

## THE TREATMENT OF SHARK ATTACK\*

G. D. CAMPBELL, M.B., M.R.C.P. (EDIN.)

*Physician and Research Associate, Durban Oceanographic Research Institute, Durban, Natal*

Among the more terrible emergencies that a doctor may have to face are those which arise from shark attacks on humans. Few tropical or sub-tropical seas are wholly immune from such incidents, which assume an importance out of all proportion to their mortality significance — mostly because of the story-book fierceness of sharks, and from pictures of their teeth and jaws, which, once seen, are not soon forgotten. In the last 20 years there have been 40 such attacks off the Natal coast, of which 16 have been fatal. In spite of the fact that 20 people are killed on the roads of this country almost weekly, one single shark attack on the Natal coast is enough

\* This paper was presented in a shortened form at the National Congress of Artificial Respiration and Asphyxia, held at the University of Natal Medical School, Durban, December 1960.

to empty every hotel within miles. Tourists stream back home on the roads, where they face an astronomically greater risk of being hurt than if they were to bathe daily for years in the most 'dangerous' surf.

Recent research carried out at the Oceanographic Research Institute in Durban,<sup>7</sup> with the able help and collaboration of the Director, Prof. David Davies, in conjunction with observations made during the 1957-1958 'rash' of shark attacks and close examination of the 1960 victim, has shown that the medical attitude towards the treatment of these patients has changed, this change has occurred firstly because of the more efficient beach resuscitation of victims, and secondly because of the newer and more powerful antibiotics. For the most

comprehensive work on the aetiology and incidence of shark attacks reference may be made to Dr. V. M. Copleston's monograph *Shark Attack*.<sup>1</sup> This author is regarded, by general consent, as the world authority on the subject; his work was written more for scientists and laymen than for doctors, and because of this, he has made no reference to treatment. This paper is written to fill the gap.

#### *The Aetiology of Shark Attacks*

Since Dr. Copleston's book is readily available for reference, it would perhaps be superfluous to enter into a discussion about the aetiology of these attacks, except to make certain superficial comments. Sharks can quite accurately be described as organisms that are rarely, and cyclically, pathogenic to man, and are rendered more virulent by certain circumstances. It is well documented that sharks attack people at certain times of the year, generally when the temperature of the water is over 70°F., and that these attacks often coincide with a shortage of the shark's natural food. To sharks, in contradistinction to more arduously-won food, the bathing human must represent a very succulent and easily-acquired morsel. When one realizes the density of sharks near most bathing beaches, it is surprising that such attacks are not more common. Fortunately, the shark is a far more timid creature than the story books will allow!

Sharks will sometimes bite in terror or desperation, or in pique. A marine biologist colleague was relieved of his right breast and most of his pectoralis major muscle by a shark which, enclosed by a seine net, had tried several times to escape; in apparent terror it turned and rushed with vicious intent at this colleague who was standing shoulder-deep at the mouth of the net. The technician-diver who, in an aqualung, feeds the fish at the Durban Oceanarium to entertain the crowds, was recently bitten quite severely on the thigh by a 3-foot shark who apparently felt neglected in the 'hand-out'. It is difficult to group these two instances with the determined 1958 Scottburgh attack, where a large shark rushed among a number of people in 3 feet of water, to inflict, in 3 onslaughts, ghastly and almost immediately fatal injuries on a man who had merely entered the edge of a crystal-clear surf to wash the sand from his legs.<sup>2</sup>

#### *Sharks Responsible for the Attacks*

Many species of sharks have been incriminated in shark attacks all over the world. They vary, not only according to locality, but also according to the type of beach and the depth of water in which people may be swimming at a particular place. In Durban, for instance, the South Pier, which stands in 40 feet of water, is a veritable Mecca for shark anglers—no less than 17 large man-eating sharks have been landed on rod and line on a single afternoon. There the large grey and tiger sharks are seen and taken—probably because of the fact that the whaling ships coming from the South Coast steer very close to the pier towing their catches, which shed gallons of blood. Not more than 2 miles from here are the premier bathing beaches of the country—Durban South and North beaches. These areas are guarded by nets, which have cut the number of attacks on those beaches to nil, since we had the good sense to follow the example of the Australians in this respect. In these nets, the very large sharks seen at the South Pier are not caught in any great numbers, possibly because the water is shallower, and possibly because the whalers do not approach the port as commonly from the north. In fact the hotels at Umhlanga Rocks, 10 miles to the north, openly advertise their beaches as 'shark-free', simply on the grounds that an attack has never occurred there, whereas only 5 miles to the south there have been several attacks.

From the point of view of the clinician, sharks are divided into 2 classes: (a) those which bite cleanly, such as the grey sharks (*Carcharinus* Spp. in Natal), and (b) those which leave a very jagged and dirty bite, such as the ragged-toothed shark (*Carcharias taurus* Rafinesque) which bites with the accent more on tearing than on cutting, as the clinical description of the 1960 Natal coast attack shows.<sup>3</sup> In spite of their untidy bites, these ragged-toothed sharks can do an enormous amount of bony damage, as was seen in the 1960 attack mentioned above, and in the 1958 Scottburgh attack.<sup>5</sup>

#### THE CHANGING FACE OF TREATMENT OF SHARK ATTACK

Judging by previous reports, the treatment of shark attack in the past has been to tie tourniquets on the patient, wrap him up warmly, bundle him into the nearest car, and rush him to hospital. There radical surgery was invariably performed, mainly to offset the possibility of serious infection. The words 'the victim was rushed to hospital, but died soon after admission' occur so frequently in Dr. Copleston's records,<sup>1</sup> that one is forced to the conclusion that the 'rushing' contributed materially to the fatal outcome in these cases.

By the time the shark victim has reached the beach, he is generally exhausted and shocked by the double exertion of struggling with the shark, and the extra efforts that a crippled person has to make to swim through the surf to the beach. Such a patient would fare far better if he spent 30 or even 60 minutes lying quietly (whether sedated or not) in the 'head-down' position on the slope of the beach, and slightly chilled—rather than being carried bodily to a waiting car in which he sits propped up, smothered in coats and other materials in a warm atmosphere, having to undergo what is often a very rough ride to the main road, upon which he faces the prospect of a hectic ride to the nearest hospital. It is small wonder that such patients arrive at the hospital in irreversible shock. A far better plan is to rush plasma or blood to the patient, and he should be left lying on the beach near where he was attacked, though out of reach of the waves; if tourniquets are properly applied, then not much further harm can come to him if he is kept still, cold, and in the head-down position.

Surf bathers are generally very fit people, and if allowed a short while to bring their acute anti-stress mechanisms into play, will apparently make dramatic recoveries. This point is borne out by the description of the 1960 Natal South Coast attack,<sup>4</sup> where a young, fit victim arrived on the shore without aid, with 'two-thirds of his small bowel' outside a rent in his abdominal wall, the right kidney actually being exposed; in addition he had severe lacerations on his right arm and his right leg, and finger injuries on his left hand. Fortunately he was seen soon after by a doctor, who sedated him with morphine, even though he was free of pain, and kept him in the head-down position for about 30 minutes, checking his blood pressure and pulse. Only after this time, when the doctor was satisfied with his improvement, did he allow the patient to be moved to hospital; note that in this case no intravenous therapy was available. There is no other recorded instance of survival from a major abdominal wound in shark bite, and in my opinion it was the doctor's treatment on the beach that paved the way to this boy's remarkable recovery—not that I wish to belittle the magnificent major surgery that was performed upon him in hospital, which turned what was virtually a pathological specimen into a fit and vigorous young man.

Two main factors have caused a change of approach to the victims of shark attack: firstly, the fact that it is now possible to provide powerful anti-shock measures for the patient on the beach, without moving him, and secondly, the effect of the newer and more effective antibiotics on the infective factor, which has always haunted surgeons in the past.

#### *Adjuvant Resuscitative Measures on the Beach*

*The use of the 'Feinberg pack'.* Probably because of the proximity of his consulting rooms to a beach that has been the site of several attacks, pride of place in beach resuscitation after shark attack must go to Dr. S. Feinberg of South Coast, Natal. He has evolved a 'pack' for emergency use, which contains the following:<sup>6</sup> 1 vacoliter of normal saline; 1 bottle of dried human plasma; 1 bottle of plasma diluent; 2 plastic intravenous giving sets; ampoules of morphine, coramine and 'levophed'; syringe, swabs, spirit and tourniquets. A doctor can keep this pack, which is known at the Oceanographic Research Institute in Durban as the 'Feinberg pack', separately from his bag in the back of his car; another can be kept in his rooms, if they are near a 'bad' beach. Since the pack contains what is required for emergency resuscitation only, it is wise for the doctor to send someone for his bag, and at the same time ask the nearest hospital to send some more plasma and diluent, or group O blood. The use of the pack is described later.

*The use of Minnett's apparatus.* The 'minute man', as Minnett's apparatus is familiarly known among life savers, is now available on the more populous Natal beaches, for use in resuscitation of the apparently drowned. It is generally kept in the life saver's hut, and is valuable for the administration of oxygen, and for its use as a suction apparatus. Its principal application in the treatment of shark attacks would be as an adjuvant to Feinberg's pack. It can be carried for long distances quite easily. Any beach that has Feinberg's pack and a Minnett's apparatus in its life saver's hut, is well equipped for the emergency treatment of shark attacks.

#### *The Infective Factor and the Newer Antibiotics*

Studies carried out by the Oceanographic Research Institute in Durban in 1959 and 1960,<sup>2</sup> have shown that an unusual germ can frequently be isolated from the teeth of living sharks.

This is a paracolon bacillus, which has such powerful haemolytic properties that it is able to clear a whole 'blood plate' on subculture after 24 hours. It is, however, sensitive to most of the newer antibiotics (especially 'terramycin', chloramphenicol and 'aureomycin'), though it is resistant to the sulphonamides and penicillin. Its fermentation properties are described in detail elsewhere.<sup>3</sup> This same organism, with an identical antibiotic-sensitivity spectrum, was isolated from the wounds of the victim of the 1960 attack. As mentioned earlier, this was the first recorded case of recovery from a major abdominal injury due to shark attack; in this case, the ileum was cut from the caecum,<sup>3</sup> and the caecum was punctured, together with parts of the small bowel. The antibiotic, which was instrumental in keeping this gross infection at bay, was intravenous terramycin. Chloramphenicol was used very successfully in 2 of the Port Shepstone cases,<sup>4</sup> in one of whom there were very extensive superficial lacerations as well as the loss of an arm; incidentally this was the first case in which Feinberg's pack was used with success. Though we have not, as reported in Australia, encountered tetanus or gas gangrene,<sup>5</sup> we believe that it would be wise to incorporate the use of their antisera in treatment in view of the fact that the Natal surf is frequently contaminated by mud from many rivers.

In the light of the above remarks, it would appear that one of the serious factors complicating shark wounds in the past — infection — has not nearly the significance that it had before, and this, coupled with the powerful anti-shock measures that can be implemented on the beach, has laid the emphasis upon conservative surgery and thorough early resuscitation. Any patient who is properly revived on the beach, and who reaches hospital, will almost certainly survive. Apparently it does not take long for the acute stress mechanisms of the healthy surf swimmer to come into effect, *provided they are given the chance.*

#### *Preparations Which Should be Made in 'Shark Areas'*

It goes without saying that those doctors who are prepared to treat shark victims can render valuable service. 'He gives twice who gives quickly' was never truer of any emergency than of shark bite. The following measures are recommended:

1. Ensure that Feinberg's pack and Minnett's apparatus are available near 'bad' beaches, and that all doctors know where they are available.
2. Doctors near shark beaches should have some sort of rota, so that the telephone exchange knows who is available and where he can be found.
3. Ensure that local hospitals have reserve supplies of dried human plasma; most Natal coastal hospitals have both plasma and group O blood.
4. The public should be urged to bathe only on netted beaches, and should scrupulously observe the instructions of life savers.

#### CLINICAL FEATURES OF SHARK ATTACKS AND LINES OF TREATMENT

##### 1. In the Water

Help the patient ashore. This is of necessity carried out by lay people or life savers. Try to chase the shark away. Frequently the shark will make more than one attack. A very gallant person was decorated for 'rugby-tackling' a shark after

one of the South Coast attacks, since it persisted in its attacks upon a young girl.

##### 2. On the Beach

###### *Clinical Features*

- (a) To what extent is the patient shocked? Has he lost a lot of blood?
- (b) Has the wound penetrated the abdominal cavity?
- (c) Is there gross contamination of the wound?

###### *Treatment*

Move the patient no further up the beach than is necessitated by wave action, and place him in the 'head-down' position on the slope of the beach. Apply tourniquets immediately. Lay people should restrain their natural urge to do anything more than this, and should call a doctor at once.

Give no warm drinks or alcohol, and cover the patient with a light wrap. Sips of fresh water may be given. Attempt no other local measures apart from stopping bleeding and covering the wounds with a towel.

The doctor should use Feinberg's pack at once. The bottle of saline must be set up as soon as possible. While this is running into a vein, the plasma should be reconstituted; when ready it can be substituted immediately. Send for more plasma, and for blood.

Give morphine,  $\frac{1}{4}$ - $\frac{1}{2}$  gr., whether pain is present or not. Record the blood pressure and pulse frequently.

Use Minnett's apparatus, levophed or coramine if the patient is severely collapsed. *Severe shock should be a contra-indication to moving the patient from the beach.*

Lay people should not attempt to move the patient without medical supervision.

When the patient is ready to move, that is, when *significant improvement is demonstrable*, forewarn the hospital. Do not move to any centre that it not fully competent to carry on with further intravenous therapy.

Record the pulse and blood pressure as the patient leaves the beach, together with a note of the drugs given, and give this record to the driver of the ambulance or car. He should drive slowly.

Note for the benefit of the surgeon whether the wound is very jagged and whether it appears to have involved the abdominal cavity or not. Note whether there was any sewage or other contaminant in the sea at the time of the attack.

Do not remove the needle from the vein even if the drip is finished, since the surgeon may be very grateful for its presence. If possible, maintain a slow drip on the way to hospital.

##### 3. At the Out-patient Department

Since the hospital has been forewarned, group O blood and plasma should be available for immediate administration. Blood samples should be taken for routine and emergency compatibility, and for haemoglobin estimation.

The blood pressure and pulse should be checked against the beach readings.

##### 4. In the Surgical Ward

###### *Clinical Features*

- (a) Just how much has been achieved by emergency resuscitation?
- (b) Will it be possible to leave the patient in the ward for some hours before operating, so that his shock can be satisfactorily countered?

###### *Treatment*

As soon as the patient is admitted, give large doses of terramycin, chloramphenicol or aureomycin parenterally.

Give gas gangrene and tetanus antisera.

Do not remove dressings in the ward, unless wounds are minor, or unless it is decided to delay operating.

Delay operating as long as possible.

##### 5. In the Theatre

###### *Clinical Features*

- (a) Is resuscitation really complete?
- (b) What is the extent of wound contamination?
- (c) Record carefully the following features:
  - (i) The diameter of the sweep of the jaws from the wounds.

- (ii) Are there any bony defects present?
- (iii) What are the characteristics of the skin punctures?
- (iv) Are the cut skin edges clean-cut or jagged?
- (v) Are there 2 discrete rows of teeth marks visible in 'tentative' bites? Record the distance between the rows.
- (vi) What is the distance between the lesions made by adjacent teeth in the front row?
- (vii) Are there any lesions that might have been made by 'bumps' from the shark? (That is to say lesions not caused by its teeth.)

(d) Make careful photographic records of all wounds.

#### Treatment

Be ultra-conservative in all surgical measures. Remove dressings after induction, and swab all lesions with sterile throat swabs, which should be inserted deeply into all 'stiletto' lesions. These should be 'plated out' at once for organism sensitivity.

Having made careful measurements of the wounds as stated above, smear any visible bony defects with sterile BIPP (bismuth, iodoform and paraffin paste), to facilitate subsequent X-ray examination.

Debride only obviously necrotic tissue, and do not attempt to remove all the tissue involved. If the blood supply is intact, even the most infected and lacerated limb can possibly be saved with a return of function.

Do not attempt tendon suture unless the wound is very clean.

If bowel is involved, resect widely and exteriorize.

Do early skin grafting wherever possible, to preserve nerves, tendons, vessels, joints and even muscles and to reduce the postoperative 'illness of trauma'.

#### 6. Postoperative Care

These measures will be governed by the usual surgical principles. In such healthy patients, the surgeon can expect a very clean field in a short time, with the combination of healthy tissues and powerful antibiotics. It is wise to ensure that the antibiotic used is the one shown to be the best by sensitivity tests. Intravenous therapy should be prolonged only as long as is necessary, and intensive physiotherapy should be instituted as soon as possible.

#### PREVENTIVE MEASURES

Even with the most modern and effective methods of treatment, we can still expect a mortality of about 25% of shark-bite victims. The chief remedy is in prevention, and this is really outside the realm of the doctor. It would appear impossible to prevent people bathing on un-netted beaches, since there are few resorts which can afford these costly barriers. In addition to shunning such beaches, bathers should avoid bathing in muddy water of whatever depth, and they should not wear brightly coloured bathing suits; they should

take off all ornaments that reflect the light, but above all should always heed the directions of the life savers. As long as bathers neglect these few simple rules, then doctors and scientists can say with confidence that they will have ample opportunity of studying further cases of shark attack. Probably the greatest factor determining whether the patients will survive or not is whether they get the right emergency treatment; possibly the greatest task of the life saver or ambulance worker on the spot will be to protect the victim from members of the public, who can seldom restrain their desire to 'do something' for seriously injured people.

#### SUMMARY

Three main points underly the modern treatment of shark attack victims:

1. Leave the patient lying flat in the head-down position on the beach, just out of reach of the waves. Lay people should restrain their overwhelming urge to 'do something' for such patients. This is probably the most important factor determining survival.

2. Carry out thorough beach resuscitation. Rush the plasma to the patient, and not the patient to the plasma.

3. Rely on the power of the newer antibiotics. These have reduced the need for radical and emergency surgery.

#### ADDENDUM

Since this paper was submitted, 2 young patients who were savagely attacked on the Natal South Coast, and who lost large amounts of blood, would appear to have derived benefit from the 'treat them on the beaches' regime.

Unfortunately the victim of the Christmas Eve lower Natal coast attack was so determinedly injured by an enormous shark that both his legs were cleanly severed in 2 bites (one at the level of the lesser trochanter, and the other at the knee joint) in a few seconds. Needless to say the patient expired before reaching the beach.

Fragments of teeth in the body of this last patient identified the shark as a shovel-nosed grey (*Carcharinus* Sp.), weighing about 1,000 lb.

I should like to thank Prof. D. H. Davies of the Oceanographic Research Institute in Durban for his cooperation, help, encouragement and criticism. Mr. E. Barker, F.R.C.S., kindly read and amended the manuscript.

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