

Perceptions of Middle Ear Squeeze: Crowd Sourcing Web Site vs Diver Comparison



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Background

- Middle ear barotrauma (“middle ear squeeze”) affects more than 40% of divers at some point in their diving career, making it the most common disorder affecting scuba divers (Glazer, 2016).
- Middle ear barotrauma and its precursor impaired equalization, occur during descent when pressure is placed on the gas-filled middle ear without equalization (Livingstone, 2017).
- Symptoms of middle ear barotrauma include congestion of the tympanic membrane (Azizi, 2011), fullness of the ear, decreased hearing, ear pain, or tympanic membrane rupture (Lynch, 2014).
- There are several equalization techniques including but not limited to: the Valsalva maneuver, Toynbee maneuver, or Frenzel maneuver.
- Several over-the-counter products are marketed to divers to prevent middle ear squeeze which have not been studied.

Purpose of the Study

The purpose of this study was to determine the current state of knowledge and perceptions of the scuba diving community in the U.S. and determine which products and techniques are being used to prevent impaired equalization and middle ear barotrauma.

Methods/Study Design

We conducted a grant-funded, survey-based, research study using an anonymous questionnaire delivered using an online survey website and hosted through a crowdsourcing website marketplace. We compared these data to data from surveys completed by individuals known to be divers.

Survey hosted on Crowd Sourcing Marketplace

- Responses limited to individuals with;
- Historical survey acceptance rate >95%
 - Greater than 50 accepted Human Intelligence Tasks

Group 1-Web Site Marketplace (n=192)

Study period: August 1, 2021 to August 31, 2021

Group 2-Known Divers (n=13)

Study period: January 25, 2022 to March 1, 2022

Survey sent to three diving shops in SC and FL, EMS involved in search/rescue, and divers known to the PI.

- Survey went through elicitation, face validity, and cognitive interviews.
- Ten questions were placed in the survey to screen out non-divers and crowdsourcing individuals motivated by the completion fee.
- All individuals who completed the survey on the crowdsourcing website and accepted by the PI, were given \$5.

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Results

Table 1. Respondent Characteristics

	Sex (%)	Average Age year (range)	Lifetime Dives, mean (range)	% Divers with <20 Lifetime Dives	% Divers with <100 Lifetime Dives	Rating Concern of Middle Ear Squeeze (0-100)	% Divers Able to Equalize without use of Product
Website Marketplace (n=192)	F: 29%	36 (24-70)	10 (3-500)	57%	84%	63.8	66.7%
	M: 71%	34 (22-68)	10 (4-1000)				
Known Diver (n=13)	F: 30%	27 (21-33)	20 (10-30)	38%	76.9%	50	89.5%
	M: 70%	40 (32-48)	72 (5-7500)				

Table 2. % Responded “rarely or never experienced middle ear squeeze” with dive frequency on Likert scale 1-5 (Never, Rarely, Sometimes, Often, Very Often)

	Single Day Dives	Interrupted Dives	Repetitive Dives	Third Day Dive
Website Marketplace (n=192)	36.5%	28.1%	27.1%	27.0%
Known Diver (n=13)	92.3%	84.6%	84.7%	92.3%

Table 3. % Responded using product to prevent middle ear squeeze “often or very often” and % responded effectiveness was “somewhat or very effective” on Likert scale 1-5 (NA, Not Effective, Rarely Effective, Somewhat Effective, Very Effective)

	Vented Ear Plug	Dive Mask with Ear Cups	Oral Decon-gestant	Oral Antihis-tamine	Nasal Decon-gestant Spray	Nasal Cortic-osteroid Spray	Nasal Saline	Other
Website Marketplace (n=192)	54.1%	60.9%	59.9%	34.4%	55.7%	49.5%	53.6%	29.7%
	46.4%	56.8%	55.2%	50.0%	53.1%	45.3%	48.4%	22.9%
Known Diver (n=13)	0%	0%	0%	0%	0%	0%	0%	0%
	0%	8%	8%	0%	0%	0%	0%	8%

Table 4. % Responded use of manual maneuver to prevent middle ear squeeze as “often or very often” and % responded effectiveness as “somewhat or very effective” on Likert scale 1-5 (NA, Not Effective, Rarely, Somewhat, Very)

	Valsalva	Toynbee	Frenzel	Lowry	Edmonds
Website Marketplace (n=192)	56.3%	61.5%	63.5%	60.4%	60.9%
	37.5%	49.5%	55.7%	56.8%	53.6%
Known Diver (n=13)	69.3%	23.1%	0%	0%	7.7%
	69.3%	38%	8%	8%	38%

Limitations

- Despite the use of screening questions, there were disparate responses between marketplace respondents and known divers.
- PI rejected 231 surveys from the website marketplace for the following reasons: age and date of birth mismatch, fictitious credentialing organization, responses didn’t match the question.
- The known diver group only had 13 respondents

Discussion

- In our review of literature, there was a lack of quality research focused on prevention of middle ear squeeze in divers.
- The most common preventable cause of middle ear squeeze is reversible nasal congestion.
- Divers should be counseled to avoid diving if they are currently experiencing acute upper respiratory infection, uncontrolled polyposis or allergic rhinitis.
- Yamaguchi T(1994) reported that divers who are older than 50 require more pressure with Valsalva maneuver to open their Eustachian tubes. Additionally, in the same study, divers who are greater than or equal to 60 years old have Eustachian tubes that close faster. Theoretically, both conditions could lead to increased middle ear squeeze. Therefore, we expected that our results would show that individuals older than 50 would have more difficulty equalizing without the use of a supplemental which was not observed in our study.
- There is level 2a evidence that supports decongestants for preventing middle ear barotrauma. Furthermore, oral decongestants appear to be more effective than topical decongestants (Lynch 2014). However, decongestants can lead to reverse ear squeeze. As the medication wears off, the air that fills the middle ear can become trapped. When the diver ascends, that air expands, and because the air cannot leave the chamber, it can lead to rupture of the tympanic membrane and significant pain, which rarely can cause a diver to drown.

Conclusions/Significance of Findings

- The majority of individuals in both website marketplace and known diver groups were concerned with middle ear squeeze
- The majority (89%) of known divers were able to equalize without the use of a product.
- There was no relationship between frequency of dives and perceived frequency of middle ear squeeze
- Divers would likely benefit from education on different manual maneuvers.
- More research is needed to ascertain the effectiveness and safety of these products and medications.

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