesia was performed in 18% of the cases (n = 12),^{19,20,22,23} and the anesthesia procedure was not detailed in 8% of the cases (n = 5).^{17,19} Oxytocin use for induction of labor and/or after delivery was uneventful.^{18,19,21,23,24} In a few cases, parturients experienced mild symptoms such as pruritus, generalized erythema, and flushing during or immediately after labor. These symptoms were sometimes treated with H₁-antihistamines.^{18,23} However, because the relation between the

occurrence of generalized erythema and flushing and a drug was not established, it may have been due to triggers other than drugs. Even though most reported cases of SM during pregnancy have a good fetal and maternal outcome, there are potential maternal and fetal complications, including preterm labor. Hypotension and difficulty breathing requiring intravenous epinephrine were reported 10 min after delivery in one patient with SM.²⁵ However, the relation between the occurrence of clinical symptoms and a drug was not established.

The peripartum period is often accompanied with stress, anxiety, pain, and cutaneous compression, which are conditions that may precipitate mast cell degranulation. Early epidural administration is likely to minimize stress and provide an adequate analgesic level, which decreases the possibility of mast cell degranulation.

What Should Be Done before Anesthesia/Surgery?

Basal Tryptase

A baseline serum tryptase level is a marker of the total mast cell load and should be measured before the procedure as a reference point. It can then be compared with serum tryptase levels after perioperative immediate hypersensitivity.^{9,11}

Are Skin Tests Useful before Anesthesia?

There is no need to perform skin tests in patients with mastocytosis prior to an anesthetic.^{9,11} Mastocytosis itself is not a risk factor for perioperative drug- or latex-induced IgE-mediated allergic hypersensitivity. However, all patients with prior uninvestigated perioperative immediate hypersensitivity should undergo skin tests with the medications that could have potentially been the triggering agent including antibiotics and latex.

Premedication

The use of preoperative H₁- and H₂-receptor antagonists and/or corticosteroids is usually recommended in patients with mastocytosis but has never been evaluated in placebo-controlled trials. Therefore, the best way to avoid mast cell degranulation in mastocytosis is to avoid known triggers that have precipitated prior episodes and potential triggers. The latter include pharmacological, psychological and mechanical factors, and temperature changes. Any regular medications used to maintain mast cell stability and limit the effects of mast cell mediators should be continued until the day of surgery.^{11,12}

Ambulatory Surgery

Some authors have argued that patients with mastocytosis should not be candidates for ambulatory surgery because reactions might be delayed for several hours. However, no evidence is currently available to support this.

Conclusion

Even though mastocytosis is a rare disease, anesthesiologists are likely to encounter patients with this disease at one point in their practice. The perioperative course of these patients is usually uncomplicated provided that triggers for mast cell release are avoided. In cases of immediate hypersensitivity occurring during the perioperative period, the etiological diagnosis relies on a triad including the clinical history (onset delay and clinical features), tryptase measurement, and skin tests assessment to identify the pathomechanism of the reaction (nonallergic *vs.* allergic).

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Competing Interests

The authors declare no competing interests.

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