

Question n°3

Comment rapporter à l'anaphylaxie l'accident observé ?

Conduite du bilan diagnostique

D. Laroche¹, L. Guilloux², J-L. Guéant³

¹ *Laboratoire de biophysique, radio-isotopes radio-immunologie, CHRU, avenue Côte-de-Nacre, 14033 Caen cedex,* ²*unité d'immuno-allergologie, laboratoire Mérieux, avenue Tony Garnier, 69007 Lyon,* ³*laboratoire de biochimie des protéines, CHU Nancy-Brabois, rue du Morvan, 54511 Vandœuvre-les-Nancy*

REFERENCES

- 1 - Laxenaire MC et le Groupe d'études des réactions anaphylactoïdes peranesthésiques. Epidémiologie des réactions anaphylactoïdes peranesthésiques. Quatrième enquête multicentrique (juillet 1994-décembre 1996). *Ann Fr Anesth Réanim.* 1999 ; 18 : 796-809.
- 2 - Schayer RW. Catabolism of histamine in vivo. *Handb Exp Pharmacol* 1966 ; 18 : 672-83.
- 3 - Stephan V, Zimmermann A, Kuhr J, Urbanek R. Determination of N-methylhistamine in urine as an indicator of histamine release in immediate allergic reactions. *J Allergy Clin Immunol* 1990 ; 86 : 862-8.
- 4 - Schwartz LB, Metcalfe DD, Miller JS, Earl H, Sullivan T. Tryptase levels as an indicator of mast-cell activation in systemic anaphylaxis and mastocytosis. *N Engl J Med* 1987 ; 316 : 1622-6.
- 5 - Castells MC, Irani AM, Schwartz LB. Evaluation of human peripheral blood leukocytes for mast cell tryptase. *J Immunol* 1987 ; 138 : 2184-9.
- 6 - Schwartz LB. Tryptase: a clinical indicator of mast cell-dependent events. *Allergy Proc* 1994 ; 15 : 119-23.
- 7 - Enander I, Matsson P, Nystrand J, Andersson AS, Eklund E, Bradford TR, et al. A new radioimmunoassay for human mast cell tryptase using monoclonal antibodies. *J Immunol Methods* 1991 ; 138 : 39-46.
- 8 - Duff Hogan A, Schwartz LB. Markers of mast cell degranulation. *Methods* (San Diego, Calif.) 1997 ; 13 : 43-52.
- 9 - Schwartz LB, Sakai K, Bradford TR, Ren S, Sweiman B, Worobec AS, Metcalfe DD. The α form of human tryptase is the predominant type present in blood at baseline in normal subjects and is elevated in those with systemic mastocytosis. *J Clin Invest* 1995 ; 96 : 2702-10.

- 10 - Granerus G, Lönnqvist B, Nystrand J, Roupe G. Serum tryptase measured with B12 and G5 antibody-based immunoassays in mastocytosis patients and its relation to histamine turnover. *Br J Dermatol* 1998 ; 139 : 858-61.
- 11 - Laroche D, Vergnaud MC, Sillard B, Soufarapis H, Bricard H. Biochemical markers of anaphylactoid reactions to drugs. *Anesthesiology* 1991 ; 75 : 945-9.
- 12 - Schwartz LB, Yunginger JW, Miller J, Bokhari R, Dull D. Time course of appearance and disappearance of human mast cell tryptase in the circulation after anaphylaxis. *J Clin Invest* 1989 ; 83 : 1551-5.
- 13 - Van der Linden PWG, Hack CE, Poortman J, Vivié-Kipp YC, Struyvenberg A, van der Zwan JK. Insect-sting challenge in 138 patients: relation between clinical severity of anaphylaxis and mast cell activation. *J Allergy Clin Immunol* 1992 ; 90 : 110-8.
- 14 - Ordoqui E, Zubeldia JM, Aranzabal A, Rubio M, Herrero T, Tornero P, et al. Serum tryptase levels in adverse drug reactions. *Allergy* 1997 ; 52 : 1102-5.
- 15 - Bosso JV, Schwartz LB, Stevenson DD. Tryptase and histamine release during aspirin-induced respiratory reactions. *J Allergy Clin Immunol* 1991 ; 88 : 830-7.
- 16 - Ohtsuka T, Matsumaru S, Uchida K, Onobori M, Matsumoto T, Kuwahata K, et al. Time course of plasma histamine and tryptase following food challenges in children with suspected food allergy. *Ann Allergy* 1993 ; 71 : 139-46.
- 17 - Laroche D, Dubois F, Lefrançois C, Vergnaud MC, Gérard JL, Soufarapis H, et al. Marqueurs biologiques précoces des réactions anaphylactoïdes peranesthésiques. *Ann Fr Anesth Réanim* 1992 ; 11 : 613-8.
- 18 - Laroche D, Lefrançois C, Gérard JL, Dubois F, Vergnaud MC, Guéant JL, et al. Early diagnosis of anaphylactic reactions to neuromuscular blocking drugs. *Br J Anaesth* 1992 ; 69 : 611-4.
- 19 - Watkins J. Tryptase release and clinical severity of anaesthetic reactions. *Agents Actions* 1992; Spec conf issue : C203-5.
- 20 - Fisher MM, Baldo BA. Mast cell tryptase in anaesthetic anaphylactoid reactions. *Br J Anaesth* 1998 ; 80 : 26-9.
- 21 - Guéant JL, Aimone-Gastin I, Laroche D, Pitiot V, Gérard P, Moneret-Vautrin DA, et al. Prospective evaluation of cell mediator release in anaphylaxis to anesthetic drugs. *Allergy Clin Immunol Int* 1996; 8 : 120-2.
- 22 - Cottineau C, Drouet M, Costerousse F, Dussaussoy C, Sabbah A. Intérêt des médiateurs plasmatiques (histamine et tryptase) et urinaires (méthylhistamine) lors de réactions anaphylactiques et/ou anaphylactoïdes peranesthésiques. *Allergie Immunol* 1996 ; 28 : 270-6.

- 23 - Matsson P, Enander I, Andersson AS, Nystrand J, Schwartz L, Watkins J. Evaluation of mast cell activation (tryptase) in two patients suffering from drug-induced hypotensoid reactions. *Agents Actions* 1991 ; 33 : 218-20.
- 24 - Fernandez J, Blanca M, Moreno F, Garcia J, Segurado E, del Cano A, et al. Role of tryptase, eosinophil cationic protein and histamine in immediate allergic reactions to drugs. *Int Arch Allergy Immunol* 1995 ; 107 : 160-2.
- 25 - Laroche D, Aimone-Gastin I, Dubois F, Huet H, Gérard P, Vergnaud MC, et al. Mechanisms of severe, immediate reactions to iodinated contrast material. *Radiology* 1998 ; 209 : 183-90.
- 26 - Ring J, Messmer K. Incidence and severity of anaphylactoid reactions to colloid volume substitutes. *Lancet* 1977; 1 : 466-8.
- 27 - Ownby DR, Tomlanovich M, Sammons N, McCullough J. Anaphylaxis associated with latex allergy during barium enema examinations. *AJR* 1991 ; 156 : 903-8.
- 28 - Volcheck GW, Li JTC. Elevated serum tryptase level in a case of intraoperative anaphylaxis caused by latex allergy. *Arch Intern Med* 1994 ; 154 : 2243-5.
- 29 - Saitoh J, Mitsuhata H, Horiguchi Y, Saitoh K, Fukuda H, Shimizu R. Usefulness of measurement of mast cell tryptase for differential diagnosis of anaphylaxis and anaphylactoid reaction. *Masui* 1995 ; 44 : 1265-8 (**japonais**).
- 30 - Mounier P, Laroche D, Divanon F, Mosquet B, Vergnaud MC, Esse-Comlan A, et al. Réactions anaphylactoïdes à une solution polyvitaminée injectable contenant un crémophore. *Thérapie* 1995 ; 50 : 571-3.
- 31 - Takenoshita M, Sugiyama M, Okuno Y, Inagaki Y, Yoshiya I, Shimazaki Y. Anaphylactoid reaction to protamine confirmed by plasma tryptase in a diabetic patient during open heart surgery. *Anesthesiology* 1996 ; 84 : 233-5.
- 32 - Stöckle M, Maachi B, Tunon de Lara M, Roche A, Maurette P. Hypersensibilité au phloroglucinol (Spasfon) dans un contexte d'administration médicamenteuse multiple peranesthésique. *Cah Anesthésiol* 1997 ; 45 : 133-7.
- 33 - Alvarez MJ, Acero S, Mendoza H, Tabar AL. Cuantificación de las concentraciones de triptasa sérica en el diagnóstico de anafilaxia. *Med Clin (Barc)* 1998 ; 110 : 357-8.
- 34 - Lopez-Saez MP, Ordoqui E, Tornero P, Baeza A, Sainza T, Zubeldia JM, et al. Fluorescein-induced allergic reaction. *Ann Allergy Asthma Immunol* 1998 ; 81 : 428-30.
- 35 - Butrus SI, Negvesky GJ, Rivera-Velazques PM, Schwartz LB. Serum tryptase: an indicator of anaphylaxis following fluorescein angiography. *Graefe's Arch Clin Exp Ophthalmol* 1999 ; 237 : 433-4.

- 36 - Galindo PA, Borja J, Feo F, Gomez E, Garcia R, Cabrera M, Martinez C. Anaphylaxis to omeprazole. *Ann Allergy Asthma Immunol* 1999 ; 82 : 52-4.
- 37 - Laroche D, Mayo P, Lefrançois C, Dubois F, Vergnaud MC, Bricard H. Exploration in vitro de l'anaphylaxie médicamenteuse. *Immunoanal Biol Spéc* 1998 ; 13 : 63-73.
- 38 - Yunginger JW, Nelson DR, Squillace DL, Jones RT, Holley KE, Hyma BA, et al. Laboratory investigation of deaths due to anaphylaxis. *J Forensic Sci* 1991 ; 36 : 857-865.
- 39 - Edston E, van Hage-Hamsten M. β -tryptase measurements post-mortem in anaphylactic deaths and in controls. *Forensic Sci Int* 1998 ; 93 : 135-42.
- 40 - Petit N, Moneret-Vautrin DA, Sainte-Laudy J, Kanny G, Vedel G. Dosage post-mortem d'un marqueur biologique d'activation mastocytaire, la tryptase sérique. Etude préliminaire de spécificité. *Rev Fr Allergol* 1997 ; 37 : 827-31.
- 41 - Randall B, Butts J, Halsey JF. Elevated postmortem tryptase in the absence of anaphylaxis. *J Forensic Sci* 1995; 40 : 208-11.
- 42 - Fisher MM, Baldo BA. The diagnosis of fatal anaphylactic reactions during anaesthesia : employment of immunoassays for mast cell tryptase and drug-reactive IgE antibodies. *Anaesth Intensive Care* 1993 ; 21 : 353-7.
- 43 - Edston E, Van Hage-Hamsten M, Johansson SGO. Tryptase - at last a useful diagnostic marker for anaphylactic death. *Allergy* 1996 ; 51 : 443-5.
- 44 - Schwartz LB, Bradford TR, Rouse C, Irani E, Rasp G, van der Zwan JK, van der Linden PWG. Development of a new, more sensitive immunoassay for human tryptase: use in systemic anaphylaxis. *J Clin Immunol* 1994 ; 14 : 190-204.
- 45 - Sabbah A, Drouet M, Guittot M. La tryptase : médiateur de la réaction anaphylactique. Etude comparative des dosages fluoro-immuno-enzymométrique (FEIA) et radio-immunologique (RIA). *Immunoanal Biol Spéc* 1998 ; 13 : 161-6.
- 46 - Sainte-Laudy J, Cado S. Comparaison des dosages de l'histamine, de la tryptase et de l'interleukine 6 pour l'exploration des réactions anaphylactoïdes médicamenteuses. *Allergie Immunol* 1998 ; 30 : 209-11.
- 47 - Sabbah A, Hassoun S, Drouet M, Lauret MG, Loiry M, El Founini M, et al. Immuno-biologie allergique et anesthésiologie. *Allergie Immunol* 1998 ; 30 : 173-6.
- 48 - Ryckwaert Y, Barthelet Y, Bonnet-Boyer MC, Rochette A, Capdevila X, d'Athis F. Choc anaphylactique après dose-test d'aprotinine en chirurgie orthopédique pédiatrique. *Ann Fr Anesth Réanim* 1999 ; 18 : 904-8.
- 49 - Toh KW, Deacock SJ, Fawcett WJ. Severe anaphylactic reaction to cisatracurium. *Anesth Analg* 1999 ; 88 : 462-4.

- 50 - Seed MJ, Ewan PW. Anaphylaxis caused by neostigmine. *Anaesthesia* 2000 ; 55 : 574-5.
- 51 - Enrique E, Garcia-Ortega P, Sotorra O, Gaig P, Richart C. Usefulness of UniCAP-tryptase fluoroimmunoassay in the diagnosis of anaphylaxis. *Allergy* 1999 ; 54 : 602-6.
- 52 - Renz CL, Laroche D, Thurn JD, Finn HA, Lynch JP, Thisted R, et al. Tryptase levels are not increased during vancomycin-induced anaphylactoid reactions. *Anesthesiology* 1998 ; 89 : 620-5.
- 53 - Cuculo A, Summaria F, Schiavino D, Liuzzo G, Meo A, Patriarca G, et al. I livelli di triptasi sono elevati durante episodi ischemici spontanei nell'angina instabile ma non dopo test all'ergonovina nell'angina variante. *Cardiologia* 1998 ; 43 : 189-93.
- 54 - Li L, Li Y, Reddel SW, Cherrian M, Friend DS, Stevens RL, et al. Identification of basophilic cells that express mast cell granule proteases in the peripheral blood of asthma, allergy, and drug-reactive patients. *J Immunol* 1998 ; 161 : 5079-86.
- 55 - Lorenz W, Duda D, Dick W, Sitter H, Doenicke A, Black A, et al. Incidence and clinical importance of perioperative histamine release: randomised study of volume loading and antihistamines after induction of anaesthesia. *Lancet* 1994 ; 343 : 933-40.
- 56 - Moss J, Rosow CE, Savarese JJ, Philbin DM, Kniffen KJ. Role of histamine in the hypotensive action of d-tubocurarine in humans. *Anesthesiology* 1981 ; 55 : 19-25.
- 57 - Moss J. Muscle relaxants and histamine release. *Acta Anesthesiol Scand* 1995 ; 39 (Suppl) 106 : 7-12.
- 58 - Oosting E, Neugebauer E, Keyzer JJ, Lorenz W. Determination of histamine in human plasma: the European external quality control study 1988. *Clin Exp Allergy* 1990 ; 20 : 349-57.
- 59 - Ind PW, Brown MJ, Lhoste FJM, Macquin I, Dollery CT. Determination of histamine and its metabolites. Concentration-effect relationships of infused histamine in normal volunteers. *Agents Actions* 1982 ; 12 : 12-6.
- 60 - Morel AM, Delaage MA. Immunoanalysis of histamine through a novel chemical derivatization. *Allergy Clin Immunol* 1988 ; 82 : 646-54.
- 61 - McBride P, Bradley D, Kaliner M. Evaluation of a radioimmunoassay for histamine measurement in biologic fluids. *J Allergy Clin Immunol*. 1988 ; 82 : 638-46.
- 62 - Halmerbauer G, Hauk P, Forster J, Urbanek R, Kaufmehl K, Koller DY. In vivo histamine release during the first minutes after deliberate sting challenges correlates with the severity of allergic symptoms. *Pediatr Allergy Immunol* 1999 ; 10 : 53-7.
- 63 - Laroche D, Dubois F, Gérard JL, Lefrançois C, André B, Vergnaud MC, et al. Radioimmunoassay for plasma histamine: a study of false positive and false negative values. *Br J Anaesth* 1995 ; 74 : 430-7.

- 64 - Moss J, Fahmy NR, Sunder NS, Beaven MA. Hormonal and hemodynamic profile of an anaphylactic reaction in man. *Circulation* 1981 ; 63 : 210-3.
- 65 - Cottineau C, Moreau X, Drouet M, De Brux JL, Brenet O, Delhumeau A. Choc anaphylactique lors de l'utilisation de l'aprotinine à fortes doses en chirurgie cardiaque. *Ann Fr Anesth Réanim* 1993 ; 12 : 590-3.
- 66 - Lorenz W, Neugebauer E, Schmal A. Le dosage de l'histamine plasmatique lors de réactions anaphylactoïdes chez le sujet anesthésié. *Ann Fr Anesth Réanim* 1982;1:271-6.
- 67 - Torok EE, Brewer JI, Dolkart RE. Serum diamine oxidase in pregnancy and in trophoblastic diseases. *J Clin Endocr Met* 1970, 30 : 59-65.
- 68 - Baylin SB, Beaven MA, Krauss RM, Keiser HR. Response of plasma histaminase activity to small doses of heparin in normal subjects and patients with hyperlipoproteinemia. *J Clin Invest* 1973 ; 52 : 1985-93.
- 69 - Laroche D, Gallet E, Bricard H. Histamine sanguine et diagnostic rétrospectif précoce du choc anaphylactique. *Ann. Fr. Anesth. Réanim.* 1988 ; 7 : 425-6.
- 70 - Laroche D, Chrysanthou S, Lefrançois C, Gérard JL, Dubois F, Malet M, et al. Evidence of a progressive degranulation of basophil in subjects operated on without adverse reaction. *Agents Actions* 1992 ; 36 (special issue) : C199-C200.
- 71 - Keyzer JJ, Breukelman H, Wolthers BG, Richardson FJ, de Monchy JGR. Measurement of N-methylhistamine concentrations in plasma and urine as a parameter for histamine release during anaphylactoid reactions. *Agents Actions* 1985 ; 16 : 76-9.
- 72 - Hammar E, Berglund A, Hedin A, Norrman A, Rustas K, Ytterstrom U, et al. An immunoassay for histamine based on monoclonal antibodies. *J Immunol Methods* 1990, 128 : 51-8.
- 73 Keyzer JJ, Udding H, de Vries K. Measurement of N-methylhistamine concentrations in urine as a parameter for histamine release by radiographic contrast media. *Diagn Imag Clin Med* 1984 ; 53 : 67-72.
- 74 Harle DG, Baldo BA, Fisher MM. Inhibition of histamine-N-methyltransferase activity by neuromuscular blocking drugs. *Agents Actions* 1985;17:27-31.
- 75 Imamura I, Watanabe T, Maeyama K, Kubota A, Okada A, Wada H. Effect of food intake on urinary excretions of histamine, N-methylhistamine, imidazole acetic acid and its conjugate(s) in humans and mice. *J Biochem* 1984 ; 96 : 1931-7.
- 76 Keyzer JJ, De Monchy JGR, Van Doormaal JJ, Van Voorst Vader PC. Improved diagnosis of mastocytosis by measurement of urinary histamine metabolites. *N Engl J Med* 1983 ; 309 : 1603-5.

- 77 Morel DR, Skoskiewicz M, Robinson DR, Bloch KJ, Hoaglin DC, Zapol WM. Leukotrienes, thromboxane A₂, and prostaglandins during systemic anaphylaxis in sheep. *Am J Physiol* 1991 ; 261 (Heart Circ Physiol 30) : H782-H792.
- 78 Lee TH, Smith CM, Arm JP, Christie PE. Mediator release in aspirin-induced reactions. *J Allergy Clin Immunol* 1991 ; 88 : 827-9.
- 79 O'Sullivan S, Dahlen B, Dahlen SE, Kumlin M. Increased urinary excretion of the prostaglandin D₂ metabolite 9 α ,11 β -prostaglandin F₂ after aspirin challenge supports mast cell activation in aspirin-induced airway obstruction. *J Allergy Clin Immunol* 1996 ; 98 : 421-32.
- 80 Butterfield JH, Kao PC, Klee GG, Yocum MW. Aspirin idiosyncrasy in systemic mast cell disease: a new look at mediator release during aspirin desensitization. *Mayo Clin Proc* 1995 ; 70 : 481-7.
- 81 Bellia V, Bonanno A, Cibella F, Cuttitta G, Mirabella A, Profita M, et al. Urinary leukotriene E₄ in the assessment of nocturnal asthma. *J Allergy Clin Immunol* 1996 ; 97 : 735-41.
- 82 Yoshida S, Nakagawa H, Yamawaki Y, Sakamoto H, Akahori K, Nakabayashi M, et al. Bronchial hyperresponsiveness, hypersensitivity to analgesics and urinary leukotriene E₄ excretion in patients with aspirin-intolerant asthma. *Int Arch Allergy Immunol* 1998 ; 117 : 146-51.
- 83 Sabbah A, Drouet M, El Founini M. Intérêt du dosage des leucotriènes E₄ (LTE₄) dans les urines. Etude préliminaire. *Allergie Immunol* 1998 ; 30 : 177-8.
- 84 Geuenich S, Haberl C, Egger D, Kaspers U, Hültner L, Wilmanns W, et al. Induction of leukotriene production by bleomycin and asparaginase in mast cells in vitro and in patients in vivo. *Biochem Pharmacol* 1998 ; 55 : 447-53.
- 85 Takase B, Maruyama T, Kurita A, Uehata A, Nishioka T, Mizuno K, et al. Arachidonic acid metabolites in acute myocardial infarction. *Angiology* 1996 ; 47 : 649-61.
- 86 Szczeklik A. Mediator assays in aspirin-induced asthma. *Allergy Proc* 1994 ; 15 : 135-8.
- 87 Watkins J, Wild G. Improved diagnosis of anaphylactoid reactions by measurements of serum tryptase and urinary methylhistamine. *Ann Fr Anesth Réanim* 1993 ; 12 : 169-72.
- 88 Fisher M, Baldo BA. Anaphylaxis during anaesthesia: current aspects of diagnosis and prevention. *Eur J Anaesth* 1994 ; 11 : 263-84.
- 89 Withington DE. Allergy, anaphylaxis and anaesthesia. *Can J Anaesth* 1994 ; 41 : 1133-9.
- 90 McKinnon RP, Wildsmith JAW. Histaminoid reactions in anaesthesia. *Br J Anaesth* 1995 ; 74 : 217-28.
- 91 Leynadier F. Choc anaphylactique. Physiopathologie, diagnostic, traitement avec la posologie. *Rev Prat* 1995 ; 45 : 1971-6.

- 92 Whittington T, Fisher MM. Anaphylactic and anaphylactoid reactions. *Baillière's Clin Anaesthesiol* 1998 ; 12 : 301-23.
- 93 Laxenaire MC. Choc anaphylactique peranesthésique : conduite à tenir. *Ann Fr Anesth Réanim* 1997 ; 16 : fi2-fi4.
- 94 The diagnosis and management of anaphylaxis. VII. Evaluation and management of patients with a history of anaphylaxis. *J Allergy Clin Immunol* 1998 ; 101 : S482-S485.
- 95 Baldo BA, Fisher MM. Detection of serum IgE antibodies that react with alcuronium and tubocurarine after life-threatening reactions to muscle relaxant drugs. *Anaesth Intensive Care* 1983 ;11 :194-7
- 96 Baldo BA, Fisher MM. Substituted ammonium ions as allergenic determinants in drug allergy. *Nature* 1983 ;306:262-4
- 97 Harle DG, Baldo BA, Fisher MM. Immunoassays employing substituted ammonium compounds other than neuromuscular blocking drugs to increase the detection of IgE antibodies to these drugs. *Mol Immunol* 1990 ; 27: 1039-45
- 98 Fisher MM, Baldo BA. Immunoassays in the diagnosis of anaphylaxis to neuromuscular blocking drugs: the value of morphine for the detection of IgE antibodies in allergic subjects. *Anaesth Intensive Care* 2000 ; 28 :167-70
- 99 Guéant JL, Mata E, Monin B, Moneret-Vautrin DA, Kamel L, Nicolas JP, et al. Evaluation of a new reactive solid phase for radioimmunoassay of serum specific IgE against muscle relaxant drugs. *Allergy* 1991 ;46 : 452-8
- 100 Guilloux L, Ricard-Blum S, Ville G, Motin J. A new radioimmunoassay using a commercially available solid support for the detection of IgE antibodies against muscle relaxants. *J Allergy Clin Immunol* 1992;90:153-9
- 101 Assem ES. Predictive value of in vitro tests for the IgE-dependent and the IgE-independent anaphylactoid reactions to muscle relaxants. *Ann Fr Anesth Réanim* 1993 ;12 :203-11
- 102 Guéant JL, Kamel L, Moneret-Vautrin DA, Widmer S, Laxenaire MC, Nicolas JP. Méthode radio-immunologique de détection des IgE spécifiques à l'alcuronium. *Ann Fr Anesth Réanim* 1986 ;5 : 570-3
- 103 Moneret-Vautrin DA, Guéant JL, Kamel L, Laxenaire MC, El Kholty S, Nicolas JP. Anaphylaxis to muscle relaxant: cross-sensitivity studied by radioimmunoassays compared to intradermal tests in 34 cases. *J Allergy Clin Immunol* 1988 ;82 : 745-52
- 104 Baldo BA, Fisher MM. Anaphylaxis to muscle relaxant drugs: cross-reactivity and molecular basis of binding of IgE antibodies detected by radioimmunoassay. *Molec Immunol* 1983 ;20 :1393-400
- 105 Guéant JL, Mata E, Masson C, Moneret-Vautrin DA, Laxenaire MC. Non-specific interactions in anti-agent IgE-RIA to anaesthetic agents. *Ann Fr Anesth Réanim* 1993 ;12 : 141-6

- 106 Harle DG, Baldo BA, Fisher MM. Antigenic similarity between the protein neurotoxin alpha-bungarotoxin and neuromuscular blocking drugs. *Agent Actions* 1986 ; 18: 512-7
- 107 Guéant JL, Namour F, Romano A, Mata E, Aimone-Gastin I, Kanny G, et al. Criteria of evaluation and of interpretation of Sepharose-drug IgE-RIA to anaesthetic drugs. *Allergy* 2000 ;54 :17-22
- 108 Guéant JL, Mata E, Masson C, Gérard P, Moneret-Vautrin DA, Mouton-Faivre C, et al. Non-specific cross-reactivity of hydrophobic serum IgE to hydrophobic drugs. *Mol Immunology* 1995 ; 32: 259-66
- 109 Mata E, Guéant JL, Moneret-Vautrin DA, Bermejo N, Gérard P, Nicolas JP, et al. Clinical evaluation of in vitro leukocyte histamine release in allergy to muscle relaxant drugs. *Allergy* 1992 ; 47: 471-6
- 110 Baldo BA, Fisher MM. Diagnosis of IgE-dependent anaphylaxis to neuromuscular blocking drugs, thiopentone and opioids. *Ann Fr Anesth Réanim*1993 ;12 :173-81
- 111 Didier A, Benzarti M, Alazia M, Hémon Y, Senft M, Charpin J, et al. Accidents anaphylactiques au suxaméthonium. *Ann Fr Anesth Réanim* 1986 ;5 :361-6
- 112 Fisher MM, Baldo BA. Persistence of allergy to anaesthetic drugs. *Anaesth Intensive Care* 1992 ; 20: 143-6
- 113 Didier A, Benzarti M, Senft M, Charpin D, Lagier F, Charpin J, et al. Allergy to suxamethonium: persisting abnormalities in skin tests, specific IgE antibodies and leukocyte histamine release. *Clin Allergy* 1987 ;17 :385-92
- 114 Fisher MM, Baldo BA, Silbert BS. Anaphylaxis during anesthesia: use of radioimmunoassays to determine etiology and drugs responsible in fatal cases. *Anesthesiology* 1991 ;75 :1112-5
- 115 Porri F, Lemiere C, Birnbaum J, Guilloux L, Lanteaume A, Didelot R, Charpin D, Vervloet D. Prevalence of muscle relaxant sensitivity in a general population : implications for a preoperative screening. *Clin Exp Allergy* 1999 ; 29: 72-5
- 116 Harle DG, Baldo BA, Coroneos NJ, Fisher MM. Anaphylaxis following administration of papaveretum. Case report : Implication of IgE antibodies that react with morphine and codeine, and identification of an allergenic determinant. *Anesthesiology* 1989 ;71:489-94
- 117 Baldo BA, Fisher MM, Harle DG. Allergy to thiopentone. *Clin Rev Allergy* 1991 ;9: 295-308
- 118 Harle DG, Baldo BA, Smal BA, Wajon P, Fisher MM. Detection of thiopentone reactive IgE antibodies following anaphylactoid reactions during anaesthesia. *Clin. Allergy* 1986 ;16 : 493-8
- 119 Harle DG, Baldo DA, Smal MA, Fisher MM. Drugs as allergens: the molecular basis of IgE binding to thiopentone. *Int Archs Allergy Appl Immun* 1987 ;84 :277-83
- 120 Moneret-Vautrin DA, Widmer S, Guéant JL, Kamel L, Laxenaire MC, Mouton C, Gérard H. Simultaneous anaphylaxis to thiopentone and a neuromuscular blocker: a study of two cases. *Br J Anaesth* 1990 ; 64 : 743-5
- 121 Laxenaire MC, Guéant JL, Bermejo E, Mouton C, Navez MT. Anaphylactic shock due to propofol. *Lancet* 1988 ;2:739-40

- 122 Laxenaire MC, Mata-Bermejo E, Moneret-Vautrin DA, Guéant JL. Life-threatening anaphylactoid reactions to propofol (Diprivan®). *Anesthesiology* 1992 ;77 :275-80
- 123 Guéant JL, Aimone-Gastin I, Namour F, Laroche D, Bellou A, Laxenaire MC. Diagnosis and pathogenesis of the anaphylactic and anaphylactoid reactions to anaesthetics. *Clin Exp Allergy* 1998 ; 28: 65-70
- 124 Aimone-Gastin I, Guéant JL, Laxenaire MC, Moneret-Vautrin DA. Pathogenesis of allergic reactions to anaesthetic drugs. *Int J Immunol Pharmacol* 1997 ;10 :193-6
- 125 Vervloet D, Arnaud A, Vellieux P, Kaplanski S, Charpin J. Anaphylactic reactions to muscle relaxants under general anesthesia. *J Allergy Clin Immunol* 1979; 63: 348-53
- 126 Assem ESK. Characteristics of basophil histamine release by neuromuscular blocking drugs in patients with anaphylactoid reactions. *Agents Actions* 1984;14: 435-40.
- 127 Vervloet D, Arnaud A, Senft M, Dor Ph, Bongrand P, Charpin J, et al. Leukocyte histamine release to suxamethonium in patients with adverse reactions to muscle relaxants. *J Allergy Clin Immunol* 1985; 75: 338-42.
- 128 Vervloet D, Arnaud A, Senft M, Dor Ph, Didier A, Bongrand P, et al. Anaphylactic reactions to suxamethonium. Prevention of mediator release by choline. *J Allergy Clin Immunol* 1985; 76: 222-5.
- 129 Didier A, Cador D, Bongrand P, Furstoss R, Fourneron P, Senft M, et al. Role of the quaternary ammonium ion determinants in allergy to muscle relaxants. *J Allergy Clin Immunol* 1987; 79: 578-84.
- 130 Stellato C, de-Paulis A, Cirillo R, Mastronardi P, Mazzarella B, Marone G. Heterogeneity of human mast cells and basophils in response to muscle relaxants. *Anesthesiology* 1991; 74: 1078-86.
- 131 Assem ESK. Anaphylactic anaesthetic reactions. The value of paper radioallergosorbent tests for IgE antibodies to muscle relaxants and thiopentone. *Anaesthesia* 1990; 45: 1032-8.
- 132 Facon A, Gosset P, Tonnel AB, Scherpereel P. Intérêt des tests de libération de l'histamine leucocytaire et des intradermoréactions dans le diagnostic des accidents anaphylactoïdes aux produits anesthésiques. *Ann Fr Anesth Réanim* 1985;4: 233-7.
- 133 Vervloet D, Nizankowska E, Arnaud A, Senft M, Alazia M, Charpin J. Adverse reactions to suxamethonium and other muscle relaxants under general anesthesia. *J Allergy Clin Immunol* 1983; 71: 552-9.
- 134 Shore PA, Burkhalter A, Cohn VH Jr. A method for the fluorometric assay of histamine in tissues. *J Pharmacol Exp Ther* 1959;127 :182-6.
- 135 Siraganian RP, Brodsky MJ. Automated histamine release for in vitro allergy testing: I. A method utilizing allergen induced histamine release from whole blood. *J Allergy Clin Immunol* 1976;57: 525-40.

- 136 Assem ESK. IgE antibody-dependent and IgE independent release of histamine in patients with anaphylactoid reactions to neuromuscular blockers. *Agents Actions* 1992; 36 (SPEC.ISS): C206-C210.
- 137 Guilloux L, Ricard Blum S, Ville G, Motin J. Histamine release assay and radioimmunoassay for the detection of IgE antibodies against neuromuscular blocking drugs. *Ann Fr Anesth Réanim* 1993; 12: 182-6.
- 138 Mata E, Guéant JL, Moneret-Vautrin DA, Bermejo N, Gerard P, Nicolas JP, et al. Clinical evaluation of in vitro leukocyte histamine release in allergy to muscle relaxant drugs. *Allergy* 1992; 47: 471-6.
- 139 Widmer S, Moneret-Vautrin DA, Laxenaire MC, Mouton C. Leukocyte histamine release tests for the diagnosis of anaphylactic reaction to curare-like agents. *Allerg Immunol* 1988; 20: 344-5.
- 140 Moneret-Vautrin DA, Motin J, Mata A, Guéant JL, Kanny G, Widmer S, et al. Preventing muscle relaxant anaphylaxis with monovalent haptens. A preliminary study. *Ann Fr Anesth Réanim* 1993; 12: 190-202.
- 141 Moneret-Vautrin DA, Kanny G, Guéant JL, Widmer S, Laxenaire MC. Prevention by monovalent haptens of IgE-dependent leukocyte histamine release to muscle relaxants. *Int Arch Allergy Immunol* 1995; 107: 172-5.
- 142 Laxenaire MC, Gastin I, Moneret-Vautrin DA, Widmer S, Guéant JL. Cross reactivity of rocuronium with other neuromuscular blocking agents. *Eur J Anaesthesiol* 1995; 11 Suppl: 55-64.
- 143 Bermejo N, Guéant JL, Mata E, Gerard P, Moneret-Vautrin DA, Laxenaire MC. Platelet serotonin is a mediator potentially involved in anaphylactic reaction to neuromuscular blocking drugs. *Br J Anaesth* 1993; 70: 322-5.
- 144 Charpin D, Vervloet D, Lanteaume A, Gouffonnet J, Fondarai J. Etude critique des conditions d'application du test de dégranulation des basophiles humains en diagnostic allergologique. *Rev Fr Allergol Immunol* 1987; 2, 57-60.
- 145 Abuaf N, Rajoely B, Ghazouani E, Levy DA, Pecquet C, Chabane H, et al. Validation of a flow cytometric assay detecting in vitro basophil activation for the diagnosis of muscle relaxant allergy. *J Allergy Clin Immunol* 1999; 104(2 Pt 1): 411-8.
- 146 Monneret G, Benoit Y, Gutowski MC, Bienvenu J. Detection of basophil activation by flow cytometry in patients with allergy to muscle-relaxant drugs. *Anesthesiology* 2000; 92: 275-7.
- 147 Sabbah A. A propos de l'allergie médicamenteuse. *Allerg Immunol (Paris)* 1996; 28: 230-3.
- 148 Assem ESK. Release of eosinophil cationic protein (ECP) in anaphylactoid anaesthetic reactions in vivo and in vitro. *Agents Actions* 1994; 41(SPEC. ISS.): C11-C13.
- 149 Assem ESK. Leukotriene C4 release from blood cells in vitro in patients with anaphylactoid reactions to neuromuscular blockers. *Agents Actions* 1993; 38(SPEC. ISS. II): C242-C244.
- 150 Stellato C, Casolaro V, Ciccarelli A, Mastronardi P, Mazzarella B, Marone G. General anaesthetics induce only histamine release selectively from human mast cells. *Br J Anaesth* 1991; 67: 751-8.

- 151 Stellato C, Cirillo R, de-Paulis A, Casolaro V, Patella V, Mastronardi P, et al. Human basophil/mast cell releasability: IX. Heterogeneity of the effects of opioids on mediator release. *Anesthesiology* 1992; 77: 932-40.
- 152 Genovese A, Stellato C, Marsella CV, Adt M, Marone G. Role of mast cells, basophils and their mediators in adverse reactions to general anesthetics and radiocontrast media. *Int Arch Allergy Immunol* 1996; 110: 13-22.
- 153 Laxenaire MC, Mata E, Guéant JL, Moneret-Vautrin DA, Haberer JP. Basophil histamine release in atopic patients after in vitro provocation with thiopental, Diprivan and chlormethiazole. *Acta Anaesthesiol Scand* 1991; 35: 706-10.
- 154 Koller DY, Rosenkranz AR, Pirker C, Götz M, Jarisch R. Assessment of histamine release from basophils in whole blood by benzylpenicilloyl-poly-L-lysine in penicillin- sensitized patients. *Allergy* 1992; 47: 459-62.
- 155 Demoly P, Lebel B, Messaad D, Sahla H, Rongier M, Daures JP, et al. Predictive capacity of histamine release for the diagnosis of drug allergy. *Allergy* 1999; 54: 500-6.
- 156 Fernandez-Rivas M, Carral CP, Cuevas M, Marti C, Moral A, Senent CJ. Selective allergic reactions to clavulanic acid. *J Allergy Clin Immunol* 1995; 95: 748-50.
- 157 Igea JM, Fraj J, Davila I, Cuevas M, Cuesta J, Hinojosa M. Allergy to cefazolin: study of in vivo cross reactivity with other betalactams. *Ann Allergy* 1992; 68: 515-9.
- 158 Tadokoro K, Niimi N, Ohtoshi T, Nakajima K, Takafuji S, Onodera K, et al. Cefotiam-induced IgE-mediated occupational contact anaphylaxis of nurses; cases reports, RAST analysis, and a review of the literature. *Clin Exp Allergy* 1994; 24: 127-33.
- 159 Igea JM, Quirce S, de la Hoz B, Fraj J, Pola J, Diez Gomez ML. Adverse cutaneous reaction due to macrolides. *Ann Allergy* 1991; 66: 216-8.
- 160 Lopez Serrano C, Quiralte E, Martinez Alzamora F. Urticaria from erythromycin. *Allergol Immunopathol* 1993; 21: 225-6.
- 161 Cardot E, Tillie-Leblond I, Jeannin P, Facon A, Breuil K, Patte F, et al. Anaphylactic reaction to local administration of rifamycin SV. *J Allergy Clin Immunol* 1995; 95: 1-7.
- 162 Sabbah A, Bruchmann C, Drouet M, Vitale L, Lauret MG. Etude du cycle cellulaire par cytométrie de flux dans l'allergie médicamenteuse. *Allerg Immunol (Paris)* 1993; 25: 91-97.
- 163 Sabbah A, Lauret MG, Maillard H. Etude préliminaire du test d'activation des basophiles à l'aide d'anticorps membranaires par cytométrie de flux dans l'allergie médicamenteuse. *Allerg Immunol (Paris)* 1995; 27: 274-6.
- 164 Sainte-Laudy J, Vallon C, Guerin JC. Intérêt du test de libération du leucotriène C4 pour le diagnostic d'une allergie médicamenteuse (résultats préliminaires). *Allerg Immunol (Paris)* 1996; 28: 44-7.
- 165 Sanz ML, Sanchez G, Vila L, Dieguez I, Oehling AK. Antigen-specific sulphidoleukotriene production in allergy to beta-lactam antibiotics. *Int Arch Allergy Immunol* 1999; 118: 364-5.

- 166 Halpern B, Ky N, Amache N. Diagnosis of drug allergy in vitro with the lymphocyte transformation test. *J Allergy Clin Immunol* 1967, 40: 168-81.
- 167 Bircher AJ. Lymphocyte transformation test in the diagnosis of immediate type hypersensitivity reactions to penicillins. *Curr Probl Dermatol* 1995; 22: 31-7.
- 168 Perez T, Dayer E, Girard JP. Hypersensitivity reactions to drugs: correlation between clinical probability score and laboratory procedures. *J Investig Allergol Clin Immunol* 1995; 5: 276-82.
- 169 Nyfeler B, Pichler WJ. The lymphocyte transformation test for the diagnosis of drug allergy: sensitivity and specificity. *Clin Exp Allergy* 1997; 27: 175-81.
- 170 Cederbrant K, Stejskal V, Broman P, Lindkvist L, Sundell K. In vitro lymphocyte proliferation in the diagnosis of allergy to phenoxymethylpenicillin. *Allergy* 1998; 53: 1155-61.
- 171 Dunoyer-Geindre S, Ludi F, Perez T, Terki N, Gumowski PI, Girard JP. PAF acether release on antigenic challenge. A method for the investigation of drug allergic reactions. *Allergy* 1992; 47: 50-4.
- 172 Pytsky VI, Filatov OY. Phenomenon of specific inhibition of luminol-dependent chemiluminescence of polymorphonuclear leukocytes under the influence of allergen. *J Investig Allergol Clin Immunol* 1996; 6: 256-60.
- 173 Turjanmaa K, Räsänen L, Lehto M, Mäkinen-Kiljunen S, Reunala T. Basophil histamine release and lymphocyte proliferation tests in latex contact urticaria. In vitro tests in latex contact urticaria. *Allergy* 1989;44: 181-6.
- 174 Marais GI, Fletcher JM, Potter PC. In vivo and in vitro diagnosis of latex allergy at Groote Schuur Hospital. *S Afr Med J* 1997; 87: 1004-8.
- 175 Fernandez de Corres I, Moneo I, Munoz D, Bernaola G, Fernandez E, et al. Sensitization from chestnuts and bananas in patients with urticaria and anaphylaxis from contact with latex. *Ann Allergy* 1993; 70: 35-9.
- 176 Latasa M, Dieguez I, Sanz ML, Parra MJ, Pajaron MJ, Oehling A. Fruit sensitization in patients with allergy to latex. *J Investig Allergol Clin Immunol* 1995; 5: 97-102.
- 177 Rodriguez M, Vega F, Garcia MT, Panizo C, Laffond E, Montalvo A, et al. Hypersensitivity to latex, chestnut, and banana. *Ann Allergy* 1993, 70: 31-4.
- 178 Ebo DE, Bridts CH, de Clerck LS, van Offel JF, Stevens WJ. Immunoglobulin E-mediated natural rubber latex (NRL) hypersensitivity. *ACI International* 1999, 11: 112-7.
- 179 Ebo DG, Stevens WJ, Bridts CH, de Clerck LS. Latex-specific IgE, skin testing, and lymphocyte transformation to latex in latex allergy. *J Allergy Clin Immunol* 1997; 100 : 618-23.
- 180 Johnson BD, Kurup VP, Sussmann GL, Arif SA, Kelly KJ, Beezhold DH, et al. Purified and recombinant latex proteins stimulate peripheral blood lymphocytes of latex allergic patients. *Int Arch Allergy Immunol* 1999; 120: 270-9.
- 181 Raulf-Heimsoth M, Chen Z, Liebers V, Allmers H, Baur X. Lymphocyte proliferation response to extracts from different latex materials and to the purified latex allergen Hev b 1 (rubber elongation factor). *J Allergy Clin Immunol* 1996; 98: 640-51.

182 Murali PS, Kelly KJ, Fink JN, Kurup VP. Investigations into the cellular immune responses in latex allergy. *J Lab Clin Med* 1994;124: 638-43.