

diving medicine

VISUAL CORRECTION WHILE DIVING

A VERY LARGE PERCENTAGE OF DIVERS REQUIRE GLASSES TO SEE CLEARLY. WHAT OPTIONS DO THEY HAVE TO CORRECT THEIR VISION WHILE DIVING?

Corrective Dive Masks

Some divers wear their glasses under the mask. If the arms on the glasses are very thin and flexible, this might work. In general however the mask will leak. Other divers take the arms off an old pair of glasses and mount the front part of the glasses in the mask. The mask will not leak and the visual correction will be OK, but it will be hard to clean, hard to avoid fogging, and just plain ugly! This is also a very poor solution to the problem. Fortunately, there are several options for buying or making a prescription dive mask. The easiest is to buy a dive mask that has been designed so that you can

WHEN WE DIVE, THE GAS IN THE MASK IS UNDER THE SAME PRESSURE AS THE GAS IN YOUR LUNGS. THEREFORE, THE TEARS AND SURFACE OF THE CORNEA TAKE UP INERT GAS (NITROGEN IN AIR) JUST LIKE THE BODY ABSORBS IT FROM THE GAS IN THE LUNGS.

put a separate, off-the-shelf corrective lens in for each eye. These lenses typically come in 0.5 diopter jumps. You should round the 'spherical equivalent' of your glasses prescription down to the nearest available lens as it is better to be slightly under corrected than over corrected. This is only an approximate visual correction but it is fast, easy, and relatively inexpensive. If your visual problem is simple near or far sightedness without too much astigmatism (max 3 or 4 diopters), the off the shelf lenses will do a good job of correcting your vision. In addition, the dive mask already magnifies everything by 25% so this solution will work well for people with these kinds of visual problems. If you require larger amounts of astigmatism, reading glasses, bifocals, trifocals, or prism, you will need to try one of the following options. The next solution is to have the prescription for your glasses made into special lenses that are completely flat on

the front. These lenses are permanently glued onto the inside of the glass in your dive mask. This should be done by a professional company as the position of the lenses is critical (the visual center of the lens has to be lined up with the position of your pupils). This option will give you the best vision as it will correct for visual problems exactly like your glasses, but it is quite expensive and your mask usually has to be sent away to have the lenses fitted (there are only a few companies that can provide this service). The only problem with this solution is that it can be quite difficult to clean the glass in the dive mask outside the corrective lens as the lens sticks up from the surface of the glass creating a narrow space around the lens. I used this kind of mask from 1982 until 1996 when I had corrective laser eye surgery. Older divers with presbyopia (reading

vision with two different lenses for each eye.

A new solution is to buy a dive mask that is designed to allow you to temporarily insert off-the-self corrective lenses inside the mask. The bottom line is that there are now a large number of ways to 'make' a corrective dive mask and most of them give very good visual correction while diving.

Contact Lenses and Diving

One obvious solution to the problem of visual correction and diving is to wear your contacts under your dive mask. This can be a good solution but there are several potential problems you should be aware of. There are many different types of contact lenses but this discussion will be limited to the three most common; hard, gas permeable, and soft. Hard contact lenses were the first

available. The most significant factors for diving are that they are relatively small (smaller than the colored part of the eye) and they do not allow gas to penetrate through them. The cornea has no blood supply. Therefore, the only way for it to obtain oxygen and get rid of its' waste products is through the tears and direct exchange with the air covering the eye. The tears form a continuous film over the surface of the eye and every time you blink they are moved around and exchanged. A hard contact lens prevents the part of the cornea covered by the lens from exchanging oxygen and carbon dioxide with the air. This is not normally a problem because in a well fitted lens, every time you blink approximately 20% of the tear film between the lens and the cornea is exchanged. Never-the-less, the underlying cornea slowly becomes hypoxic. This is one of the reasons why many individuals can not wear hard contacts all day long and everyone has to

take them out when they sleep (you do not blink while you are sleeping). Soft contact lenses are much larger (covering more than the colored part of the eye) and allow gas to permeate through the lens. Therefore, the cornea under the lens does not become hypoxic and the contact can be worn longer. All extended wear contacts are soft contact lenses. In addition, soft contacts have very little tear exchange when you blink. This means you are less likely to get an object (dust, etc.) between the contact and the cornea, a common problem for all hard contact lens wearers. One problem with soft contacts is that because the lens is so soft and flexible, it does not correct for astigmatism. The hard lens forces the cornea to become round to fit the lens and in this way can correct for significant amounts of astigmatism. The gas permeable contact is an attempt to combine the advantages of both hard and soft contacts in a single lens. The gas permeable contact is more gas permeable than a hard lens and does allow some oxygen from the air to get to the underlying cornea but less gas permeable than a soft contact. It is larger than a hard contact but smaller than a soft contact. It is softer than a hard contact but still stiff enough to correct for some astigmatism. Many divers are concerned with loosing their contacts if they flood their dive mask or it comes off while they are diving. Hard contacts are small and they will wash out of the eye relatively easily. Gas permeable contacts are larger and soft contacts are so large that simply keeping the eyelids partially closed should keep them in the eye, even if you loose your mask while diving. Of course, once you loose your dive mask your visual correction will be very bad as you will have also lost the air space in front of the eyes. An additional characteristic of soft contacts is that when they are exposed to a solution with a higher (seawater) or lower (fresh water) osmolarity than tears, they stick to the cornea. If your mask

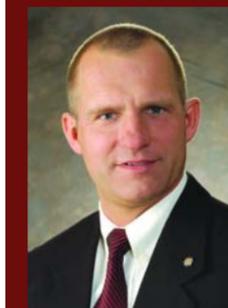
comes off while diving and if you keep your eyes partially closed for 30 seconds, soft contacts will stick to the cornea and be less likely to wash out while you are replacing and clearing your mask and/or surfacing. Swimmers and water polo players who use this technique seldom loose a soft contact. Unfortunately, this does not work for hard contacts and works less well for gas permeable contacts. To loosen the contact before taking it out, the eye should be irrigated with an isotonic saline solution (any contact solution) and allowed to equilibrate for two to three minutes. The contact should then have loosened and be easily removed without damaging the cornea. A disadvantage of soft contacts is that they can absorb the defogging chemicals some divers use in the mask and irritate the eye. These chemicals should be avoided if you are diving with soft contacts (spit works just fine) or the mask should be rinsed very carefully after applying the defogging solution. Soft contacts can also become infected if exposed to contaminated water (especially fresh water) and it is important to clean and disinfect them after diving. Some divers who dive while wearing contacts complain of blurred vision after the dive. When we dive, the gas in the mask is under the same pressure as the gas in your lungs. Therefore, the tears and surface of the cornea take up inert gas (nitrogen in air) just like the body absorbs it from the gas in the lungs. When we surface, the tears and cornea must 'decompress'. The tears and surface of the cornea are very fast tissues (they absorb and eliminate inert gas very quickly). In the diver not wearing contacts, a normal ascent will allow the tears and cornea enough time to unload the extra inert gas. If the diver is wearing contacts however, they can have a problem. Soft contacts allow the gas to diffuse through the contact relatively quickly and

they do not pose a problem. Gas permeable and hard contacts do not allow the inert gas to escape quickly and bubbles can form between the contact and the cornea. If the bubbles become larger in diameter than the thickness of the tear film, they will form indentations on the surface of the cornea. This stippling of the cornea will cause blurred vision. After the dive, the bubbles will quickly disappear and over the next 30 to

DAVID SAWATZKY, S.C., C.D., B.Med.Sc., M.D., M.Sc., is a diving medical specialist on contract at Defence Research and Development Toronto from 1998 to 2005. Previously he was the Canadian Forces Staff Officer in Hyperbaric Medicine at DCIEM (1986-1993) and later the Senior Medical

Officer at Garrison Support Unit Toronto (1993-1998). He's written a monthly column on diving medicine in Canada's *Diver Magazine* since 1993, has been on the Board of Advisors for the International

Association of Nitrox and Technical Divers (IANTD) since 2000, and is an active cave, trimix and closed circuit rebreather diver/instructor/instructor trainer. David's first love is cave diving exploration and he's been exploring and surveying underwater passages in Canada since 1985. David was responsible for the exploration and mapping of almost 11 kilometres of underwater passages in the Ottawa River Cave System. In 1995, he executed the first successful rescue of a missing trained cave diver. David received the Canadian Star of Courage for this rescue which took place in the chilly Canadian waters of Tobermory, Ontario. He still dives as much as possible, but admits his three year old son Lukas, two year old daughter Emeline and wife (Dr Debbie Pestell) are currently higher priorities than diving!



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120 minutes the cornea will return to its normal shape and the diver's vision will clear. It is unknown if there are any long-term effects from this type of repeated damage to the cornea but it seems unlikely. Fortunately, it can be easily avoided.

The simple solution is to wear soft contacts. For those divers who want to wear hard or gas permeable contacts, the following suggestions should avoid the problem. For hard contact lens wearers, it is vital to ensure that the lens is fitted correctly. If it is too tight there will be reduced tear exchange when you blink and the bubbles will be more likely to accumulate. The tear film between the contact and the cornea will also be thinner and smaller bubbles will damage the cornea.

Hard and gas permeable contact lens wearers must reduce their rates of ascent, especially near the surface, so that the gas will have a chance to clear from the tears and surface of the cornea. For all divers, air in the mask will be 100 percent saturated with water vapor.

Therefore, tears will not dry and there will be less stimulus to blink. Contact wearing divers must consciously blink while diving, especially during the last 10 msw (30 fsw) of ascent.

Contacts have several advantages over glasses while diving. First, they provide a wider field of corrected vision than corrective lenses mounted inside the dive mask. Second, you do not have to worry about finding a safe place to put your glasses while diving. Third, when you surface and take your mask off, you have corrected vision immediately (it always takes some time to get out of your gear and find your glasses). Many divers find glasses such a hassle that they simply leave them on shore and function with greatly reduced vision while on the boat or moving to and from the dive site.

In conclusion, contacts can be worn while diving. Soft contacts are preferable to gas permeable contacts and gas permeable contacts are preferable to hard contacts. However, all contacts can be safely worn while diving if a few simple precautions are taken. If you lose or flood your mask, keep your eyes closed to reduce the risk losing a contact. If you are wearing soft contacts, you might be able to simply squint for 30 seconds to stick the contact to the eye and then carry on. Soft contact lens wearers need to be careful using defogging solutions and take special care to clean and disinfect their contacts after diving. If you are wearing hard or gas permeable contacts, remember to ascend slowly for the last 10 msw (30 fsw) and all divers wearing contacts should consciously blink more often while diving.

HydroOptix Dive Masks and Diving

I would not normally discuss a specific product, but this one is so unique that it deserves mention (check out www.hydrooptix.com/index2.html).

Normal flat dive masks limit our field of view and they create distortion near the edges of that field of view. The designers of the HydroOptix dive mask have come up with a unique solution to this problem. They have designed a dive mask with a curved lens. The curved lens allows for a much larger field of view (they claim 5 times that of a flat mask) and the resulting vision is sharper. Most interesting, the curved lens converts the water into a corrective lens, a lens that changes strength depending on how far away the object you are looking at is!

To try and simplify a very complex topic, these dive masks will give superior vision compared to a normal flat mask, BUT the vast majority of people will have to wear a corrective contact lens to make the mask work for them, including divers who do NOT require glasses to see clearly on the surface. The only exception to this requirement is divers who require correction for near sightedness within a specific range, and the size of this range decreases as you get older.

This sounds not too bad, but it seems to me that the 'hassle factor' might be quite large. If you do not normally need glasses, you will have to insert contact lenses just before each dive and take them out immediately after the dive. If you wear the contacts on the surface your vision will be distorted. If you wear glasses, you will need your glasses on the surface, plus you will have to insert and remove contacts to see clearly with the HydroOptix mask in the water. If you wear contacts, you will have to change them for the HydroOptix contacts before and after each dive. Even if you are one of the lucky people who do not require contacts to see clearly with the HydroOptix mask in the water, you will still require your normal glasses or contacts when you are out of the water. These masks and the usually required contacts are also quite expensive. I personally don't think the increase in vision is worth the added expense and 'hassle factor' but that is a decision each diver will have to make for themselves. Never-the-less, this is an innovative and fascinating product.



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