The diving doctor's diary

A case of unilateral facial swelling

Greg van der Hulst

Key words
Underwater medicine, scuba diving, treatment, decompression sickness, barotrauma, case reports

Abstract

(Van der Hulst G. A case of unilateral facial swelling. *Diving and Hyperbaric Medicine*. 2007; 37: 79-81.)
A case of recurrent unilateral facial swelling subsequent to diving in a fit, young, male recreational diver is presented. The right side of his upper lip has become swollen several times over a two-year period immediately following deep recreational dives. A definite diagnosis remains to be made.

Case report

Mr T is a regular diver with about 10 years' experience. His first dive of the day was to 36 metres' sea water (msw) for a total dive time of about 40 minutes, his computer profile staying well out of decompression. At the start of the safety stop on the anchor rope, the rope lifted up and Mr T found himself at the surface, thus not doing a safety stop, and the last four or five metres' ascent having been fairly quick.

Back on the boat, Mr T's face was noted to be swollen as though he had been to the dentist, or been bitten or punched (Figure 1), and this worsened over several hours. He said that he knew at about eight metres on the ascent that it was going to happen because of how his face felt. He suffered no pain, shortness of breath, paraesthesia, or numbness during or after his ascent. He did note a feeling of "gas going under the skin" in the affected area. The site of swelling did not contact any fitting or piece of equipment. His dive buddy reported that about ten hours later, the area was oozing a tiny amount of clear fluid.

Mr T is 37, in good general health, fit and active and on no medications. He had a "dodgy" dive about two years previously, when he came up much too fast from about 20 msw after a dive to 30 msw. Since doing a DAN oxygen providers course, he now thinks that he might have been 'bent' on that occasion, as he felt "pretty crook" the next morning. At the time, being bent did not cross his mind.

Over the previous two years or so he has had swelling of the right upper lip within minutes of surfacing on at least four occasions following deep dives. The swelling takes a couple of days to settle, and sometimes initially feels a bit "crinkly". Mr T has never experienced similar cutaneous eruptions anywhere else. Mr T knows in the final part of his ascent it is about to occur, but finds it difficult to clearly describe the sensation. He experiences this sensation only on the dives where he has developed the 'rash'. There is no associated pain in his face, teeth or sinuses. The dives in question have all been 20 msw or deeper, but have all been within his computer's no-stop limits. He has dived many times between these incidents and experienced no other symptoms.

Figure 1
Diver T soon after a dive to 36 metres' sea water

Figure 2
Diver T 40 hours after he surfaced from the dive

In summary, the pattern is always the same: his right upper lip swells quickly, can worsen over the first few hours, then resolves over a period of days, often weeping yellow, serous liquid in a manner similar to a minor burn.

On examination some 40 hours after he had surfaced from the dive in question, he was completely well, except for his erythematous, swollen right lower face (Figure 2). The swelling extended laterally to involve the tissue of his medial cheek. There appeared to be a dependent oedema forming a 'jowled' appearance as it tracked inferiorly past the mouth to involve the lateral part of his right chin. It was difficult to identify the exact tissue plane involved, but there was no swelling or discoloration of the upper gum, nor of the buccal mucosa. No skin crepitus was palpable over the affected area, although Mr T and his dive buddy both report this being present earlier. There was no subcutaneous air detectable in the neck.

Discussion

The cause of this diver's unilateral facial swelling has yet to be diagnosed. The trigger appears to be dives in the deeper part of the recreational diving range.

Differential diagnoses include:

1 Localised subcutaneous air: no confirmed subcutaneous air (via imaging) but history is suggestive. Rupture of a maxillary sinus or dental cavity into the soft tissues is a possible mechanism.
2 Cutaneous lymphatic obstruction secondary to decompression sickness (DCS): in the absence of associated, more generalised manifestations of DCS, this seems unlikely.
3 Marine envenomation: the consistent anatomical site makes this diagnosis unlikely.
4 Irritant dermatitis to unknown allergen: possible, but to which allergen?

This diver is awaiting a full dental assessment including dental X-rays. Intermittent tissue air may well be related to a tooth root cavity, though the lack of pain suggests otherwise. Sinus X-rays and a sinogram will be considered if the problem persists. Facial subcutaneous emphysema is rare, even in post-operative ENT and dental populations, and it is almost always associated with pneumomediastinum.[1] The isolated nature of this diver's symptoms makes associated chest pathology unlikely, leaving one lacking a plausible mechanism for introduction of air into facial soft tissues.

Cutaneous lymphatic obstruction secondary to DCS has been reported, though little is known about it.[2,3] It is assumed that soft-tissue swelling in these cases is secondary to lymphatic obstruction from bubbles. In the absence of other manifestations of DCS in this case, other diagnoses must first be ruled out.

Marine envenomation cannot be excluded despite the diver having four episodes of this 'rash' in the same location as stings are common around the lips in scuba divers. They may not be acutely painful and the marks they leave are not always initially visible.[4]

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Greg van der Hulst, BSurv, MBChB, is a registrar in the Emergency Department
Whangarei Base Hospital
Northland, New Zealand
Phone: *+64-(0)9-438-1294*
E-mail: *<gvdh@slingshot.co.nz>*

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Dr Carl Edmonds comments:

I have encountered three divers with swelling of the upper lip post-dive; one was an international phone consultation, but I personally saw the other two. I tracked down this poor photograph of the first (Figure 1). The presumptive diagnosis was lymphatic decompression sickness (DCS) of the face.

Figure 1
Unilateral upper lip swelling after scuba diving

All three divers had conducted moderately deep (> 30 msw) air dives, with bottom times close to the 'no-stop' limits, and surfaced without staging or safety stops. Decompression computer profiles were not available. Of the two seen by me, one responded to recompression therapy, but the other was not recompressed, due to the delay in presentation. The appearance of unilateral upper lip swelling lasted a couple of days in both divers. Both were 'repeat offenders' from similar dives; I have noticed this predictability in other cases of DCS lymphoedema. For the international diver, I suggested treatment with 100% oxygen (O_2), but was not informed of the result.

Why the upper lip? Perhaps the parotid gland is relevant in temporarily obstructing lymph flow.

> "*Lymphatic drainage from the upper lip is unilateral except for the midline. The lymphatics coalesce to form* [five] *primary trunks that mainly lead to the ipsilateral submandibular nodes, with some drainage also going to the periparotid lymph nodes. The submandibular and parotid lymph nodes are the first echelon nodes for the lips*."[1]

What treatment is most cost effective? In delayed cases or in remote areas where hyperbaric facilities are not available, I would still try 100% O_2 for 3–4 hours, but with reservations. It will remove all intra-vascular bubbles, but will it remove intra-lymphatic bubbles? Recompression therapy (100% O_2 for two hours at 203 kPa) is preferred. It is possible that normobaric O_2 may not be as effective as in other DCS presentations if the lymphatic drainage is totally blocked and so de-nitrogenated perfusion of the area may not be achieved. This is a unique situation, and warrants investigation.

Why did I not perform lymphangiograms? Because they were not easily done in the 1970s when these divers presented.

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Dr Carl Edmonds is the Foundation President and a Life Member of SPUMS.
E-mail: *<puddle@bigpond.com.au>*

Trauma in the marine environment requiring surgery after diving

David Smart

Key words
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Abstract

(Smart D. Trauma in the marine environment requiring surgery after diving. *Diving and Hyperbaric Medicine*. 2007; 37: 82-4.)
The author reports a personal injury when after two dives he fell from the dive boat, sustaining a deep laceration to the arm. This required surgical repair under general anaesthesia approximately six hours later while the diver was still offgassing nitrogen. The report reviews the use of antibiotics for marine wounds, and the choice of anaesthesia for a diver when residual inert gas is present. Wounds sustained in the marine environment should be cleaned, irrigated, debrided and foreign material removed. Prophylactic antibiotics are recommended if injuries penetrate the dermis, and when the patient has immune compromise or other medical co-morbidities. A theoretical risk of nitrous oxide precipitating decompression illness is supported by basic scientific literature, and should be avoided after diving. The incidence of pneumothorax from parascalene block is low in modern anaesthesia.

A previously healthy 45-year-old male undertook two dives on the third day of a multi-dive week at the 2006 SPUMS conference at Pacific Harbour in Fiji. A total of 20.5 hours had lapsed since completion of the previous day's diving. The boat was anchored on a site in Beqa lagoon, 20 km off Fiji's main island, Viti Levu. The entry time of the first dive was 0845 hours and it was undertaken to 26 metres' sea water (msw) as a multi-level dive for a total time in the water of 53 minutes. The dive finished in 10 msw and ascent was commenced at 48 minutes with 3 minutes spent at 5 msw before surfacing at 0938 hours. A second dive was commenced, after a surface interval of 84 minutes, at 1102 hours. The maximum depth of this dive was 15.7 msw with a multi-level profile; ascent was commenced from 8 metres at 1152 hours. Five minutes were spent at 5 msw, before surfacing at 1158 hours (in-water time 56 minutes).

Soon after completing the second dive, the diver whilst returning from the bow of the dive boat slipped from the port-side gunwale, lacerating the inner aspect of his upper left arm. He fell into the sea and swam to the rear of the boat to seek assistance from other divers. The laceration exposed biceps and brachialis muscles and created a distally based flap that was 10 cm across the base. It had been exposed to tropical sea water. Fortunately, there was no significant blood vessel or nerve trauma. A first-aid dressing was applied and he was evacuated to Suva Private Hospital for surgical assessment, arriving around 1345 hours. The injured diver declined a generous offer of surgical repair under local anaesthesia at the conference venue, despite the eminent qualifications of conference delegates.

Pethidine, tetanus vaccination and ceftriaxone were administered. Initial surgical assessment indicated that the wound was likely to need debridement and delayed primary closure because of the risk of tropical marine infection. At this point, the diver contacted Divers Alert Network South East Asia-Pacific (DAN SEAP) to seek assistance with return travel to Australia. Within 90 minutes DAN SEAP had authorised a return flight by commercial aircraft to Melbourne, if required.

Surgical debridement under general anaesthesia was undertaken at 1730 hours. The diver received fentanyl, midazolam and propofol anaesthesia, spontaneously breathing via a laryngeal mask. Fortunately, the wound was judged to be suitable for primary closure (Figure 1). Metronidazole was administered intravenously during the procedure and post-operatively, and further ceftriaxone the next morning. At 2045 hours, the diver was contacted by DAN SEAP, and the flight was cancelled as primary closure had been successful. After review by the surgeon, the diver was discharged on the following day, and commenced oral ciprofloxacin 750 mg b.d. The diver then returned to the

Figure 1
Laceration of left arm following suture

conference and travelled home with the conference group as planned. The wound has since healed uneventfully. Costs were all fully covered by the diver's travel insurance.

Discussion

This case illustrates two issues worthy of consideration for the treatment of a diver sustaining trauma in the marine environment.

INFECTION RISK AND ANTIBIOTIC MANAGEMENT

The marine environment carries a number of *Vibrio* species (*alginolyticus*, *damsela*, *fluvalis*, *holliisae*, *parahaemolyticus* and *vulnificus*), *Alteromonas* species (*espejiana*, *haloplaktis* and *macleodii*), *Pseudomonas marina*, *Mycobacterium marinum*, *Erysipelothrix rhusiopathiae* and *Delaya venustus*. Bacterial counts and species vary, depending on proximity to human habitation.[1] Faecal bacteria may contaminate sea water where untreated sewage is discharged into the sea, creating a higher risk of wound infection.[2]

There is a paucity of literature on the question of prophylactic antibiotics for marine wounds. A structured literature search using the headings *marine wound, marine trauma*, *antibiotic prophylaxis* or *treatment* identified 11 papers over 20 years; nine were case histories or small case series and two were reviews. A broadened search to include specific marine organisms identified a further 29 case reports (32 subjects, 18 of whom sustained marine wounds). Reports were biased towards wounds that were contaminated, and therefore complicated, resulting in the affected individual seeking hospital treatment. No prospective series of marine wounds were identified.

It is not possible to assess the incidence of contamination from marine injuries. It is likely that the majority of marine wounds are uncomplicated. Despite the focus in the literature on marine organisms, data from a larger series of contaminated wounds acquired in the tropics demonstrated that marine organisms were causative in less than 40% of cases.[1] The most common organisms were *Staphylococcus aureus*, pyogenic *Streptococcus* and enteric bacilli (Table 1). The largest series, reported in 1993, involved 93 soft-tissue infections caused by marine *Vibrio* species; 76 had definite sea water contact with wounds.[3] Nearly 60% of affected individuals had underlying conditions that compromised their immunity, for example: liver disease, diabetes, steroid use, and cancer. Factors affecting risk of infection included the degree of contamination of the marine environment, the depth of wound and tissue planes crossed, presence of foreign material, host defences and delay since injury. A recent review recommended "*trauma occurring in brackish or salt water should be treated with doxycycline or ceftazidime, or a fluoroquinolone*",[2] and also indicated the need for appropriate wound management.

An additional hazard of marine wounds is the potential for marine animal venoms (e.g., from stingrays) to cause delayed tissue necrosis. Isbister recommended that prophylactic antibiotics are typically not necessary for venomous marine fish spines unless there has been a residual foreign body or the patient is immunosuppressed.[4]

The level of evidence for recommended treatment of marine wounds is level 4 (case data) or level 5 (expert opinion/ consensus guidelines). The following general principles apply:

- All wounds should be cleaned, irrigated and foreign material removed.
- If a marine spine such as a stingray barb has penetrated skin, retained foreign material should be excluded by imaging (ultrasound or plain X-ray).
- Surgical exploration or excision should be undertaken, particularly when an underlying deep structure might be penetrated.
- Debridement of dead or devitalised tissue should occur, including the possibility of excising the wound track if the spine or barb was likely to have venom surrounding it.
- For minor wounds not penetrating the dermis, wound care only is required and antibiotics are not considered necessary.
- For injuries penetrating the dermis or when the patient is immune compromised, antibiotic prophylaxis is recommended. Single antibiotic therapy is recommended using doxycycline, co-trimoxazole, the fluoroquinolones or third-generation cephalosporins. When samples are taken from marine wounds for microbiological evaluation, the laboratory should be informed so they can perform specific cultures for marine organisms that may require varying salt concentrations and incubation temperatures for growth.[1–3]

Table 1
Sea-water contaminated injuries requiring hospital treatment in Northern Queensland during 1990–1991 (N = 41)[1]

Mechanism	**Number**
Coral cuts	25
Fish spines	2
Fish hooks	6
Boating mishap	3
Other injuries	5
Infections indentified	**Number**
Streptococcus pyogenes	19
Staphylococcus aureus	20
Enteric Bacilli	17
Marine Vibrios	12
Aeromonads	4

MANAGEMENT OF ANAESTHESIA SOON AFTER DIVING

This issue caused the author (patient) some concern. Despite offers of debridement/repair by SPUMS colleagues at the conference venue, the flap was quite large and would have involved high doses of local anaesthetic for infiltration anaesthesia. This may have been the only option if a properly constituted operating theatre with sterile equipment was not available.

Two other methods of anaesthesia had the potential to precipitate diving-related illness, or impact on diving in the future. Nitrous oxide (N_2O) is often still used as part of inhalation anaesthesia. A literature search using the headings *nitrous oxide*, *anaesthesia*, and *decompression sickness* identified 11 papers: one case report, one letter and nine basic science studies. Three laboratory studies showed N_2O has the potential to diffuse into pre-existing nitrogen bubbles, potentially precipitating decompression sickness (DCS).[5–7]

The case report recorded a six-day interval between the diving and onset of symptoms consistent with DCS, which appeared after anaesthesia for an elective ENT procedure. Symptom resolution occurred with recompression.[8] In the author's personal case the temporal relationship between diving and anaesthesia was much closer. According to US Navy, DCIEM, and dive computer tables, there were significant amounts of residual nitrogen creating a risk of diffusion of nitrous oxide into nitrogen micronuclei. The author's impassioned request to the anaesthetist to refrain from using N_2O was granted.

Regional anaesthesia using a parascalene brachial plexus block was also discussed. The risks to divers of this procedure stem from the potential to cause pneumothorax – a possible contra-indication to further diving. The author identified ten papers specifically examining the incidence of pneumothorax associated with this procedure; the two largest series were evaluated.[9,10] An incidence of 0.8% was reported in1,248 blocks performed without ultrasound or nerve stimulator, and no cases in a second series of 2,810 blocks using a nerve stimulator.[9,10] Neither a nerve stimulator nor an ultrasound was available for the procedure, so this method of anaesthesia was declined.

Conclusions

Cleansing, decontamination and debridement form the basis of marine wound management. Level 4/5 evidence suggests prophylactic antibiotics are required for injuries penetrating the dermis or in patients with immune compromise. Single antibiotic therapy is recommended: doxycycline, co-trimoxazole, fluoroquinolones or a third-generation cephalosporin. A theoretical risk exists of N_2O precipitating DCS and its use should be avoided after diving. The incidence of pneumothorax from parascalene block is low in modern anaesthesia.

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Associate Professor David Smart, MB, BS, FACEM, MD, is the joint Medical Director of the Department of Diving and Hyperbaric Medicine, Royal Hobart Hospital
Hobart, Tasmania
Australia
Phone: *+61-(0)3-6222-8193*
E-mail: *<david.smart@dhhs.tas.gov.au>*

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