

Packing

First published 6 April 2015

There has been considerable discussion about packing and reverse packing as they relate to freediving. I thought it would be productive to pull together as much of the available information as possible in one place. I am not trying to encourage or facilitate the practice, but rather to educate about it, including its effects and significant risks.

Glossopharyngeal insufflation

also known as **lung packing**, frog breathing, and buccal pumping. Interestingly, [buccal pumping](#) is how amphibians inflate their lungs.

Glossopharyngeal insufflation has been used extensively by freedivers to increase total lung capacity. It was first introduced to the freediving community by [Robert Croft](#) in the 1960's. [Glossopharyngeal breathing](#), or more properly glossopharyngeal insufflation, also has medical application, and first appeared in the medical literature in a September 1951 article by Clarence W. Dail, M.D. He had observed the practice being used by patients with severe respiratory muscle impairment.^[1]

The process of glossopharyngeal [insufflation](#) consists of the following steps^[2]:

With the [glottis](#)* and [soft palate](#) closed, and the tongue flattened against the lower part of the mouth, open the lips and lower the jaw, sucking air into the mouth. Without raising the jaw, close the lips to seal the air in the mouth and upper throat. Then, opening the glottis, raise the jaw and tongue to push the air into the lungs, and then close the glottis. This process can be repeated as necessary to inflate the lung as desired.

Lung packing is NOT the process of taking the final sips of air to a full breath through an open mouth and glottis. If your mouth and glottis are both open at the same time, you are breathing, not packing. Sometimes they may look similar, but they are not, either in action or effect.

The effects of glossopharyngeal insufflation on the heart and circulation are pretty drastic^[3], and include abnormal ventricular contractions, low blood pressure, reduced venous return to the heart, and increased resistance to blood flow in the lungs.

"It is likely that acute pulmonary pressure elevation during glossopharyngeal insufflation causes right ventricular systolic dysfunction from pressure overload, contributing to systemic hypotension in a pattern similar to that described in acute pulmonary embolism"^[3]

"Due to its marked depressive effect on cardiac function, glossopharyngeal

insufflation is associated with serious hemodynamic consequences for divers in the nonimmersed state; therefore, the safety of this practice warrants further investigation."^[3]

All of those things make sense given the increased intrathoracic pressure caused by lung packing. The question remains - what are the long term effects?

The risks

There are no pain receptors in the lungs^[4], so injuries can occur there with no feeling of pain at all.

Excessive glossopharyngeal insufflation "is known to have caused various ailments, including, but not limited to, air in the arteries ([air embolism](#)), air between the lungs ([pneumomediastinum](#)), [pneumothorax](#), and lung bleeding. All of these ailments can be potentially fatal when insufficiently recognized and treated."^[5]

Blackout, [asystole](#) (stoppage of heart electrical activity), and increased serum myoglobin level (probable indication of heart muscle damage) have also occurred.^[6]

During ascent, blood shift back into the extremities from the thorax will always lag behind your ascent, so when you get close to the surface, the air in your lungs may be filling a smaller space than it did when you submerged. This may cause an increase in intrathoracic pressure relative to when your dive started. Lung packing would increase the risk of barotrauma in this situation.^[5]

It is impossible in many cases for the average person without constant access to sophisticated medical equipment to even know for sure if one of these injuries has occurred. The incidents below, which all occurred pursuant to medical studies on breath holding, illustrate this fact, as the overt symptoms were either nonexistent or passed quickly. The risk here is that in any normal freediving setting, those injuries may have gone completely undiagnosed and untreated.

The long term risks of glossopharyngeal insufflation are unknown.

Incidents

1. Case Report - [Pneumomediastinum after lung packing](#)^[7]
2. Case Report - [Suspected Arterial Gas Embolism After Glossopharyngeal Insufflation in a Breath-Hold Diver](#)^[8]
3. Case Report - [Asystole and increased serum myoglobin levels associated with 'packing blackout' in a competitive breath-hold diver](#)^[6]

Low-risk applications of packing (my opinion)

1. Compensating for a tight wetsuit in order to attain a full breath.
2. Compensating for different inhalation volumes for a particular starting position, i.e face up, upright, or face down start position in static apnea, in order to attain a full breath. For me, it takes about 7 packs above a full breath when starting from an upright position in order to get the same breath I get normally when starting from a face-up position.
3. Packing from anything less than a full breath in order to attain a full breath.

Glossopharyngeal exsufflation

also known as **reverse packing**

Glossopharyngeal exsufflation^[2] has been used by freedivers as a means to improve chest and diaphragm flexibility in order to reduce lung residual volume. It has also been used by freedivers at depth to retrieve air from their lungs to aid in the equalization of their sinuses and ears. This process has no medical application I can find.

The process of glossopharyngeal [exsufflation](#) can be done in the following ways:

1. With the mouth closed, the nose or soft palate closed, and the glottis open, lower the tongue and jaw, drawing air up from the lungs into the mouth. Close the glottis, and then raise the jaw and tongue, squeeze the cheeks together, and allow the air to escape from the lips.
2. There is a second method which is slower and moves much less air, probably about 20% of the volume and speed of the first method. In this method, the jaw remains shut the whole time. The tongue is sealed against the roof of the mouth and used as a piston to draw air out of the lungs and then to expell the air out of the mouth.

Both of these methods can be repeated to achieve the desired effect.

The risks

Performing this process removes air from the lungs, decreasing infra-alveolar gas pressure relative to pulmonary blood pressure. When diving, this increases the risk of lung squeeze (pulmonary edema).^[2] This is especially a concern as the diver is probably already having trouble equalizing if reverse packing is being used, so reverse packing just compounds the diver's problems.

Using reverse packing to simulate depth in a pool carries possibly more risk of a lung squeeze than doing the actual depth in the ocean. It might take you a minute or more to get to 50 meters depth in the ocean, allowing the blood shift to keep up with your dive. In a 5 meter pool you can get to that simulated depth in a few seconds, inducing huge stresses in your chest, lungs, and diaphragm while the blood shift is catching up with what you are doing.

As to its risk as a training practice to reduce residual volume, your guess is as good as mine. There are no studies I could find on this subject. I will only say that, using method one, it is difficult to make small incremental changes in the amount you pack, as each reverse pack is a significant fraction of your residual volume. Method two is much more metered, but is also very slow by comparison. Use of either method requires extreme caution.

The long term risks of glossopharyngeal exsufflation are unknown.

Low-risk applications of reverse packing (my opinion)

none

Warning

It is important to note that glossopharyngeal insufflation and exsufflation both entail **serious risks**, so should only be attempted after proper training, with appropriate caution, and under the supervision of a physician or other appropriately trained individual.

Notes

* Just to clear up a bit of a biological misconception commonly found in freediving literature -

If you close your throat to hold your breath, the [epiglottis](#) is not what holds the air in your lungs. The epiglottis and the associated aryepiglottic folds at the entrance to the larynx serve only a swallowing function. The epiglottis is neither strong enough nor in the right position to hold the pressure of a breath hold. It is just a flexible, non-muscular flap of cartilage and tissue that folds over onto the rising larynx during swallowing to prevent solids and liquids from entering the airways.^[10]

There are two sphincters in the larynx that close to hold air inside the lungs - the ventricular folds (also called the superior or false vocal cords) and the true vocal cords (also called the inferior vocal cords). You feel these close whenever you cough, or strain during childbirth or defecation. When you close your throat off to hold your breath, that is what you are closing. In fact, holding air in the lungs when needed is the primary function of the ventricular folds. The [glottis](#) encompasses these vocal folds and the openings between

them.^[11]

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First published 6 April 2015

Revised on 12 and 14 April 2015

References

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