Original articles

Otitis externa in military divers: more frequent and less harmful than reported

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Abstract

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Introduction: Although otitis externa (OE) is a common disease, data related to (military) divers are limited. This study aimed to determine the incidence of OE in military divers during their initial training. We also wished to consider seasonal influences on incidence and whether early detection increases completion of the diving course.

Methods: From January 2011 to October 2016 the Royal Netherlands Navy Diving School trained 189 divers. Up to December 2015 we used the training records for the analyses. From January 2016 onward all divers were prospectively screened. Pearson's χ^2 and Fisher's exact tests were used to analyse the data.

Results: In the 162 included divers, 30 cases of OE were identified. The incidence in 2016 was significantly higher than in 2011–2015 (17/35 (49%) versus 13/127 (10%), $P < 0.001$). Almost all cases developed after three weeks of diving. No influence of season was found ($P = 0.354$). Early diagnosis and treatment of OE does not seem to affect completion of diving courses ($P = 0.280$). Only in three cases did a diver have to discontinue the course due to OE.

Discussion: This study suggests that OE is more frequent among military divers than earlier reported, most likely caused by prolonged water exposure. Diving activities can often be continued with standard topical treatment.

Key words

Scuba diving; Ear infection; Treatment

Introduction

Infection of the outer ear canal, otitis externa (OE), is a common disease in general practice. Lifetime prevalence is estimated at 10%, while the yearly incidence ranges from 1–1.4%.[1–4] There is a profound seasonal effect in the general population, with the highest incidence in the summer.[5,6] This has been attributed to increased aquatic activities and rising ambient temperatures, generating the ideal circumstances for developing OE.[7–9] Although contaminated fresh water lakes, pools and hot tubs are known to cause epidemics, sufficiently filtered and chlorinated water can also cause OE.[5,6,10] Prolonged exposure to (any type of) water macerates the ear canal and washes away the acidic cerumen, making the ear vulnerable to infection.[5,11,12] Bacterial overgrowth is responsible for more than 90% of the cases of OE, with *Pseudomonas aeruginosa* and *Staphylococcus aureus* being the most common pathogens.[1,2,13,14] The remaining 10% is caused by mycosis (*Candida* and *Aspergillus*), which is more common in tropical climates.[7,12]

Data on the incidence in aquatic athletes and scuba-divers is surprisingly limited. OE was reported to be 2.5 times more frequent in swimmers and water polo players than in football players.[5] A survey among experienced sport divers showed a 'diving career prevalence' of 43.6%.[15] Diving activities are highly likely to be discontinued when OE occurs in divers.

There is much debate on preventive or therapeutic interventions in OE, with some stating there should be no difference in the treatment of divers compared with non-aquatic athletes.[16] The use of prophylactic acidic drops has not proven effective.[1,2,9,17] Unless there are signs of systemic inflammation, there is no place for systemic antibiotic treatment.[1,2,8,12,18] Evidence is unclear which topical agent is preferred to treat OE.[1,18,19] While OE is treated effectively with a course of eardrops, the cornerstone of treatment is to keep the outer ear canals dry and clean.[8,18,19] This is particularly difficult in the case of military diving, since diving activities are continued as long as possible for operational reasons.

While sport diving is a leisure activity, military diving must be considered as hard work in harsh environments. It seems plausible that OE in military diving is far more frequent than earlier reported. The aim of this study was to determine the incidence of OE among military divers during their initial diving training. We were also interested in seasonal effects on the incidence of OE and whether early detection and treatment reduces interference with the diving course.

Methods

STUDY CONTEXT

The Royal Netherlands Navy Diving School (NDS) is responsible for training of all military divers in the Netherlands. While follow-up training depends on their

trade (e.g., clearance diver, construction, special forces, etc.), the initial training is a six-week course with three weeks in pool water followed by three weeks of training in open water. Although the locations of various elements of the course have changed over the years, the basic outline has remained the same. The NDS operates throughout the year. All trainees are healthy candidates who passed thorough dive medical screening in accordance with the European Diving Technology Committee (EDTC) guidelines prior to entering the course.[20] The Medical Ethics Committee affiliated with the Amsterdam Medical Centre approved our methods for handling personal details and privacy and concluded that they were concordant with the guidelines of the Association of Universities in the Netherlands and the Declaration of Helsinki (document reference: W16-281).

In 2013, the deep pool exercises switched from a naval sonar maintenance pool to an indoor pool solely used for diving. As of 2014, the free ascents from 15 metres' depth could be practiced in the naval harbour, which previously had to be practiced in an indoor pool in Belgium. During the entire study period, all diving locations (pools and outside) were tested monthly regarding water quality and all met the quality and safety conditions according to both Dutch and international standards.[21,22]

DATA COLLECTION

The NDS keeps detailed records of course results of all diving trainees, including medical problems. The training records of all diving trainees from January 2011 to October 2016 were reviewed. Up to December 2015, each diver could request a consultation with a dive medical nurse or physician. The diver can also be ordered by the instructors to visit medical staff if they suspect a medical problem. As of January 2016, one dive medical physician and two nurses actively engaged the trainees and performed regular checkups on all divers. All data up to the end of December 2015 were gathered retrospectively, while data from January 2016 onwards were acquired prospectively. During the entire training period, OE was defined as a combination of: 1) otalgia, itching or otorrhoea, and 2) oedema or erythema of the external ear canal or pain when manipulating the tragus.[3] Training records with incomplete data were excluded from the analysis. All information was documented in a database that registered: 1) occurrence of OE, 2) whether the diver missed any diving days and 3) whether the diver was able to successfully complete the course. The two latter parameters were categorized into those that were caused by OE, or were due to other reasons.

TREATMENT PROTOCOL

Our treatment protocol was based on best practice and is in accordance with Dutch guidelines, primarily using acidic drops and switching to topical steroids with a cotton wick if the ear canal was severely swollen.[1,8,18] If topical steroids proved to be insufficient, a combination of dexamethasone, framycetin and gramicidin (Sofradex®) was used. In the Netherlands, the use of ciprofloxacin is reserved for post-surgery and chronic external otitis. In line with the literature, we refrained from giving systemic antibiotic treatment.[1,2,8,12,18] Bacterial culture is not part of our standard practice. A diving physician could order a patient to discontinue diving activities when complaints seemed to be incompatible with diving.

Table 1
Distribution of diver trainees by quarter of the year (Q) for the period 2011–2015 and for 2016; for each quarter the upper line is the number of divers with adequate medical records (total $n = 162$), the bottom line the number of patients with otitis externa

	2011–2015	2016	Total
Q 01	29	11	40
	3	8	11
Q 02	61	24	85
	7	9	16
Q 03	7	0	7
	0	0	0
Q 04	30	0	30
	3	0	3
Total	127	35	162
	13	17	30

ANALYSIS

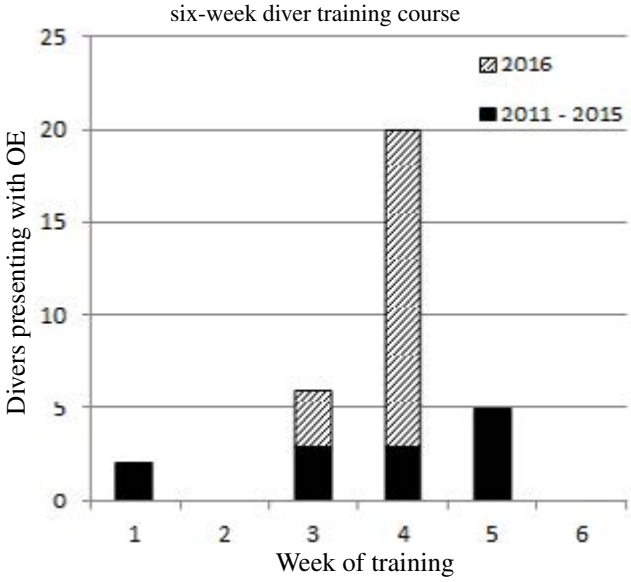
All data were binary (either OE or no OE). Statistical analyses were performed with SPSS Statistics for Windows (IBM Corp; Armonk, NY: 2015, version 23.0), using Pearson's χ^2-test for hypothesis testing. To determine any seasonal influence, we categorized the results per quarter (i.e., Q1 from January–March, Q2 from April–June, etc.) and performed a Fisher's exact test. To measure the effect of early detection and treatment, we compared the incidence in the period 2011–2015 with that in 2016. Statistical significance was assumed when $\alpha < 0.05$.

Results

In the period January 2011 to October 2016, a total of 189 divers were trained by the NDS. All training records were reviewed and 15 records (8%) were excluded because they contained no data. In 12 records (6%), information on medical status was missing, leaving a total of 162 divers for the present study. Although females are allowed in military diving, of the 162 included divers, 155 of the included subjects (96%) were male. Table 1 shows the distribution of divers over the quarters for the retrospective and prospective groups. Thirty cases of OE were identified, none in the seven female divers.

Compared with that in the previous years (10%), the increased incidence in 2016 (17/35, 49%) was significant

Figure 1
Onset of otitis externa (OE); number of cases in each week of the six-week diver training course



($P < 0.001$ for χ^2). The onset of OE is presented in Figure 1: 2016 is presented separately from the previous years to show the effect of active screening. The highest incidence of OE is in week four, after three weeks of diving in pool water. However, in 2016 all but three divers in week four presented themselves before starting open water training. In 2016, we found no cases of OE in week five and, throughout the study period, onset of OE did not occur after the fifth week.

The quarterly incidence of OE did not differ significantly (Fisher's exact test $P = 0.354$). We also tested the incidence of 2011–2015 separately to correct for the increased incidence of 2016, this difference was also not significant ($P = 0.959$). According to measurements by the Dutch Ministry of Infrastructure and the Environment, the water temperature during the study ranged from 2°C in the winter to 22°C in the summer, with ambient temperatures ranging from -10°C to 35°C.

Up to December 2015, a total of 13 divers were identified with OE, of whom 12 (10%) had to discontinue diving for at least one day due to OE. In 2016, OE caused at least one missed day of diving in five of the 35 divers (14%); this slight increase was not significant ($P = 0.280$). Thirty-two of the 162 divers (20%) failed the course either for insufficient results (12 divers) or for medical reasons (20 divers). Of these 20 divers, only three were due to OE, all of which occurred in the period of 2011–2015. In these cases, OE was so severe that continuation of diving would be too painful.

Our treatment protocol did not change during the study period. In four divers (13%), including two who had to stop the diving course, topical antibiotic treatment was given due to treatment failure of topical steroids. All other cases of OE were treated with acidic drops, with or without steroids.

Discussion

This study provides a six-year overview of the incidence of OE in naval diving trainees and its impact on their diving activities. The incidence found is much higher than reported in the literature. This might be explained by frequent and continuing water exposure during the six-week diving course. There was no seasonal influence. The study shows that early detection and treatment has no effect on participation in diving activities.

ACTIVE SCREENING

Up to December 2015, divers contacted medical staff when they experienced complaints. In 12 of the 13 divers the OE was severe enough to miss at least one diving day, and in three divers the infection was so severe that the diving course could not be completed. This is why we decided to actively screen the divers for OE and found a much higher incidence. In our opinion, this increase can be attributed to previous underreporting. In 2016, all divers had some complaints (either pain or itching), but the majority did not consider their complaints severe enough to consult a physician.

One could argue that the behaviour of the divers might have changed due to the regular screening we performed. However, we feel that this effect is negligible, since instructions to rinse and dry the ears after diving and to refrain from using objects to clean the outer ear canal were already standard practice in the diving course.[21] Also, we consider the possibility of traumatic injury and subsequent development of OE due to the screening itself to be very low, since all medical staff were trained in handling the otoscope and performed all examinations carefully.

PROLONGED EXPOSURE TO WATER

Almost all our cases of OE developed in the third and fourth weeks. Although we cannot exclude the contribution of chlorination because our study lacks a control group in unchlorinated water, studies support our observation that long exposure to water makes the outer ear canal susceptible to OE.[5,11,12] Also, although diving locations have changed over the years, the locations were similar (i.e., inside or outside training) and the water quality at all dive sites remained well within international regulations.[22] We feel this is an additional argument to conclude that OE in these divers can be attributed to the frequent and prolonged exposure to water, rather than possible contaminated or type of water.

SEASONAL INFLUENCE

As the diving school operates throughout the year, we were able to test whether seasonal conditions had any influence on the development of outer ear infection. We hypothesized that the incidence would be highest when ambient temperature was higher (i.e., in Q2 and Q3). Although our Q3 group is

small compared to the groups in the other quarters (partly due to 15 blank records in 2011 which had to be excluded), we found no significant effect. Also, the behaviour of the divers is likely to change with changing weather conditions, e.g., wearing a woolen hood when working at the surface in the winter, or just a simple cap in the summer. In contrast to the literature, we feel that our study indicates there is no significant seasonal effect on the development of OE in military divers.

EARLY DETECTION AND TREATMENT

One might suggest that early detection and treatment would lead to higher participation in the course. However, we found no significant change in missed diving days. If any, there might be a slightly lower participation. In view of the high incidence and low number of divers that had to stop the diving course, we might conclude that prolonged water exposure or continuing diving operations with OE is less harmful than earlier thought. Even severe cases of OE could be treated topically, while none of the cases required systemic antibiotic treatment.

STRENGTHS AND LIMITATIONS

To our knowledge, there are no publications on the incidence of OE in military divers. The present study combines retrospective and prospective data, providing an overview of the impact on operational diving. The study design allowed us to evaluate the effect of active screening and determine the incidence of OE in military divers. Unfortunately some divers had to be excluded due to insufficient data; a prospective design might serve to limit this influence. Although all divers were screened according to EDTC guidelines, we did not register any risk factors (such as a narrow auditory canal or history of eczema) which could predispose for OE. This information could help us determine which divers are more at risk. To our knowledge, there is no validated grading system to stratify the severity of OE. This might have provided more insight into the effects of early diagnosis and treatment. Whereas this study does provide some insight into effects of topical treatment on participation in diving courses, it does not determine which treatment is optimal to continue diving operations.

Conclusions

Otitis externa is much more frequent in military divers than earlier assumed, but continuing to dive with OE would appear to be less harmful than previously thought. We were unable to demonstrate a seasonal influence on the development of OE, as reported in the literature. Screening and early treatment do not seem to prolong diving activities and, with standard treatment using topical agents, our divers were able to continue their diving course without worsening of OE. We plan a prospective study aiming to determine the optimal treatment regimen for military divers.

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