ORIGINAL PAPERS

AUSTRALIAN DIVING-RELATED FATALITIES 1994

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Key Words
Accidents, deaths.

Summary

The available information includes only one snorkel user as having died during 1994, almost certainly greatly understating the truth. This is indicative of the problem faced in collecting a complete list of such cases, a difficulty less likely to occur with scuba or surface supply diving as the equipment from such fatalities is now required to be sent for checking by the relevant State Police Diving Unit. There were nine (9) identified scuba divers who died and three (3) divers who were using surface supply.

Breath hold (snorkel) fatalities

BH 94/1

The victim was a member of a group of visitors from overseas, all aged over 60. On one of the regular tourist trips to a Barrier Reef cay they had a trip in a glass bottomed boat to view the reef below and then went swimming. After lunch they were offered the use of mask, fins and snorkel and given some basic advice. This man chose to decrease any risk by wearing a life jacket, which made him both buoyant and very easy to observe by the safety watch. The crew included a diving instructor who advised the victim, and others, on the correct manner of water entry (walking backwards when wearing fins). The instructor watched the victim for a time after he entered the water and formed the opinion that he was competent.

The tender from another day-trip boat, as it was collecting its passengers, sent its wash across where the first boat's passengers were swimming. Its crew noticed that one snorkeller seemed strangely unresponsive to the wash and went over to investigate. They found that he was unconscious, floating face down, and pulled him into the tender. They commenced CPR and there was sufficient response for him to be still considered alive when he reached hospital but he died there next day.

The autopsy established that he had suffered an acute myocardial infarction. His medical history, as given by his widow, was minimal. He was described as possibly over weight and suffering from mild hypertension, for which he was taking (unidentified) tablets, but was apparently in good health. It was noted that vomiting made the provision of efficient CPR difficult, a frequent finding where resuscitation is described, as is the finding of rib fractures resulting from heroic efforts at resuscitation.

SNORKELLING AT SURFACE IN A CROWD. SILENT SURFACE DEATH. MILD HYPERTENSION ON THERAPY. WEARING LIFE JACKET, BUT FLOATED FACE DOWN. CPR DELAYED DEATH BUT FRACTURED HIS RIBS. ACUTE MYOCARDIAL INFARCT.

Scuba diver fatalities

SC 94/1

Lack of adequate appropriate experience is often the critical adverse factor in diving accidents and in this incident it was certainly significant. The victim had been trained for two years and made about 20 dives, but this was to be her first surf entry. Her buddy had dived for three years and made thirty dives. He regarded her as being somewhat inexperienced, but capable of deciding whether she could manage the conditions of the proposed dive. This was their second dive using their hired equipment and there had been no problems with it on the previous occasion. This time he omitted to check his companion's equipment before they entered the water, with their fins on, moving sideways and holding onto each other as they penetrated what was described as "moderate surf" and were buffeted by it. They separated when able to start swimming and the buddy reached the calmer water beyond the surf zone before looking back. He saw her 5-10 m away, floundering in the broken water. He had been using his snorkel as he swam out and it must be assumed that she did the same. He saw that she did not have the regulator in her mouth but did not notice whether she was using her snorkel. He swam back to her and gave her his secondary (octopus) regulator because he did not know if her regulator was working, then towed her out to beyond the surf line before they descended together in 3 m of water. He noted that she was breathing quietly at this time, then checked that her regulator was functioning correctly.

They remained in contact as she continued to hold his octopus regulator in her mouth, his hand on her buoyancy compensator (BC). He heard her call out (through the regulator) and saw her camera floating away. He retrieved it and they then both held onto its strap. He had been about to indicate to her that she should change to her own regulator and return to the shore with him. During this retrieval the regulator may have been pulled from her mouth but he saw she was breathing normally. A short time later he saw her face up on the sea bed and thought she would breath easier if face down so he tapped her mask. It was

only then he realised he had observed her exhalation bubbles only once in the past ten minutes and that she was unconscious, one hand holding the regulator in her mouth, the other holding the camera's strap.

He attempted to inflate her BC but failed because it vented as fast as he filled it, the reason for this was sand in the BC oral inflation tube valve which was detected when her equipment was examined. It is assumed that the sand entered the valve at the conclusion of the previous dive and was not washed out after the dive. He was also unable to ditch her weight belt, because her small size caused the BC to cover her belt. Despite inflating his own buoyancy vest he lacked sufficient buoyancy to bring her to the surface (he forgot to ditch his own weights) and towed her back underwater. He received some assistance from another diver in bringing her ashore and up onto the beach. There CPR was commenced and the emergency services attended. She died in hospital two days later without recovering consciousness. No medical cause, other than near-drowning, cerebral anoxic damage and terminal pneumonia, was found at the autopsy. It is not known why she failed to use her own regulator in preference to her buddy's.

TRAINED. SOME EXPERIENCE. FIRST SURF ENTRY. MISJUDGED ABILITY TO MANAGE ROUGH WATER CONDITIONS. VALIANT BUDDY EFFORTS TO ASSIST. SHORT STATURE AFFECTED ACCESSIBILITY TO QUICK RELEASE FOR WEIGHT BELT. SAND MADE BUOYANCY VEST VENT. CONTINUED WITH USE OF BUDDY'S OCTOPUS REGULATOR INSTEAD OF RESUMING USE OF OWN REGULATOR.

SC 94/2

Divers are human and suffer from the same range of problems as do others. This man had been the passenger in a road traffic accident (RTA) where another person was killed and it had a severe effect on him because he had been aware that the driver, a workmate, had drunk too much but had been unable to prevent him from driving. He lost weight and suffered from headaches after the accident but refused to seek treatment. His mother had been unaware of the reason until the police called on him for a statement. He took up scuba diving about 5 months after the accident and progressed to dive master level, liking to dive alone. There was an episode of possible suicide attempt, friends saving him. A further stress was when a girl friend became pregnant (by another) and chose to abort, refusing his offer of marriage. His preparations were careful and successfully executed. He left a note confirming his intentions. No warning signs of his risk of suicide had been observed.

TRAINED. EXPERIENCED. FEELINGS OF GUILT FOR NOT PREVENTING ALCOHOL RELATED FATAL ROAD TRAFFIC ACCIDENT. DEPRESSION. PREVIOUS ATTEMPTED SUICIDE. SOLO DIVER. SUCCESSFUL SUICIDE.

SC 94/3

In this case hubris and an apparently minor engineering inadequacy led to death. He was very experienced, including cave and deep diving, and an instructor in several organisations. He was reputedly obsessive about diving safety and had been enlisting the help of an engineer at work to improve a switch unit to make changing from one tank to another easier when using multiple tanks and differing gas mixtures. He was a teacher of the use of "Nitrox" mixtures and was at this time attending a course on "Trimix" diving. However he had told his girl friend, and others, that he would not be using "Nitrox" for this dive, though he had used it previously without problems.

His two buddies were also well experienced in deep diving. They intended to dive on a wreck which lay at a depth of 50 m. He was wearing a twin cylinder unit, which the others believed to contain air, and also had a small reserve cylinder on his belt. Although he possessed a full face mask (for cave diving) he chose to wear the more usual "eyes-only" mask for this dive. The twin tanks were borrowed but he undoubtedly knew that one of the cylinders contained a "Nitrox" (50% oxygen) gas mix. The hoses were colour tagged but, for some unknown reason, were attached to the three way control valve other than in the conventional order, which may have been a factor in what occurred.

Their dive was uneventful for 17 minutes. The buddies were close to the anchor line, ready to ascend, when the victim was seen, head down, about 3 m above the sea bed. His fins were twitching and regulator out of his mouth. They righted him and tried to replace his regulator, but failed because he was unconscious and not breathing. One buddy inflated the victim's vest and they brought him up to 15 m, where they remained to commence their planned decompression, letting him continue unaccompanied to the surface. They knew that the boat crew would see and recover him and they would avoid serious decompression risks by following this plan. Deep divers are said to be aware that at depth self preservation may take precedence before taking excessive risks for a buddy which would result in them seriously endangering themselves. In this case they believed that he was dead when reached so took him up to the 15 metres depth deco stop before letting him free ascend or attempting to replace his regulator. They were possibly correct in this opinion. When they completed their decompression 45 minutes later they found the emergency services present and in charge of matters.

Examination of the equipment showed that he had evidently used the "Nitrox" mixture rather than air for all or

PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and Experience		Dive	Dive	Depth in m		Weights	
		Victim	Buddy	group	purpose	Water	Incident	On	kg
BH 94/1	66	No training Experience not stated	Training and Experience not stated	Group Separation before incident	Recreation	Not stated	Surface	No weights	- -
SC 94/1	39	Trained Some experience	Trained Experienced	Buddy No separation	Recreation	3	Surface	On	9
SC 94/2	23	Trained Experienced	Not applicable	Solo	Suicide	15	15	On	Not stated
SC 94/3	43	Trained Experienced	Trained Experienced+	Group No separation	Recreation	50	47	On	6
SC 94/4	45	Trained No experience	Trained Experienced+	Group Separation before incident	Recreation	36	27	On	10
SC 94/5	46	Trained No experience	Trained Some experience	Buddy Separation before incident	Recreation	4.5	Surface	Buddy ditched	17
SC 94/6	38	Trained No experience	Trained Some Experience	Group No separation	Recreation	7.6	7.6	Buddy ditched	16
SC 94/7	36	No training No experience	Trained Experienced+	Group Separation before incident	Resort dive	9	9	On	5
SC 94/8	43	No training Experienced+	Not applicable	Solo	Recreation	15	Not stated	Off	Not stated
SC 94/9	40	No training No experience	Trained+ Experienced+	Group Separation before incident	Resort dive	4.5	4.5	On	7
H 94/1	34	Trained Experienced	Trained Experienced	Buddy Separation during incident	Work	4.2	4.2	On	Not stated
H 94/2	60	Trained Experienced	Trained Experienced	Buddy Separation before incident	Work	23	23	On	13
H 94/3	55	Training not stated Experienced	Training not stated Experienced	Buddy Separation before incident	Work	12	12	On	Not stated

DIVING RELATED DEATHS IN 1994

Buoyancy vest	Contents gauge	Remaining air	Equipment Tested	Equipment Owner	Comments
Life jacket	Not appliable	Not appliable	Not appliable	Hired	Silent surface death among others. Found floating face down. Cardiac death.
Failed to inflate	Yes	Adequate	Serious fault	Hired	First surf entry. Rough sea and equipment factors. Buddy unable to ditch weights. Asthma history.
Not inflated	Yes	None	“fault”	Own	Depression after fatal RTA. Suicide.
Buddy inflated	Yes	Adequate	Significant fault	Borrowed	Deep dive. Faulty 3 way selector, so mixing of Nitrox with air. Oxygen convulsion.
Not inflated	Yes	Low	Adequate	Hired	6th dive, 1st night dive. Buddy pair separation from dive master “guide”. Went too deep for experience. Complacent planning control.
Inflated	Yes	Low	Adequate	Borrowed	No dives for 18 months after course. Rough. Separation. Inflated vest tight. Overweighted. Cardiac death ?
Not inflated	Yes	None	Some adverse comments	Borrowed	Newly trained. Night dive. Out of air. Panic ascent. Possibly CAGE
Not inflated	Yes	Adequate	Some adverse comments	Dive shop	2nd Resort Dive. Surface separation then solo dive. CAGE.
Not inflated	Yes	Adequate	Adequate	Own	Solo. CAGE. History asthma. Reason for developing CAGE unknown.
Not inflated	Yes	Low	Adequate	Dive shop	Resort Dive. Separation. Possible CAGE.
No vest	Not appliable	Not appliable	Significant fault	Employer	In tunnel with pumps working. Difficult access. Air intake hose melted. CO poisoning.
No vest	Not appliable	Not appliable	Serious fault	Own	Unexplained rapid ascent. Previous and recent myocardial infarction. Cardiac death.
No vest	Not appliable	Not appliable	Adequate	Employer	Cold water. Unexplained loss consciousness near surface. Inadequate air supply.

most of his dive, a fatal error possibly caused by his unorthodox connection of the supply hoses to the three way gas selector. He had removed the "air safe" (nitrox) tag from the bottle so the boat's skipper/dive master was not aware that he did not have air in both his tanks. There was no gas escape from the gas selector block but there was some leakage within it such that gas from the tank not in use was able to enter the mixture being breathed. This may have delayed onset of the oxygen convulsion which led to his drowning.

The dichotomy which can exist between factual knowledge and its correct application is illustrated by the fact that during the dive the other two divers practised their buddy breathing while at depth, despite one having air and the other Trimix in his tank. Incidentally the latter diver had not taken a Trimix course and was using it "because it was in the tank". This despite them being very experienced "deep divers". Had the victim been wearing the full face mask he used when cave diving he probably would not have drowned.

VERY EXPERIENCED, HIGHLY TRAINED DEEP DIVER. FAILED TO DECLARE HAD NITROX 50/50 IN ONE TANK. NON-COMMERCIAL THREE WAY GAS SELECTOR HAD IMPERFECT SEAL BETWEEN GAS SOURCES. NON-STANDARD TANK/HOSE ARRANGEMENT POSSIBLE REASON WHY HE MADE DEEP DIVE USING NITROX. . OXYGEN CONVULSION. ONE BUDDY UNTRAINED IN USE OF TRIMIX BUT USING IT.

SC 94/4

The four members of this family had completed their diving course one week before their live-aboard dive trip on the Barrier Reef. The victim had missed the night dive the others had made because she had been on duty at the time. They showed documentary proof of having successfully completed the course before being accepted on the boat. There were about 23 passengers aboard and a crew of 10, which included 3 with diving instructor qualifications. When they joined the boat the victim had made, at most, only three scuba dives.

All the passengers undertook the two daytime dives on the first day but some declined the opportunity to make a night dive that evening. The victim and her husband were among the 14 who took up the night dive offer, joined by the three instructors. They were told they were to choose their own buddy pairs. This was to avoid experienced divers having the enjoyment of their, paid for, dives spoilt by being paired with inexperienced divers who might require supervision. Possibly a sensible commercial practice, but hardly likely to maximise diver safety. The passengers were told that they could have an instructor accompany them on the night dive so they asked for one. Unfortunately the offer was poorly communicated to the dive master who was detailed to accompany them. He had an experienced diver, a passenger, as his buddy and was himself suffering from a sinus problem although he had had no problems on the other two dives. The dive master apparently thought his job was only to be a guide and he appears to have been unaware of any responsibility for the safety of the pair. They descended after the two experienced divers and when they reached the sea bed found that the first couple had not waited for them to arrive but had swum away. Thinking they had seen a light disappear behind some coral, the pair set off in an attempt to join their guide, but failed to make contact. The victim's buddy said that early in the dive she appeared to become somewhat disorientated and made her way back to the surface. After a discussion she said that she wanted to descend and continue the dive, which they did.

It is probable that she was over weighted, as her buddy reported that she had no trouble descending but had "a buoyancy problem". After a short time they were surprised to discover they were at 18 m although the dive plan was for no descent below 10-12 metres. The dive master described how he saw them deeper than him but was unable to dive down to them because of an inability to equalise his ears. His attempts to attract their attention by shining his torch failed and he apparently never thought to send his buddy to them and did not regard them as being in any danger. The victim had been swimming a little behind and deeper than her husband and now made a rapid ascent. He noticed that she appeared to be "having some trouble breathing and her eyes were glazed" as he began to ascend with her. However "she suddenly dropped away and dropped like a rock to the sea bottom". He described her as having the regulator out of her mouth, which was clenched tight shut at this time. He was unable to prevent her descent to the sea bed, a depth of between 36 and 46 m (statements vary), where he found the regulator was out of her mouth. He reported that she grabbed his regulator but he was able to get her to use her own, then it came out again and he was unable to replace it.

By this time he was running low on air and had to ascend, never thinking to try to ditch her weight belt or inflate her buoyancy vest . Though there was a safety watch on the boat it was a passenger who heard his calls for help after he surfaced. A immediate search was made and was rapidly successful as she had a cyalume safety stick attached to her tank. When her buoyancy vest was inflated she began to lift off the sea bed and ascent became rapid after the weight belt was removed. The contents gauge was checked on the boat and showed a reading of 20 bar. Resuscitation attempts were unavailing although sufficiently vigorous to fracture several ribs.

The cause of death was drowning. Examination of the equipment revealed no faults, although it was noted that 21 lbs (9.5 kg) weight was excessive. She managed to reach the surface from 10-12 m during this dive but failed to do so from 18 m. In all probability the critical factor was the

reduced buoyancy provided by her wet suit at this depth. It is not known whether she wore the same weight belt for previous dives or whose property it was. Although she suffered from Raynaud's disease and had been advised to cut dive times to 50% of that allowed by the Tables, this was not an factor in her death.

Following this tragedy the Company strictly defined the basic requirement divers must have before they were accepted for the deep, wreck or night dives it ran. They now required an advanced diver certification or equivalent or having made over 15 ocean dives before acceptance for such dives. It is not known whether the de facto the policy of pairing inexperienced divers with each other has been addressed.

NEWLY TRAINED. 6th SCUBA DIVE. 1st NIGHT DIVE. PROMISED SUPERVISION FROM DIVE MASTER NOT PROVIDED. INEXPERIENCED DIVERS PAIRED. SEPARATION FROM SUPPOSED DIVE LEADER. DRIFTED INTO DEEP WATER. OVERWEIGHTED. STARTED ASCENT IN POSSIBLE PANIC THEN ABRUPTLY SANK TO SEA BED. REGULATOR OUT OF MOUTH. VALIANT BUDDY ATTEMPT TO ASSIST WITH OCTOPUS REGULATOR THEN USED HER REGULATOR. REGULATOR DROPPED FROM MOUTH. UNABLE TO REPLACE AS CLENCHED MOUTH. FAILED TO DROP WEIGHTS OR INFLATE BUOYANCY VEST. LOW AIR BUT ADEQUATE TO INFLATE VEST. PANIC A FACTOR.

SC 94/5

Neither of these divers was experienced, indeed the victim had not dived during the 18 months since his basic course ended and his buddy had only completed his training 6 months before this dive. Their intention had been to join a charter boat dive but this was cancelled because of the rough sea and poor visibility, so they went to a popular dive location, a reef reached by a jetty from the beach. There was a swell but no white caps, the tide was incoming and water covered the reef. They decided that they could manage the conditions and completed their preparations. They entered the water with inflated buoyancy vests, deflated them and descended to near the sea bed. Initially they swam into the current and remained on the landward, sheltered, side of the reef. When they agreed it was time to start their return swim they were disappointed to find that the tide had changed and they were again faced with an into the current swim. They decided to swim back under the jetty to exit at the nearby boat ramp and when they surfaced to check their position they found they were now 200 m from the jetty, 100 m from the local boat ramp, and 75 m from the shore They inflated their BCDs and decided to make a surface return as the current under water was as strong as that at the surface. The buddy used his regulator but it is not known whether the victim was using his snorkel or regulator for the surface swim.

The buddy became so fatigued during his swim in the rough surface water that he ditched his weight belt. He believed his friend was swimming close behind him and was dismayed to find he was alone when he had recovered from the effort needed to get ashore. A fisherman drove him to a nearby lookout and from there he saw the victim floating face up about 100 m from the shore. He made his way back to the beach and swam out, ditched the weight belt, and managed with difficulty to tow the body back to the rocky shore. The swell was described as being 2 m. He was helped to pull the victim up onto the rocks and then CPR was started, though unavailingly. He noticed that the mask and snorkel were missing, that the vest was inflated and the contents gauge read 50 bar at this time. As the victim was a large man, the buddy very fatigued and sea rough, the buddy was heroic in his efforts.

At the autopsy, conducted with respect for the methods required for a diving-related death, it was noted that there an atheromatous plaque producing a 40% narrowing of the left anterior descending coronary artery. However this was not considered a significant factor in his death. His drowning resulted from their failure to recognise that the sea conditions were too marginal for their ability, probably due to their inexperience. Other factors were that he was over weighted (15 kg) and the borrowed buoyancy vest was too small for him so was constricting when fully inflated (though not when only part inflated at the time of their water entry). The other equipment was hired and without faults.

TRAINED. GROSSLY INEXPERIENCED. NO DIVES SINCE COURSE 18 MONTHS BEFORE. TIDE CHANGED SO RETURN SWIM AGAINST CURRENT. SURFACE RETURN WITH INFLATED BUOYANCY VEST IN ROUGH SEA. SEPARATION. OVERWEIGHTED. FAILED TO DROP WEIGHT BELT. 40% NARROWING OF CORONARY ARTERY. DROWNED. VALIANT RESCUE EFFORT BY BUDDY. BORROWED VEST TIGHT WHEN INFLATED

SC 94/6

Only one of the six divers making this group night dive had any significant experience, though two had made previous night dives. The victim had only completed his basic training course two weeks before this dive, which was on an underwater trail marked by a chain on the sea bed. After about 26 minutes in water 9.5 m deep, they surfaced. By now the victim was low on air although the others had sufficient remaining to dive again. When it was suggested they make another dive, and he was offered the loan of another tank, he was able to continue with them. This borrowed tank was less buoyant than his usual tank and the inflation button on the BCD was different, which was explained to him.

Only four chose to make the second dive and one of them experienced difficulty in equalising his ears early in the dive and surfaced, accompanied by one of the others. After a surface discussion he decided to swim back to shore and the other diver then rejoined the other two. The trio followed the guide chain for a time, then realised that they were following a different route and going away from rather than returning to the entry point so they decided to return to the surface. Their depth was 8 m and when they were at 4 m the victim indicated that he was out of air and started to swim vigorously towards the surface. One of his buddies tried to assist him, holding his equipment and pulling him. He pulled his mask off and let the regulator fall from his mouth during his ascent and at the surface he gasped a few short breaths and said he was out of air. He looked around but failed to use the buddy's offered octopus regulator, and was thrashing about trying to remain at the surface. He appeared to be pressing the deflate button on the buoyancy vest, presumably intending to inflate the vest but he had no air remaining. Then he sank but was quickly retrieved and took a breath, then sank again. He was unconscious when found on the sea bed and the buddy who found him ditched his weight belt and inflated her vest to bring him up. Once at the surface his back pack was ditched and he was towed back to the rocky shore where resuscitation efforts were commenced. Although he lingered till the morning of the fourth day he never regained consciousness.

The equipment was recovered after several days and the tank then contained sea water. No faults were found in the equipment beyond the mention that the buoyancy vest was of a medium size and he was a large man. It was tested by being orally inflated underwater and failed to bring the backpack up so was an unsuitable piece of equipment. However there is no evidence that he ever inflated it. The autopsy was unhelpful because he had already "donated generously" to provide organs for transplant surgery. Although his actions invited CAGE it is unlikely that this occurred, his drowning resulted from his panic response to being over weighted and out of air at the surface, a situation potentially aggravated by his wearing a borrowed tank (heavier than his usual one) and buoyancy vest with a different inflation/deflation button placement to his own unit's arrangement.

He was described as being overweight but not obese. His father regarded him as too unfit to scuba dive so he took care not to let him know of his dive plans. His pre-course medical showed normal blood pressure. He was said to be a smoker and deaf, but inexperience and failure to monitor his remaining air rather than his health were the actual critical factors. It was noted at the autopsy that his heart was enlarged and there was up to 50% atherosclerotic narrowing of some of his coronary vessels, but this was of uncertain significance in this fatality.

RECENTLY TRAINED. VERY LITTLE EXPERIENCE. 1st NIGHT DIVE. OUT-OF-AIR ASCENT THEN LACK OF BUOYANCY AT SURFACE. BORROWED TANK LESS BUOYANT. DIFFERENT BUTTON CONTROLS FOR (SMALL) VEST. FAILED TO DITCH WEIGHTS. NO AIR REMAINING TO INFLATE BUOYANCY VEST. ADVERSE HEALTH FACTORS. DEAF. SMOKER. OVERWEIGHTED. PANIC. VALIANT BUDDIES. DELAYED DROWNING DEATH.

SC 94/7

Two overseas visitors, one of whom did not speak English, decided to see the Barrier Reef and joined a day trip to one of the reefs. There were 100 passengers aboard and they were offered the chance to snorkel or, for an extra fee, make a scuba dive supervised by one of the two instructors there to provide this service. During the trip out a talk was given to the passengers about scuba diving and those showing interest were identified, initially only 7, while 30-40 chose the option of snorkelling. A large school group was aboard and some the girls later decided to make a scuba dive. The school authorities had circulated the parents in advance of this special excursion and none had given permission for scuba diving or supplied them with money for such an option but this did not impede the vessel's operators or induce a response from the teachers supposedly responsible for the safety of their charges. However, events transpired to prevent their diving. The water was described as being sufficiently cold for all who entered the water to be provided with wet suits. There was also reportedly some current and waves.

The first "resort dive" passed without problems and all those involved, who included the two friends, decided to repeat the adventure that afternoon after lunch. The dive groups were unchanged, the victim and her friend with two others led by one instructor, the other three with the other instructor. They were under-weighted but their instructor assisted one to descend after dumping remaining air from her buoyancy vest, then returned to the surface to assist the other. There was no air in her vest so he pulled her down to 1.5 m but she found she was unable to equalise her ears, so rather than abort the dive the instructor inflated her buoyancy vest and told her to follow them, swimming at the surface. After about 5 minutes the one who had descended noticed the absence of her friend and started to ascend to look for her. The instructor realised he could not see anyone at the surface so ascended rapidly and reached the surface first. There he reassured the victim's friend and then called to the vessel's lookout to inquire whether he had seen anything. Then three children, who were snorkelling nearby, said they had seen a woman surface, that she had looked worried and they had later seen her lying on the sea bed below them with no bubbles coming from her. The instructor promptly dived where they indicated and found her, ditched her weight belt and inflated her buoyancy vest and brought her up. Resuscitation attempts were commenced as soon as she was pulled into the dinghy sent

from the vessel. These efforts ensured that she was still living when transported by helicopter to hospital but she died there next day without ever regaining consciousness, the result of cerebral anoxic damage and terminal pneumonia.

The delay of 9 weeks which occurred between the incident and examination of the equipment probably allowed the development of some corrosion changes and damage to an O-ring with some loss of air. However there was no suggestion that equipment factors caused this fatality. The autopsy, in addition to the noted changes, disclosed the presence of massive surgical emphysema of the mediastinum which extended into the retroperitoneal space, and air was present in the subarachnoid space. Aspiration of vomit had occurred into the lungs. The strenuous resuscitation efforts and delay before death occurred make these findings of uncertain relevance in understanding the scenario of this incident. The most likely is that she believed she knew how to scuba dive and decided to try to join the others underwater and succeeded in descending, then panicked and ascended holding her breath. She had retained her weight belt and not inflated her buoyancy vest and possibly suffered a cerebral arterial gas embolism, the reason for her behaviour as witnessed by the children, then sank. Her lack of understanding of English would have resulted in her being totally uninstructed in how to scuba dive safely and separation would have been anxiety producing. The survivor told how their instructor told them before the second dive that if they did not wish to go as deep as he was intending to go they need not follow him. An extraordinary failure of responsibility for the safety of those in his charge. It is tragic that she discovered how to equalise her ears while alone and was thereby able to make her solo dive.

2nd RESORT DIVE THAT DAY. INSTRUCTOR WITH 4 "PUPILS". UNDER WEIGHTED. EAR EQUALISATION PROBLEM. SO LEFT AT SURFACE WITH INFLATED BUOYANCY VEST. MANAGED TO DEFLATE VEST AND DESCEND ALONE. PROBABLE RAPID PANIC ASCENT CAGE. FOUND ON SEA BED. WEIGHT BELT ON. VEST UNINFLATED. DELAYED DROWNING DEATH. INADEQUATE INSTRUCTOR AWARENESS OF NEED FOR ADEQUATE SUPERVISION AT ALL TIMES. ORGANISATION WILLING TO ACCEPT CHILDREN FOR RESORT DIVE WITHOUT PARENTAL PERMISSION. LANGUAGE PROBLEM SO VICTIM WAS PROBABLY TOTALLY UNINSTRUCTED.

SC 94/8

This man, although an active asthmatic and untrained, had been diving frequently for twenty years, usually alone. He reportedly claimed he felt better after a dive. There are no details of his asthma's severity or his management routine. There were four divers making this boat dive but they dived as a trio group while he went solo. When they returned to the boat after 30 minutes they saw him floating face up about 30 m from the boat, so one of them swam over to him to check. He found the victim was unresponsive, mask in place, weight belt missing, regulator out of his mouth and water covering his mouth. He attempted EAR while towing him back to the boat where the others were able to commence CPR, though no response was obtained. The contents gauge read 110 bar.

The autopsy was preceded by both X-Ray and CT scans and was itself performed with awareness of diving medicine problems. Clear evidence was found of CAGE and the degree of coronary atheroma noted was considered to be insufficient to cause him symptoms. Neither was there evidence of active asthma. As he was an experienced diver and had sufficient remaining air, the reason for this incident remains unknown. He was reported to have the habit of using his "Ventolin" (salbutamol) inhaler before he dived and although none of his companions saw him use it on this occasion, an inhaler was found in the pocket of his buoyancy vest.

UNTRAINED. EXPERIENCED. 20 YEARS REGULAR DIVING. ACTIVE ASTHMA OF UNKNOWN SEVERITY. NO DETAILS OF ASTHMA MEDICATION USED. ADEQUATE REMAINING AIR. DITCHED WEIGHT BELT. BUOYANCY VEST UNINFLATED. FLOATED FACE UP WITH SUBMERGED FACE. CAGE.

SC 94/9

There were 21 passengers making the trip to the Barrier Reef. During the outward trip the diving instructor told them that, in addition to snorkelling, they would have the opportunity to scuba dive on the reef once they arrived there. Medical history forms were distributed to those interested. After the vessel was moored he gave a 5-10 minute talk on how to enter the water, equalise the ears, clear the mask and purge the regulator, before the first four passengers entered the water. He took them down the shot line one by one, to ensure they managed equalisation of their ears. One of the group had made a single previous "resort experience" dive and the victim (and possibly her husband also) had made two and was keen to make more. The water was described by the people who went snorkelling as being cold, but none of the scuba group mentioned this.

The victim and her husband were excessively buoyant, the former floating up to the surface several times before the instructor handed each an extra weight. Her husband placed his in the pocket of his buoyancy vest while she apparently kept hers in her hand. The instructor led, maintaining hand contact with the other two of his group, with the victim and her husband in the rear, supposedly keeping close to him. When they reached an open area where

the depth increased from 4 m to 7 m the instructor stopped and checked their contents gauges. He noted that the victim's gauge read 70 bar and her husband's read 50-60 bar. He decided it was time to bring them back to the surface, then noticed that one diver was now missing. The dive had lasted 15 minutes. There had been no indication of anyone having a problem. He brought the three who remained to the surface and then saw the skipper coming towards them in the vessel's dinghy. He had seen a solo diver surface and although there was no signal or sign that assistance was needed he decided to go and check the diver personally. This diver had been observed to remove the regulator from (her) mouth in a calm and "professional" way before descending again. The surface was sufficiently rough to prevent them determining whether any bubbles were coming to the surface when they looked.

After an unsuccessful search, till he ran out of air, the instructor returned to the yacht with the others and there he obtained a fresh tank and asked one of the crew to dive with him. Although not formally trained, the instructor had given this man sufficient instruction in the past to believe he would dive safely in this emergency situation. One of her fins was noticed, then her body close by, about 15 m from her last known position, depth 9-10 m. The instructor brought her to the surface by inflating her buoyancy vest. He ditched her weight belt at the surface. Resuscitation was commenced in the water and maintained until the helicopter arrived with a medical team who took over management. She died in hospital early next day from the cerebral anoxic damage she had suffered.

When examined later no fault was found with the equipment, and the contents gauge then showed 28 bar although the reading was higher before the instructor inflated her buoyancy vest. It is unknown why she left the group and made a solo ascent as she had more air than her husband when the signal to ascend was about to be given. Autopsy disclosed that there were fractured ribs, and a large paravertebral haematoma extended from the retropharyngeal level to behind the upper part of the stomach, involving the oesophagus and bronchi in the upper mediastinum. Although the pathologist thought that this represented barotrauma, resuscitation trauma is a more likely explanation. However, a cerebral arterial gas embolism may indeed have occurred and would explain her observed behaviour after she surfaced.

RESORT DIVE (3rd). SEPARATION AND SOLO ASCENT WITHOUT WARNING AS GROUP ASCENT ABOUT TO COMMENCE. SEEN TO SURFACE AND REMOVE REGULATOR FROM MOUTH THEN RESUBMERGE. APPEARED CALM. RESUSCITATION RELATED FRACTURED RIBS AND PARAVERTEBRAL HAEMATOMA. POSSIBLE CAGE. UNEXPLAINED REASON FOR HER ACTIONS. ADEQUATE BUT LOW AIR FOR ASCENT. FAILED TO DITCH WEIGHTS OR INFLATE BUOYANCY VEST AT SURFACE. LOST ONE FIN TERMINALLY. CLINICALLY CAGE.

Surface supplied diving fatalities

H 94/1

Commercial diving is frequently undertaken in less than ideal situations and with the unspoken understanding that tasks must be completed as inexpensively and rapidly as possible if there is to be any future work from the client. Undoubtedly such factors played a significant part in this tragedy. The job was an annual cleaning contract, at a power station, to clear growths and deposits from the guides in which a stop-door ran to cut off the water intake tunnel to provide water free access to clean the intake screens. They were also to replace the worn sacrificial anodes which protected the metal from electrolytic destruction in the presence of sea water. Access was difficult and made no easier by power station economies, if such were the reason for the staff reduction which resulted in the non-provision of a stand-by on-site crane, which would be required if a diver became injured and required lifting up from the tunnel to ground level.

Ladder access was down a shaft to a ledge at about water level, from which the intake tunnels could be entered. The industrial/commercial imperative was that the power station had to maintain operation of the intake to at least half of its intake pumps if electricity was to continue to be generated and this necessitated care on the part of divers to ensure they avoid straying across the entry to the in-operation tunnel.

The compressor was near the top of the shaft and the supply hoses for the two divers were measured out to allow just sufficient for them to reach the work area but no further, then tied to a railing at the top of the shaft. This made it difficult to claim that the third member of the team was tending the hoses while he minded the air compressor. One diver used a water gun to remove marine growths, a tiring and heavy task which he shared with his colleague, who was meantime replacing the anodes. This task involved him removing the old ones and returning to the bottom of the shaft to obtain fresh ones. He was, in fact, a fellow diver most of the time rather than a safety backup for the diver with the gun, which was very noisy.

This second diver noticed that he was becoming ill, feeling breathless and vertiginous. He returned to the shaft to tell the supervising diver his condition, unaware of the reason for his symptoms. His buddy had been close to him and still using the water gun when he decided he needed to get back to the surface in the shaft. The supervisor told him to return and bring out his buddy, which he attempted but he was unable to find him or to pull the hose back, and returned to report this to the supervisor. The supervisor now noticed that a hole had melted in the air intake hose where it

had come in contact with the hot compressor and that this was allowing exhaust fumes to enter. He quickly changed over to the emergency cylinder air supply, but this air was only available to the diver after the contaminated air in the hoses was cleared by usage. He jumped into the water and took the regulator from the ill diver and entered the intake tunnel. The victim's hose was found to be entering the operational tunnel, which was next to the one in which they had been working, and he also was unable to pull the victim out by pulling on the hose so returned to the surface and hit the emergency stop button, to stop a rotating screen, and yelled to workmen to stop the intake pump. He then re-entered the tunnel and retrieved the victim's body, having first to ditch his weight belt. It is assumed that the victim was making his way back when rendered weak or semi unconscious by the carbon monoxide and the intake flow in the working tunnel sucked him into it.

When the victim was brought out to the open water of the shaft he was placed on the ledge there, which was covered by a shallow depth of water, and resuscitation attempts were then commenced. By this time there were others present and assisting. In recognition of the difficulties of treating him on this ledge a loop of rope was placed under his shoulders and he was hauled to the surface. It was in just such a situation that a cradle lifted by a crane would have been useful. There was no response to their efforts. The surviving diver managed to climb the ladder back to the surface, a remarkable feat for someone as effected by carbon monoxide poisoning as he was. He was offered no treatment for his carbon monoxide poisoning until he reached hospital

The autopsy confirmed that carbon monoxide was the cause of loss of consciousness and drowning. It is possible that he would have survived if he had been wearing a full face mask, but he had a habit of vomiting when he began any dive and found it very inconvenient if wearing such equipment. The buddy was wearing such a helmet and disliked it intensely because it was too small for him. There was a helmet among the equipment they carried but it was not used. There was also a get-home bottle, similarly not in use. Their failure to wear a harness to which their air hoses could be attached was similarly a breach of the regulations.

Examination of the equipment showed that the compressor functioned correctly, although the weather conditions of the day may have caused exhaust fumes to remain around it. The melted intake pipe was of plastic, not a contravention of regulations though inadvisable. Investigation by work safety officers revealed a multitude of failures to conform to regulations, ranging from the omission of written instructions for the management of the work and absence of specific training to act as a diving supervisor to the fact that none of those involved was trained beyond the level of basic scuba diver. The air hoses were not as specified for diving air supply, no harness was worn to retain the air hoses, no get-home bottles were worn, there was no retainer strap on the victim's regulator, and no safety lines were worn. Although there was a get-home air bottle in the equipment they brought, it could not have been attached to the equipment they were wearing. The buddy described the full face mask "helmet" as extremely uncomfortable and said it had excessive dead space, allowing carbon dioxide build up. Similarly the unwillingness or inability of the engineers at the generating station to stop pumps while divers were working in the tunnels was inexcusable from a safety viewpoint, and the failure to have a crane with a cradle made recovery of the victim more difficult. All these factors were capable of adversely effecting diver safety but were not critical in the genesis of this fatality, which was entirely due to exhaust fumes entering through the air intake pipe after it melted. This accident could very easily have been a double fatality.

PART-TIME COMMERCIAL HOSE SUPPLY DIVERS. ONLY MINIMAL SCUBA CERTIFICATION. ADVERSE COMMENTS ON WORK MANAGEMENT AND EQUIPMENT USED. HOLE MELTED IN AIR INTAKE PIPE. ALLOWED ENTRY OF EXHAUST FUMES. INTAKE PUMP ALLOWED TO WORK WHILE DIVERS POTENTIALLY NEAR. VICTIM REFUSED FULL FACE MASK AS OFTEN VOMITED WHILE DIVING. CARBON MONOXIDE POISONING. NEARLY DOUBLE TRAGEDY.

H 94/2

This fatality occurred during an attempt to salvage a fishing vessel whose wreck had been purchased in hope of it being raised and resold at a profit. The first task, to locate the wreck, was successfully accomplished, then the clutter of nets and other gear had been cut away, and now the two divers were in process of placing float bags within the wreck. There was one break in the diving while curious sharks were allowed to prowl and then leave. The dive platform was a fishing boat owned by the man who had purchased the wreck and its two crewmen were acting as dive tenders to the two divers while the skipper maintained a radio and visual check to ensure no boats came near.

The victim was on the A-frame of the wreck, detaching the lift bags as they were sent down and handing them to the other diver, who was below him and in the wreck. After an hour his tender noted that his hose went taut, then slack, and the diver was seen to break the surface near the boat. He looked pale and was too unwell to attempt to climb the ladder back into the boat. He was unconscious when pulled aboard. The buddy was given a 4-pulls command to return but chose to take a routine 12 minutes decompression stop rather than surface immediately. As he alone knew anything about resuscitation this was not started until he came aboard and was unavailing. The autopsy revealed a serious degree of coronary artery disease and this disease is assumed to be the reason he ascended hurriedly

and then died. Although the equipment was in poor condition it was found to function correctly.

SURFACE SUPPLY DIVER. SUDDEN ASCENT. CORONARY ARTERY DISEASE. CARDIAC DEATH.

H 94/3

This also was a salvage attempt, on a yacht sunk in shallow water and now full of sand. It had been purchased by an experienced professional diver (A) who had been involved in its crew's rescue when it had hit the sand bar. He had with him two friends, one of whom (B) also had a financial interest in the outcome of the work in return for supplying advice on use of flotation devices. He had borrowed a hookah unit from another friend. They were on a yacht which they moored a short distance from the wreck in order to avoid any risk of damaging the wreck when they succeed in raising it, and for this reason brought two inflatables with them from which to work on the salvage task.

They placed the compressor in one inflatable, their two water pumps in the other. These pumps were used to operate a venturi tube suction hose sand dredge. The compressor had two outlets, one to supply a diver and the other to inflate the inner tubes and 25 litre plastic drums after they had been placed inside the hull of the sunken yacht. All three were divers and while B used the hose supply while clearing sand from the interior of the wreck another (C), using scuba, was placing and inflating the inner tubes and plastic drums in the wreck. The compressor could not supply sufficient air for both the diver and the inflation. The hose supplied diver (B) complained of feeling short of air, so the scuba diver ceased his inflating. Being unable to continue useful work and feeling very cold, C surfaced. A had been in the inflatable with the compressor and took the regulator from B when he surfaced. A then descended to continue clearing out the sand. Both he and B, the first diver, hand-held the regulator rather than securing the hose to themselves. There was a history of equipment problems on six previous occasions (no details are available) but none are reported on this day.

C was about to remove his scuba equipment when he heard a shout from B who had boarded one of the inflatables after handing over his hose supplied regulator to A. C immediately made his way through the array of hoses coming from the inflatables, which were tied together, and looked around. Seeing nobody at the surface he followed shouted directions and looked down. He saw the air hose and regulator lying on the sea floor and later saw A, the victim, sitting on the sea bed facing towards him with a fixed stare, his dentures hanging out of his mouth. He dived, ditched A's weight belt, and brought him to the surface. Although he was not breathing when he was reached he began to do so when his rescuer put his own regulator in A's mouth. During the tow back to the boat he could be heard taking deep, long, noisy breaths. On occasion water covered A's face despite the rescuer's best efforts. They were carried by a current towards the inflatable, which B had managed, with difficulty, to start (at one time a hose became wrapped round the propeller). C failed in his attempt to catch a rope from the boat but fortunately succeeded in catching hold of a scupper and was helped aboard by B. The victim made no attempt to assist and indeed became submerged at one stage. He failed to respond to their CPR efforts.

In his account of what occurred C described seeing the victim ascend close to the surface then remove the regulator from his mouth and sink. It is probable that he was no longer in control of his actions and allowed it to fall away as he sank. He said that they touched fingers, then A drifted down and away. No reason can be offered for the victim acting as he did, for he was an experienced diver. There was no fault with the air supply and the autopsy failed to define a certain cause of death other than drowning. Although CAGE would be a possibility there is no reason why such should occur in this dive, so the finding of coronary atheroma with a maximum narrowing of 50% is taken to indicate the possibility that he suffered a fatal arrhythmia or other cardiac event not identified. There was a suggestion that he may have mentioned having suffered a chest pain recently, but this is unsourced hearsay. He had mentioned to his friends that he had back pain due to a fall, and had bowel cancer. No evidence of any bowel disease was found at the autopsy.

EXPERIENCED COMMERCIAL DIVER. SHALLOW SURFACE SUPPLY DIVE. REGULATOR HELD IN MOUTH BUT HOSE NOT SECURED TO BODY. NEAR SURFACE LET REGULATOR FALL. UNCONSCIOUS. BREATHED FROM REGULATOR WHEN TAKEN BACK TO SURFACE. POSSIBLE CARDIAC ARRHYTHMIA. COLD WATER A POSSIBLE FACTOR. LOOSE DENTURES.

Discussion

There was only one fatality identified in a swimmer using a mask and snorkel, almost certainly an artifact of the difficulty experienced in identifying such fatalities other than where they occur during a commercial operation such as those taking tourists for day trips to the Barrier Reef. This man was apparently reasonably healthy, although a little over weight and having mild hypertension. There is no practical way in which his risk of suffering this fatal heart attack could have been identified. He died quietly among a group of people and while a general supervisory watch was being maintained. This type of fatality will inevitably occur again from time to time and is an inescapable risk.

Examination of the data concerning the factors which are potentially remediable shows that four scuba divers were

grossly inexperienced (SC 94/1, 94/4, 94/5, 94/6) and two (SC 94/7, 94/9) were supposedly under the direct supervision of an instructor while making a "resort dive". Three divers had had no training. Four trained divers were experiencing environmental factors they had never previously experienced, a surf entry (SC 94/1), a night dive (SC 94/4 and 94/6) and rough water (SC 94/5, who had not dived during the 18 months since completion of the basic training course). In one case (SC 94/4) there was a compounding of adverse factors, pairing of two inexperienced divers on their first night dive, separation from their supposed guide, and greater depth than ever before. The suicide was planned and carried out with such care that nobody could have influenced the course of events.

Although the action of the buddy in case SC 94/1 in assisting his friend in the surf zone was timely and correct, it was unwise for them to have delayed her use of her own regulator after reaching calmer water, but the need to recover the camera explains this matter. No reason is known for the victim failing to use her own regulator after leaving the surf zone but possibly this resulted from a fear of letting go an assured air supply and having to clear water from her own regulator before using it. She may well have been "spooked" by her first experience of really turbulent water. The rescue was seriously compromised by the buoyancy vest and weight belt problems. This illustrates the importance of checking the functioning of all one's equipment before entering the water. It is a wise precept to accept a maximum of one problem at any one time during a dive. If this cannot be resolved the dive should be aborted. If this rule had been followed during this dive the victim would either have resumed the use of her regulator or they would have commenced their return to the beach with less delay and (probably) there would have been no incident to report.

It is difficult to identify the reason for the death of the experienced diver in case SC 94/8, and his habit of solo diving removed the possibility of a witness being able to assist with details. In case SC 94/3 there is some doubt concerning the truth of what actually occurred as the victim had reportedly deliberately misrepresented the gas mix he intended to use and at least one of his buddies was using "trimix" merely because it happened to be in the tank he was using. The significance of the three way gas selector block in this fatality is the attention it draws to the narrow range of safety which is present when using non-air breathing gases, where even an apparently minor fault in a single piece of the diver's equipment can exact a terrible price. To this fault was married the mistake of setting up a non-conventional arrangement of the cylinders and their hoses. Where every procedure must be followed absolutely correctly, and "over learning" should be the minimal standard of achievement, it was folly to introduce such changes.

Concerning the finding of an asthma history in two instances (SC 94/1, 94/8), there is no evidence to implicate this as a factor in either, although in the absence of explanation for what occurred in case SC 94/8 there is a temptation to ascribe guilt by association.

Of the four cases where CAGE was the apparent critical factor (SC 94/6,94/7,94/8,94/9), two occurred during a "resort dive" while supposedly under the direct supervision of an instructor. This shows the need for awareness of the high level of responsibility devolving on those who take untrained persons scuba diving. These two incidents were not due to any conduct by the instructor which was unreasonable, although retrospective analysis inevitably shows that matters could have been managed differently. In case SC 94/6 the victim was left at the surface with an inflated buoyancy vest and told to swim above the underwater group but deflated the vest and made a solo dive. This was not an action which anyone would anticipate. In the second case the victim was known to have adequate air shortly before the group was to ascend and had shown no signs of being other than at ease. It is not possible to watch everyone in a group at the same time, even if there are only four to check, and unexpected actions by others will inevitably beat even the best of observers on occasion. It must be ever foremost in the minds of those responsible for the safety of others underwater that there is often only a narrow margin between a good dive and a disastrous one.

This year there were three surface supply (hookah) diver fatalities. The carbon monoxide risk is well documented from previous cases but is still liable to occur unless the intake is at sufficient height to avoid any possibility of an entry of fumes from the compressor's exhaust, and the hose remains intact. Although the commercial work in case H 94/1 was being conducted by a group of divers without commercial training and using sub-optimal equipment, it was by sheer misadventure that this tragedy occurred. Comment here should also be directed towards the responsibility of the client to provide a safe workplace for divers. In case H 94/2 the victim was probably unaware of his cardiac condition and certainly nobody else suspected he had anything wrong. Although a cardiac cause is suspected this cannot be blamed with complete certainty. Similarly in case H 94/3 cardiac arrhythmia, possibly influenced by hypothermia, may be invoked as the reason for his observed behaviour, though never proven.

In brief, diving can be fatal, and failure to follow the generally accepted and somewhat restrictive advice on safe diving protocols is an adverse factor in many dives which end fatally. Inexperience is, not unexpectedly, a significant adverse element in the safety equation and should be taken into account in the planning of all dives.

Acknowledgments

This investigation would not be possible without the understanding and support of the Law, Justice or Attorney General's Department in each State, the Coroners and police when they are approached for assistance.

Project Stickybeak

Readers are asked to assist this safety project by contacting the author with information, however tenuous, of serious or fatal incidents involving persons using a snorkel, scuba, hose supply or any form or rebreather apparatus. All communications are treated as being medically confidential. The information is essential if such incidents are to be identified.

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ACHILLES TENDON RUPTURE AS A DIVING INJURY

Jim Marwood

Key Words

Accidents, case report, first aid, injury, treatment.

Abstract

A case of ruptured Achilles Tendon, occurring during "giant stride" entry, is described with discussion of cause and symptoms, and notes on diagnosis and treatment.

Case report

As the diver stepped off the left foot, to make a "giant stride" entry, he felt a blow on the back of the left ankle. He began finning, but the ankle felt powerless. When, after a few minutes, there was no improvement he decided to surface and return to the boat.

The dive boat was an open "shark cat" type with a side-entry port over a low step. Conditions were calm, but a low swell caused the boat to roll. The diver recalled that as he strode off, his left heel was unsupported, being over the back of the step, and he was unbalanced by the motion of the boat. He believed he had been struck by a falling plank or dive-weight, but this the boat handler strenuously denied.

At 65 the diver was well over the usual age of diving patients, but apart from age he had no factors pre-disposing to injury. He was reasonably fit and accustomed to manual work. He had logged 55 dives in the preceding twelve months, with some 35 giant stride entries loaded, as he was on this occasion, with cold-water gear and heavy photographic equipment.

On return to shore removal of the left drysuit boot was painful. The diver could walk with a limp, but extreme pain on ankle flexion prevented walking on soft sand. There was a little posterior swelling but no bruising. He had full active ankle movement but was unable to rise up on the left forefoot.

Two days later, as weakness persisted, the diver sought medical advice and with the diagnosis of ruptured Achilles tendon (AT) was referred to an orthopaedic surgeon. Open repair was carried out, followed by six weeks in a non-weight bearing below-knee cast. The patient was impatient about mobilisation and this stretched the repair. The tendon healed with residual muscle weakness. At the time of writing, a year later, he can just support his weight on the left forefoot.

Discussion

A direct blow may break the AT, but about 60% of injuries occur in amateur athletes pushing off with a straight leg.[1] This group usually tears close to the tendo-muscular junction, with better healing prospects than those of older, debilitated subjects, whose tear is usually in the distal, avascular part of the tendon.[2] The patient was gratified to learn he had joined the former group.

At the time of injury the left ankle was carrying a static load of about 125 kg, increased by the forward thrust and perhaps by the boat motion. Clearly a loaded diver making a stride entry is a candidate for injury. A broad platform for a diver's take off would avoid over-extension of the tendon and seems a reasonable recommendation. When heavily laden, entry from a sitting position may be less stylish, but removes the risk of ankle injury.

Diagnosis

Symptoms may be misleadingly minor. A false positive diagnosis of AT rupture may be reached with pain and weakness from a torn Gastrocnemius or Plantaris, or occasionally with acute inflammation of an accessory Soleus muscle lying between AT and tibia.[3] Sometimes a patient may report an audible pop as the tendon breaks, but often, as in this case, there is neither sound nor much pain. There is always weakness of ankle extension, though full action remains thanks to intact Plantaris and long toe flexors. This residual action may encourage an element of denial. Sometimes there is a palpable gap in the tendon, but this may be masked by local swelling.[4] These factors explain the reported 20-30% of missed diagnoses.[5]