

# PREDICTORS OF “CHEST SQUEEZE” IN BREATH-HOLD DIVERS

Potkin R Beverly Hills Center for Hyperbaric Medicine, Los Angeles

## INTRODUCTION

Breath hold divers perform a variety of training exercises and maneuvers to optimize performance, lengthen depth and breath - hold time. These training exercises include hypoxic and hypercarbic ventilation exercises, purging, peak inhalation, lung packing also known as glossopharyngeal insufflation, reverse packing or glossopharyngeal exsufflation and negative pressure exercises.

## INTRODUCTION

Glossopharyngeal insufflation is a maneuver whereby air is forced into the lungs at peak inspiration by forced swallowing to increase lung volume beyond total lung capacity resulting in elevated intrapulmonary pressures.

Glossopharyngeal exsufflation is the reverse process whereby air is sucked out of the lungs into the pharynx resulting in reduced intrapulmonary pressures .

**Negative pressure exercises** are performed when the diver exhales to functional residual capacity or even further to residual volume at the surface and descends to at least 5 meters in a pool or to greater depths in the open water. This exposes the lungs to volumes and pressures similar to estimated depths of several hundred feet .

# INTRODUCTION

- These maneuvers may be associated with the development of coughing up blood or “chest squeeze”.
- To better understand possible risk factors associated with this phenomenon, a web based questionnaire was developed.

We are interested in learning about the occurrence of coughing up blood (hemoptysis) during or shortly after free diving. This condition is commonly referred to as "chest squeeze." We ask that you take a few minutes to complete this questionnaire. The information is strictly for medical research and the information provided will be kept anonymous and confidential.

1. email (optional):	<input style="width: 95%;" type="text"/>
2. age	<input style="width: 95%;" type="text"/>
3. sex	<div style="border: 1px solid black; padding: 2px; display: inline-block;">Unspecified ▼</div>
4. free diving experience in years	<input style="width: 95%;" type="text"/>
5. # dives greater than 50 meters	<input style="width: 95%;" type="text"/>
6. # dives between 30 to 50 meters	<input style="width: 95%;" type="text"/>
7. # dives between 15 to 30 meters	<input style="width: 95%;" type="text"/>
8. # dives between 1 to 15 meters	<input style="width: 95%;" type="text"/>

  

9. Do you have any medical conditions?	<input type="radio"/> yes <input type="radio"/> no If so, list the condition(s): <input style="width: 95%;" type="text"/>
10. Do you have any lung or chest problems?	<input type="radio"/> yes <input type="radio"/> no If so, list the condition(s): <input style="width: 95%;" type="text"/>
11. Do you have any sinus problems?	<input type="radio"/> yes <input type="radio"/> no If so, list the condition(s): <input style="width: 95%;" type="text"/>
12. Have you taken any medications in the past week?	<input type="radio"/> yes <input type="radio"/> no If yes, please list medications: <input style="width: 95%;" type="text"/>

  

13. Have you ever coughed up blood during or after a breath holding dive?	<input type="radio"/> never <input type="radio"/> once <input type="radio"/> twice <input type="radio"/> over 2X
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	<input type="radio"/> over 5X <input type="radio"/> many times
14. Were you Short of Breath at any time during any episode of bleeding?	<input type="radio"/> yes <input type="radio"/> no
15. How long did the coughing up blood last?	<input type="radio"/> minutes <input type="radio"/> over 1 hour <input type="radio"/> 1 day <input type="radio"/> several days <input type="radio"/> one week <input type="radio"/> over 1 week
16. Did you receive any medical evaluation or treatment for this problem?	<input type="radio"/> yes <input type="radio"/> no
	If yes, <input type="radio"/> medical exam <input type="radio"/> chest x-ray <input type="radio"/> medications <input type="radio"/> other : _____
17. Do you have any idea where the blood was coming from?	<input type="radio"/> don't know <input type="radio"/> nose or sinus <input type="radio"/> trachea <input type="radio"/> lungs <input type="radio"/> other _____
18. Approximate depth of dive associated with the bleeding	<input type="radio"/> 5-15 meters <input type="radio"/> 15-30 meters <input type="radio"/> 30-50 meters <input type="radio"/> over 50 meters <input type="radio"/> over 75 meters
19. Was this dive close to your personal best?	<input type="radio"/> yes <input type="radio"/> no
20. Depth of dive prior to the chest squeeze	<input type="radio"/> 5-15 meters <input type="radio"/> 15-30 meters <input type="radio"/> 30-50 meters <input type="radio"/> over 50 meters <input type="radio"/> over 75 meters
21. Depth of dive 2 dives prior to the chest squeeze	<input type="radio"/> 5-15 meters <input type="radio"/> 15-30 meters <input type="radio"/> 30-50 meters <input type="radio"/> over 50 meters <input type="radio"/> over 75 meters
22. Depth of dive 3 dives prior to the chest squeeze	<input type="radio"/> 5-15 meters <input type="radio"/> 15-30 meters <input type="radio"/> 30-50 meters <input type="radio"/> over 50 meters <input type="radio"/> over 75 meters

23. Number of dives in the past month	<input type="radio"/> less than 10 <input type="radio"/> 10 to 100 <input type="radio"/> over 100
24. Number of dives in the past 24 hours	<input type="radio"/> none <input type="radio"/> less than 10 <input type="radio"/> more than 10
25. Do You Pack?	<input type="radio"/> never <input type="radio"/> yes, but not on this dive <input type="radio"/> normal packing <input type="radio"/> extreme packing
26. Do you normally have contractions?	<input type="radio"/> yes <input type="radio"/> no
27. Did you have contractions with this dive?	<input type="radio"/> yes <input type="radio"/> no
28. Do You Use Negative Pressure Training?	<input type="radio"/> never <input type="radio"/> yes, but not when the bleeding occurred <input type="radio"/> yes, on that dive
29. Did you have any problems equalizing during the dive?	<input type="radio"/> yes <input type="radio"/> no  Please describe:
30. Were you cold during the dive?	<input type="radio"/> yes <input type="radio"/> no
31. Did you shiver?	<input type="radio"/> yes <input type="radio"/> no
32. Did you notice anything unusual for you during this dive?	<input type="radio"/> yes <input type="radio"/> no  Please describe:

## RESULTS

63 respondents 48 reported at least one episode of “chest squeeze”  
15 respondents had no episodes.  
61 Male 2 Female

Mean age with squeeze - 32 years (range 17 to 58 years)

Mean age without squeeze - 38 years (range 20 to 55 years)

The parameters analyzed described above were subjected to a stepwise logistical regression statistical analysis.

**The only variable that was clearly associated with the occurrence of “chest squeeze” was negative pressure training.**

**( $p=.0008$ ) and an odds ratio of 3.0.**



# CONCLUSIONS

63 breath-hold divers completed a web based questionnaire in an attempt to determine factors associated with “chest squeeze”.

Negative diaphragm exercises create a physiologic state on the lungs which is comparable to deep depths of several hundred feet and can be performed by the diver dry, on the surface or immersed.

In this study, the use of negative pressure exercises was highly predictive of the occurrence of “chest squeeze”.

# Study Limitations

- N is small in both groups
- Operational definition of “chest squeeze”
- No differentiation of negatives at FRC compared to negatives at RV

## PREDICTORS OF “CHEST SQUEEZE” IN BREATH-HOLD DIVERS

Potkin R. Beverly Hills Center for Hyperbaric Medicine, Los Angeles, California

**INTRODUCTION:** Hemoptysis has been observed in breath -hold divers. The source and cause of the bleeding has not been well characterized . Possible sources include the pulmonary parenchyma, trachea and/or sinuses. Breath-hold divers perform a variety of maneuvers to optimize performance, increase depth and breath hold time. These include ventilation exercises, purging, peak inhalation, packing, reverse packing and negative diaphragm exercises. To better understand possible factors associated with the phenomenon of chest squeeze a web based questionnaire was developed.

**METHODS:** A questionnaire was posted via the internet on 3 web sites, [www.worldfreedivingmedicalassociation](http://www.worldfreedivingmedicalassociation.com) , [www.performancefreediving.com](http://www.performancefreediving.com) and [www.deeperblue.com](http://www.deeperblue.com) and the results were analyzed . The data was collected over a 1 year period. Chest squeeze was defined for the purpose of this study as coughing up any amount of blood. Variables tested for statistical significance included age, sex, number of dives, depth of dives, preexisting medical conditions, medications taken, cold or shivering, problems with equalization, packing and use of negative pressure exercises.

**RESULTS:** There were 63 respondents ; 48 reported at least one episode of “chest squeeze” and 15 respondents had no episodes. The parameters analyzed described above were subjected to a stepwise logistical regression statistical analysis. The only variable that was clearly associated with the occurrence of chest squeeze was negative pressure training. ( $p=.0008$ ) and an odds ratio of 3.0.

**CONCLUSIONS:** 63 breath hold divers completed a web based questionnaire in an attempt to determine factors associated with chest squeeze. Negative diaphragm exercises create a physiological state comparable to greater lung depths which can be performed by the diver dry, on the surface or in the water. However, the use of negative pressure exercises is highly predictive of the occurrence of chest squeeze.

Category: diving

Authorizations: a. Y b. Y

Financial Disclosures: a. N b. N c. N