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Cutaneous Myiasis: Diagnosis, Treatment, and Prevention

René Caissie, DMD, MSc, Frédéric Beaulieu, PhD,†*
Marjolaine Giroux, PhD,‡ François Berthod, PhD,§ and
Pierre-Éric Landry, DMD, MSc, FRCD(C)¶

Myiasis, from the Greek *myia* for "fly," has been defined as the infestation of live human or vertebrate animals with larvae of the insect order Diptera (flies), which feed on living or necrotic tissue.[1-3] The majority of flies causing myiasis can be categorized into 1 of 2 groups, based on relationship with their hosts. Obligate parasites grow only on healthy tissue of live hosts whereas facultative parasites, associated usually with carrion, feces, or decaying plant material, can develop on necrotic tissue of living animals and tend not to invade healthy tissue. Accidental infestations represent a third category in which the eggs or larvae of saprophagous flies are inhaled or swallowed inadvertently with contaminated food (gastrointestinal myiasis).[1-3]

Myiasis can also be classified according to the site of infestation. Cutaneous myiasis involves the invasion of the skin, with the most common target being a wound, near which an obligatory or facultative parasitic fly will lay eggs.[1,2,4] In "wound myiasis," both healthy and necrotic tissues can be fed on by the larvae, depending on the conditions and species of fly involved. Other flies (eg, the human botfly *Dermatobia hominis* [L. Jr.] in tropical America, the "tumbu fly" *Cordylobia anthropophaga* [Blanchard and Berenger-Feraud] in tropical Africa, and *Wohlfahrtia vigil* [Walker] in North America) penetrate healthy skin and produce itchy sores that develop into painful boil-like lesions or furuncles, hence the term "furuncular myiasis."[1,5,6] Creeping myiasis is a type of cutaneous myiasis involving the migration of fly larvae underneath the skin.[1,7] Apart from the skin, the eyes, ears, nose, and sinuses represent relatively common sites of attack whereas less common sites are the mouth, throat, urogenital, and gastrointestinal tracts.[1,2,4,8-10]

The invasion of body orifices is sometimes considered accidental myiasis, especially when the larvae cannot complete their development.[2] The most severe cases of myiasis involve obligate parasites, typically those invading wounds or mucous membranes associated with body orifices (screwworm flies) in tropical America (*Cochliomyia hominivorax* Coquerel) or in the Old World (*Chrysomya bezziana* Villeneuve, *Wohlfahrtia magnifica* Schiner), although some facultative myiasis can be dangerous if left untreated.[1,3]

Myiasis occurs mainly in tropical and subtropical latitudes and often originates in these areas even when reported in temperate climates.[1] The main contributing factors are probably the higher levels of exposure to myiasis-causing flies due to poorer clothing and hygiene conditions, combined with the increased aggressiveness of myiasis-causing flies in the tropics.[1,3,9] Nevertheless, many cases acquired in temperate parts of Eurasia and North America, including Canada, have been described in the literature.[3,4,10,11] Despite these records, human myiasis remains an unfamiliar illness for most physicians in North America; misdiagnosis and inappropriate treatment are common.[4] Awareness of myiasis by health professionals

*Doctoral Student, Laboratoire d'Organogénèse Expérimentale (LOEX), Department of Surgery, Laval University; and Resident, Oral and Maxillofacial Surgery Department, CHAUQ, Hôpital de l'Enfant-Jésus, Québec, QC, Canada.

†Research Scientist, Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, Ottawa, ON, Canada.

‡Entomologist, Lyman Entomological Museum, McGill University, Ste-Anne-de-Bellevue, QC, Canada.

§Professor, Laboratoire d'Organogénèse Expérimentale (LOEX), CHA, Hôpital du St-Sacrement and Department of Surgery, Laval University, Québec, QC, Canada.

¶Assistant Professor and Program Director, Oral and Maxillofacial Surgery Department, CHAUQ, Hôpital de l'Enfant-Jésus and Laval University, Québec, QC, Canada.

Address correspondence and reprint requests to Dr Landry: Oral and Maxillofacial Surgery Department, CHA, Hôpital de l'Enfant-Jésus, 1401, 18, Québec, QC, Canada G1J 1Z4; e-mail: pelmax@videotron.ca

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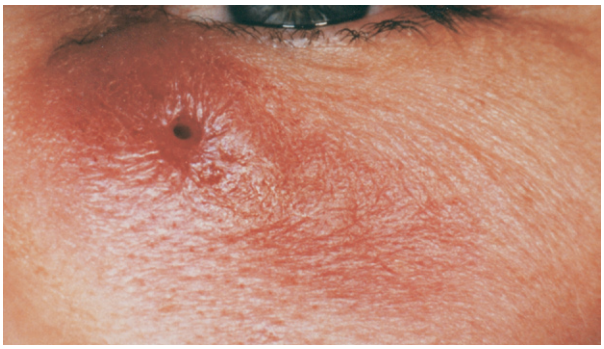

FIGURE 1. Patient as he presented 3 weeks after initial event; larva extracted.

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would facilitate recognition and augment the effectiveness and expediency of care.

We report on a new case of facial furuncular myiasis in an adult by a larva tentatively identified as *Wohlfahrtia vigil* (Diptera: Sarcophagidae), and we provide a review of human myiasis cases in Canada.

Report of a Case

A healthy 44-year-old male patient was referred to our department by the general practitioner who had first received the patient. The patient reported a history of persistent infraorbital swelling and erythema that had appeared 3 weeks beforehand during a fishing trip in northwestern Quebec, Canada. At that time, the patient had noted a raised "pimple" below his left eye. Within a few days, the lesion became larger, painful, and occasionally began to drain a sero-purulent material (Fig 1). He also complained of a "crawling" sensation in the affected area. The patient first presented to his general medical practitioner and was treated with oral antibiotics for a period of 3 weeks. Because the swelling and drainage receded but failed to respond to treatment, the patient was referred to our oral and maxillofacial surgery department.

Physical examination showed a single nodule with surrounding indurated erythema (diameter, 2 cm) and a central pore (diameter, 1.2 mm) through which a single, moving larva was observed. The larva was removed with the use of manual pressure and blunt tweezers: it measured approximately 8.3 × 3.0 mm (Fig 2). Exploration of the wound showed no other larvae. The patient recovered fully within a few weeks.

The larva was discarded inadvertently. However, by comparing the morphology, biology, and geographic distribution of major myiasis-causing flies, we concluded that the larva most likely belonged to the species *Wohlfahrtia vigil* (often reported as a distinct species, *W. opaca* [Coquillett], or subspecies *W. vigil opaca* in western North America). If our tentative diagnosis of *W. vigil* is correct, our specimen is most likely a third instar larva (third instar of *W. vigil* are 7 to 16.5 mm, whereas second instar are 3.5 to 6.75 mm).[12]

Human Myiasis in Canada: Review of the Literature

We reviewed biology (BIOSIS) and medicine databases (MEDLINE) on myiasis acquired in Canada, or acquired overseas but diagnosed in Canada. Gyorkos[11] reviewed Canadian cases of myiasis before 1977 (the first case was in 1875). We consulted most of the references in her review, summarized the data (Table 1), and added 4 more cases found before 1977.[2,13-15] We also added cases that were reported since that time (1977-2006; Table 1, numbers in bold). Gyorkos found 60 cases of myiasis. Considering the 4 additional cases we found, the total number of human myiasis in Canada before 1977 adds up to 64. Of 64 cases, 3 (4.7%) were contracted overseas (due to *Cordylobia rodhaini* and *Dermatobia hominis*). We found 24 additional cases that were reported in 1977 or after, including 9 cases (37.5%) from overseas (including an eye myiasis by *Oestrus ovis*, contracted in Hawaii,[16] although the species also occurs in Canada). The record of *C. anthropophaga* before 1977 is considered dubious as it was reported from a child in

FIGURE 2. Views of larva immediately after extraction.

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Table 1. NUMBER OF MYIASIS CASES ACQUIRED IN CANADA ARRANGED BY SPECIES AND CLINICAL SYNDROMES*

Causative Fly Species	Cutaneous: Furuncular	Cutaneous: Creeping	Cutaneous: Wound	Ocular	Aural	Mammary-Lactating	Nasopharyngeal/Tracheal	Urogenital	Gastro-Intestinal	Main Breeding Habits	Reference
Anisopodidae											
Sylvicola fenestralis (Scopoli)								1		Saprophage	15
Calliphoridae											
Cochliomyia macellaria (Fabricius)							**1**			Scavenger	21
Cordylobia anthropophaga (Blanchard and Berenger-Feraud)†	**2**									Mammal skin parasite	5,47
C. anthropophaga‡	1										17
Cordylobia rodhaini (Gedoelst)†	1									Mammal skin parasite	48
Lucilia illustris (Meigen)			1	**1**§			**1**§			Scavenger	2,22
Lucilia sericata (Meigen)					1	1				Scavenger	49,50
Phormia regina (Meigen)			1							Scavenger	51
Fanniidae											
Fannia scalaris (Fabricius)									1	Scavenger/saprophage	11
Fannia canicularis (Linnaeus)									1, **1**	Scavenger/saprophage	11,23
Oestridae											
Cuterebra fontinella (Clark)	**1**	0	0	0	0		**1**			Mice parasite	52
Cuterebra spp.	**5**‖									Rodent or rabbit parasites	18,31,36,53,54
Cuterebra sp.‡		**1**									7
Dermatobia hominis (L. Jr.)†	2, **6**									Mammal and bird skin parasite	6,19,33,34,38,47,55
Gasterophilus haemorrhoidalis (L.)		**1**								Horse gut parasite	47
Gasterophilus intestinalis (De Geer)		4								Horse gut parasite	40,43,56
Gasterophilus sp.		1								Horse gut parasite	11
Hypoderma bovis (L.)		2								Cattle parasite	39
Hypoderma lineatum (De Vill.)		5								Cattle parasite	39,57
Oestrus ovis (L.)				1, **1**†						Parasite of sheep sinuses	11,16
Sarcophagidae											
Sarcophaga (*Bercaea*) *africa* (Wiedemann)¶									3	Scavenger/saprophage	11,58,59
Sarcophaga (*Neobellieria*) *citellivora* (Shewell)					1					Skin parasite of ground squirrels	60

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Table 1. (CONTINUED)

Causative Fly Species	Cutaneous			Ocular	Aural	Mammary-Lactating	Nasopharyngeal/Tracheal	Urogenital	Gastro-Intestinal	Main Breeding Habits	Reference
	Furuncular	Creeping	Wound								
Sarcophaga (*Neobellieria*) *cooleyi* (Parker)					1					Scavenger/saprophage	14
Sarcophaga (*Liopygia*) *crassipalpis* (Macquart)‡		0	1							Scavenger/saprophage	59
Sarcophaga sp.					1					Scavenger/saprophage‡	13
Wohlfahrtia vigil (Walker)	32, **1**									Mammal (newborns) skin parasite	11,25-27,29,37,38, 47,61-68
W. vigil‡	**1**										This article
Sarcophagidae sp.		**1**									20
Syrphidae											
Eristalis tenax (L.)									1	Saprophage	69
Total no. cases (% of total syndromes)											
Before 1977	36 (56.3)	12 (18.8)	3 (4.7)	1 (1.6)	4 (6.3)	1 (1.6)		1 (1.6)	6 (9.4)		
1977-2006	16 (66.7)	3 (12.5)		2 (8.3)			3 (12.5)		1 (4.2)		

*Numbers in regular font indicate cases recorded during 1875 to 1977.[11] Numbers in bold indicate cases recorded during 1977 to 2006.
†Acquired overseas but diagnosed in Canada.
‡Indicates uncertainty in species or genus identity, or the nature of the myiasis.
§These myiases represent 1 case (ie, 1 patient).
‖Some of these cases may have involved creeping myiasis.
¶This species had been called *S. haemorrhoidalis* (Fallén) previously.

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Saskatchewan that had not traveled overseas. It is likely that either the larva was identified erroneously and belonged to another species, or that it originated from material (soil or clothing where the fly could have laid eggs) that was brought into the country from overseas.[17]

Furuncular myiasis is the dominant form of myiasis in both periods (56.3% and 66.7%, respectively) (Table 1). Before 1977, these were due mainly to *W. vigil* (88.9% of furuncular myiasis cases), whereas after 1977, *Cuterebra* spp. (including *C. fontinella*: 6 cases) and *Dermatobia hominis* (all acquired from overseas; 6 cases) seem to be more important than *W. vigil* (2 cases including the present case report). Two furuncular myiasis after 1977 involved the skin of the lower eyelid, 1 caused by *Cuterebra* sp.[18] and the other by *D. hominis*.[19] Interestingly, myiasis by *Cuterebra* spp. was not reported before 1977 in Canada, but a total of 8 cases have been reported since, concerning furuncular, creeping, and tracheal myiasis. Myiasis of the skin by the cattle grubs *Hypoderma* spp. and horse bot flies *Gasterophilus* spp. seems to be relatively common (12 total cases before 1977). However, only 1 case (by *G. haemorrhoidalis*) was reported after 1977 (Table 1). A cutaneous myiasis involving numerous larvae of an unidentified species of Sarcophagidae was observed on the foot of a 2-month-old baby, and presented symptoms reminding those of creeping eruption due to *Gasterophilus* spp.[20] Wound myiasis is relatively rare, and only 1 case could be considered as such after 1977, but it was classified here as nasopharyngeal/tracheal; in this case, fly larvae of *Cochliomyia macellaria* were acquired nosocomially and invaded the tracheotomy site (as well as the right nasal vestibule) of an aged patient in a vegetative state.[21] Another case of nosocomial myiasis affected an intubated patient, which had larvae infesting her nasopharynx and median canthus of the left eye.[22] There are few cases of invasion of the eyes or body orifices (ears, nose, trachea, nipples of lactating breasts, and urogenital tract of a boy) by flies (10.9% and 16.7% of cases in the 2 periods, respectively); 7 cases were due to flies breeding usually in carrion (scavengers) or in other dead organic matter such as dung or rotting vegetable matter (saprophages), and 4 cases have been produced by obligatory parasites of mice, sheep, and ground squirrels. Six intestinal myiasis have been reported before 1977 and only 1 case of gastric myiasis was reported after 1977, where the patient vomited partly digested food containing larvae of *Fannia canicularis*.[23] All cases were caused by scavenger/saprophagous flies (Table 1).

Among the 24 new cases from 1977 to 2006, 2 involved infants of 2 months (1 due to *W. vigil*, the other to an unidentified Sarcophagidae sp.), 3 involved children 1 to 3 years old (all due to *Cuterebra*), 3 involved children 12 to 13 years old (also all due to *Cuterebra*), and 16 involved adults. This contrasts with the results of Gyorkos[11] who found that 48.3% of cases (29 of 53 cases analyzed) before 1977 concerned infants less than 1 year old. All of these cases were due to *W. vigil*. Therefore, the lower frequency of myiasis in infants after 1977 is due to the smaller number of records of myiasis by *W. vigil*.

Discussion

Three reasons lead us to believe that the parasite involved in the reported case was *Wohlfahrtia vigil*. First, the sore had the form of a furuncle, and there was no sign of any wound or necrotic tissue that could have attracted flies before the invasion by the maggot; therefore, facultative parasitic flies that breed typically in decaying organic matter could almost certainly be excluded. Obligatory parasites that generally use wounds or mucous membranes as entry point (screwworms *Cochliomyia hominivorax*, *Chrysomya bezziana*, and *W. magnifica*) or that do not produce furuncular myiasis (eg, *Gasterophilus* produce creeping myiasis, *Oestrus ovis* L. invade nasal cavities or eyes)[2] also could be excluded. Second, the patient had not been out of the country in the previous 4 years. Therefore, species from tropical America (*Co. hominivorax*, *Dermatobia hominis*) or the Old World (*Cordylobia anthropophaga*, *Ch. bezziana*, *W. magnifica*) could be excluded. Thus, the causal agent was most likely an obligatory parasite associated with furuncular myiasis in temperate North America. In the northern United States and Canada, *Wohlfahrtia vigil*, *Cuterebra*, and *Hypoderma* spp. are the only flies known to cause furuncular myiasis in humans. Finally, the shape of the larva, pictured after extraction (Fig 2), excludes all remaining candidates except *Wohlfahrtia*.

In humans, the attack of *W. vigil* is restricted largely to infants of less than 6 months.[2,24,25] The skin thickness of older individuals is apparently too hard to penetrate for the first instar larvae of *W. vigil*.[26] Nevertheless, it is likely that *W. vigil* can attack older children or adults where skin is thinner and softer (eg, foreskin),[27] or in sites of tiny lesions (eg, tick bite, mosquito bite, scratch). It is possible that our patient was bitten beneath the eye by a mosquito or another biting fly, and that a female of *W. vigil* squirted a larva (sarcophagid flies give birth directly to first instar larvae) somewhere on the face and the latter crawled on the skin surface and penetrated the skin at the site of the putative bite. *Wohlfahrtia vigil* has been reported to cause cutaneous myiasis in domestic animals (cats, dogs), captive (minks, rabbits, ferrets, foxes) and free-ranging (eg, voles, wood rats) wildlife.[28] It had been suggested that a higher frequency

of *W. vigil* parasitism in infants during the summer of 1953 was due to an increase in the fly populations concomitant with lower local populations of normal host species, thereby forcing the female flies to target human hosts in the vicinity.[29] *Wohlfahrtia vigil* has been found throughout southern Canada, the northern United States, and Eurasia.[30]

The literature review emphasizes the fact that myiasis can be acquired by traveling overseas, but also within Canada and the United States. The apparent increase in cases acquired overseas after 1977 (9 cases, compared with 3 cases before 1977) is most likely due to the increase in international traveling. It is certain that the true number of cases occurring in Canada, and acquired by Canadians traveling overseas, is considerably higher than what Table 1 indicates. This under-representation of the disease in the literature is due likely to the fact that it is not mandatory to report myiasis, and that maggots are often considered a sign of poor hygiene: they are discarded typically with haste and disgust,[4] especially in the case of wound myiasis. We suspect that wound myiasis is the least reported type of myiasis (relative to its frequency) because it is associated with poor hygiene and untreated wounds; in a way, it is analogous to microbial secondary infections, hence it seems ordinary.

In a literature review for the period 1960 to 1995, Sherman[4] showed that wound myiasis is the most prevalent type of myiasis in the United States (32% of cases as opposed to 4.7% and 0% for the 2 periods studied here). However, this higher prevalence of wound myiasis in the United States is due partly to the presence of *Cochliomyia hominivorax*, a mainly tropical–subtropical fly that causes obligatory myiasis in wounds of humans and other mammals in the Americas.[2] Results of their own prospective study (data from 20 participating centers across the United States)[4] suggest that wound myiasis is even more prevalent (83% of 42 cases, caused mostly by *Lucilia sericata*) and support the hypothesis that wound myiasis is the least reported type of myiasis. They also observed that most cases involved aged patients (average, 60 years old), homeless folks (44%), and patients with vascular or respiratory complications (49%).

DIAGNOSIS OF CUTANEOUS MYIASIS

The initial misdiagnosis of bacterial infection of our case of cutaneous myiasis delayed appropriate treatment and caused unnecessary distress to the patient. An accurate diagnosis of cutaneous myiasis requires knowledge of the patient's exposure history (eg, recent travel to tropical endemic areas or rural areas; mosquito bite), and a degree of clinical suspicion. Main features for furuncular myiasis are: 1 or more nonhealing boil-like lesions on exposed skin, with erythema of a few mm to over 2 cm; some serous, serosanguineous, or seropurulent drainage from a central pore (associated with 1 or more of the lesions); local symptoms of pain, tenderness, pruritus, or movement inside the lesion; or a small, white, worm-like organism protruding from the lesion when pressed laterally.[1,5,6,31-35] A magnifying lens could be used to detect the orifice and to examine the larva. The presence of spiracles, breathing orifices organized in 2 clusters at the protruding end of the larva (often seen as 2 dark spots), can help recognize a fly larva. Also, if the lesion is immersed in water or saliva, air bubbles may come out of the central punctum.[35] Sometimes, a sharp sting at the site of lesion is felt a few days or weeks before the apparition of symptoms, and is due to the penetration of the larva into the skin.[31] A definitive diagnosis is achieved after extraction and identification of the fly larva(e).

Symptoms vary among the different agents of furuncular myiasis. *Cordylobia anthropophaga* tend to produce several lesions on a human host, whereas human myiasis by *Dermatobia hominis* and *Cuterebra* spp. most often involve 1 lesion.[5,19,31,34,36] Myiasis by *W. vigil* can produce 1 to several papules and although a single larva is found usually in a warble, up to 5 have been found in a single warble in a patient.[2,25,37] Note that a larva may attempt but fail to penetrate skin, and then move and invade the cutaneous tissue elsewhere; these aborted intrusions generally produce a red pimple and may be mistaken for a true warble containing a maggot.[38] Contrarily to *W. vigil*, *C. anthropophaga*, *D. hominis*, and *Cuterebra* spp. can often attack adults.

Creeping myiasis is more difficult to diagnose than furuncular myiasis because the fly larvae may not be seen if no exit/breathing hole is yet present. Creeping myiasis caused by *Gasterophilus* spp. is superficial and present clear, linear serpentine dark tunnels (creeping eruption).[2,31,39] *Hypoderma* spp. produces a deeper (subcutaneous), more painful creeping myiasis with discontinuous and transient skin swellings.[2,39] The larva then stops migrating and pierces a hole through the skin surface where it completes larval development before exiting the "furuncle" for pupation in the soil.[2] This is why myiasis by *Hypoderma* is seen usually as a furuncular myiasis. In humans, *Cuterebra* larvae presumably invade the nose or mouth to reach the trachea, burrow into the mucous membrane, and undertake a migration up to the skin where it produces a warble with a breathing/exit hole where larval maturation takes place.[31] In some cases, the larva was coughed up, presumably because it had remained in the tracheal tissues. In other circumstances, an infestation by *Cuterebra* can present symptoms of creeping myiasis because the first instar larva can invade directly the human skin (probably where a laceration occurred) and then mi-

grate through cutaneous tissues.[31] The application of machine oil to make the skin more transparent may permit one to detect the larva of *Gasterophilus*.[40] Wound myiasis can be diagnosed by the presence of maggots in a pre-existing wound.

TREATMENT

For furuncular myiasis, digital pressure on both sides of the lesion (or using a pair of wooden spatulas)[41] is often sufficient to expulse the larva(e). Pressure can be reinforced with gentle traction with forceps or tweezers. If this method is not satisfactory (may not be for *D. hominis*), petroleum jelly, paraffin oil, or beeswax can be applied to the opening of the lesion to asphyxiate the larvae and force it out.[6] Bacon fat has also been applied on lesions to prompt the larva to migrate into the fat.[42] It may take 24 hours for the larva to come out, and it may be necessary to press it out or to grasp it with tweezers while coming out.[6,32] A method using a commercial venom extractor has shown some promise and may be more expeditious and effective than the asphyxiation methods described above.[6] The injection of 2 mL of lidocaine into the nodule (beneath the larva) may be sufficient to expulse the larva out by pressure.[1,34] Surgical excision may be used if the larva is dead or if other methods have failed. To facilitate excision, the larva may be numbed by application of lidocaine gel.[19] In any case, care should be taken not to rupture the maggots because they may cause secondary infections or trigger potentially severe allergic reactions. The presence of additional maggots in the lesion should be considered (especially in wound myiasis). The wound should be disinfected and tetanus prophylaxis updated as necessary. Antibiotics should be prescribed for signs of bacterial infection.[4] Furuncular myiasis are relatively benign in humans: when treated adequately, recovery is rapid and nearly always without complication.[6,34,35,42] In the case of creeping eruption, the small, young larvae of *Gasterophilus* spp. have been removed using a needle.[40,43] Wound myiasis or body orifices infested with maggots could be treated by irrigating the area with saline or a dilute antimicrobial (eg, hydrogen peroxide, or 5% to 15% chloroform in light vegetable oil); remaining maggots can be removed manually, although deeply embedded larvae could necessitate surgery.[1,9,22]

SIGNIFICANCE OF CASE REPORTING AND SPECIES IDENTIFICATION

It is imperative that the causative fly larva(e) be either reared to adult, or preserved (in 75% alcohol) to permit proper genus or species identification. If many larvae are present, some should be preserved and others kept live for adult rearing.[1,4] In the present case, identification of the fly species was difficult and only putative because the larva was discarded after removal, as it is done in a large proportion of cases (23% in Sherman's study).[4] Preserved larvae will allow identification to family, genus, and sometimes species level, but adult specimens are much better known and therefore more reliable for species diagnosis, hence the usefulness of rearing to adult when possible (another reason not to damage the maggot during extraction). Raw meat, or alternatively a sterile liver-agar mixture, can be used as a rearing medium for facultative parasites,[1,4] whereas raw meat may be adequate for a few obligate parasites (eg, *W. vigil*).[25] Larval or adult specimens should be sent to an entomology or parasitology center for authoritative identification. The documentation of myiasis cases based on proper identification of the parasite accompanied by detailed information on the patient's history will provide data on the distribution, behavior, and epidemiology of these parasites, and thus facilitate diagnosis, treatment, and prevention of myiasis.[4]

PREVENTION

Factors predisposing to attacks by myiasis-producing flies include: *1*) summer season, *2*) contact with infested hosts or visit of an area of infested hosts, *3*) sleeping outdoors, *4*) poor hygiene and poor treatment of wounds (often associated with homelessness), and *5*) travel to an endemic area.[1,2,44,45] The attacks by *W. vigil* can be minimized by proper clothing of babies, keeping them under close supervision outdoors, and by maintaining appropriate screening of doors and windows, especially if living in rural areas or near natural habitats where host populations can occur.[24] The risk of infestations by cattle grubs (*Hypoderma* spp.), horse botflies (*Gasterophilus* spp.), the sheep nasal botfly (*Oestrus ovis*), or by screwworms (often on livestock) can be reduced by avoiding contact with infested hosts. An attack by *Dermatobia hominis* will be determined largely by the bite of an arthropod (usually a mosquito) carrying the eggs of *D. hominis*. The female fly captures a mosquito at flight, and lays eggs on it. After hatching, the larva penetrates into the skin via the bite puncture.[33] Therefore, protective clothing, insect repellents, and sleeping curtains should be used by travelers in or near forested areas of Mexico, Central, and South America where *D. hominis* is endemic. The female flies of *Cordylobia anthropophaga* lay eggs in shaded ground, especially sand, or on clothing, favoring the subsequent invasion of skin by hatched larvae; avoiding laying on the ground for long, ensuring that no clothes are left outside (especially not in the shade), or ironing clothes when left outdoors to kill eggs or larvae may help reduce the risk of myiasis in areas where *C. anthropophaga* is endemic.[1]

Good hygiene and the swift treatment and cover of wounds are the best methods against flies that facultatively or obligatorily invade wounds, necrotic tissues, or body orifices. Homeless, aged, or debilitating persons are groups at risk particularly and special attention should be given in nursing homes for window screening, wound care, and buccal hygiene.[8,22,46] Fly breeding habitats should also be reduced by managing food residues and garbage containers properly.

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Hemostatic Management During Oral Surgery in Patients With a Left-Ventricular Assist System Undergoing High-Level Anticoagulant Therapy: Efficacy of Low Molecular Weight Heparin

Yoshinari Morimoto, DDS, PhD, Hitoshi Niwa, DDS, PhD,† Akihisa Hanatani, MD, PhD,‡ and Takeshi Nakatani, MD, PhD§*

Mechanical circulatory support (MCS), such as the left-ventricular support system (LVAS), is a useful therapeutic option as a bridge to recovery or to heart transplantation in patients with severe cardiac failure. Thromboembolism, infection, and bleeding represent the major managerial problems in patients receiving MCS. Because clots are likely to form during MCS, high-level anticoagulant therapy (prothrombin time–international normalized ratio [PT-INR] ≥3.0 to 4.0) is a required aspect of patient management.[1] In candidates for heart transplantation, oral infections must be completely eliminated, which often necessitates oral surgery; however, hemostatic management is difficult in such patients, who typically receive high-level anticoagulant therapy.

At present, when performing tooth extraction in a patient receiving antithrombotic therapy, administration of antiplatelet agents is continued, and surgery is generally performed with the patient receiving warfarin as long as the patient's PT-INR remains ≤3.5.[2] However, in MCS patients on high-level anticoagulant therapy (PT-INR ≥3.0 to 4.0), intraoperative hemo-

*Associate Professor, Department of Dental Anesthesiology, Graduate School of Dentistry, Osaka University, Osaka, Japan.

†Professor, Department of Dental Anesthesiology, Graduate School of Dentistry, Osaka University, Osaka, Japan.

‡Chief Doctor, Department of Organ Transplantation, National Cardiovascular Center, Osaka, Japan.

§Director, Department of Organ Transplantation, National Cardiovascular Center, Osaka, Japan.

Address correspondence and reprint requests to Dr Morimoto: Department of Dental Anesthesiology, Graduate School of Dentistry, Osaka University, 1-8, Yamadaoka, Suita, Osaka 565-0871, Japan; e-mail: ysn-mori@dent.osaka-u.ac.jp

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