

EFFECTS OF GLOSSOPHARYNGEAL INSUFFLATION ON CARDIAC FUNCTION:

An Echocardiographic Study in Elite Breath-hold Divers

Potkin R, Siegel R, Cheng V. Beverly Hills Center for Hyperbaric
Medicine, Cedars-Sinai Medical Center and UCLA Department of
Medicine, Los Angeles, California

Background

- Breath-hold divers use a variety of techniques to increase lung volume beyond TLC to augment oxygen stores, increase intrathoracic gas for better pressure equalization and reduce chest compression allowing for free diving to greater depths.
- One technique used is glossopharyngeal insufflation also known as buccal pumping or lung packing.

Background

After maximal inspiration to TLC, the diver fills the mouth with air while the glottis remains closed, then opens the glottis and forces this air into the lung.

This results in an significant increase in lung volume above TLC and an increase in transpulmonary pressure.

Glossopharyngeal insufflation is associated with hemodynamic abnormalities

- decreased arterial blood pressure
- Increased heart rate
- decreased intrathoracic blood volume
- decreased cardiac size
- fall in stroke volume and LV performance
- light-headedness and even loss of consciousness

Glossopharyngeal Insufflation is associated with
pulmonary abnormalities

- Increased lung volumes
- Increased intrathoracic pressure
- Pneumomediastinum (case report)

METHODS

- To study the cardiac effects of GI, we performed transthoracic echocardiography using the subcostal window in 5 elite breath-hold divers.
- Blood pressure, heart rate and echocardiograms were obtained at rest and after 15 to 30 GI lasting up to 30 seconds.

Methods

- Two **asymptomatic** elite breath-hold divers underwent Chest CT scanning.
- Multiple images of the chest were obtained using a GE LightSpeed Plus helical multi channel scanner.
- Images were obtained at full inspiration in a pre-“packing” and post “packing” mode.

Table 1. Demographic data of the 5 divers studied

Characteristic	Diver 1	Diver 2	Diver 3	Diver 4	Diver 5
Sex	Male	Female	Male	Male	Male
Age (years)	28	32	35	37	54
Height (m)	1.78	1.70	1.91	1.83	1.75
Weight (kg)	75.0	59.1	88.6	84.1	83.2
BMI	23.7	20.4	24.3	25.1	27.2
Comorbidities	None	None	None	None	None
Resting Vital Capacity (L)	7.56	4.56	6.17	6.49	6.26
(% of predicted)*	155%	119%	115%	117%	149%
Insufflation Vital Capacity (L)	9.59	5.65	6.45	8.42	7.47
(% of predicted)*	197%	149%	121%	152%	178%
Insufflation Volume (L)	2.03	1.09	0.28	1.93	1.21

*Predicted vital capacities are from Knudsen

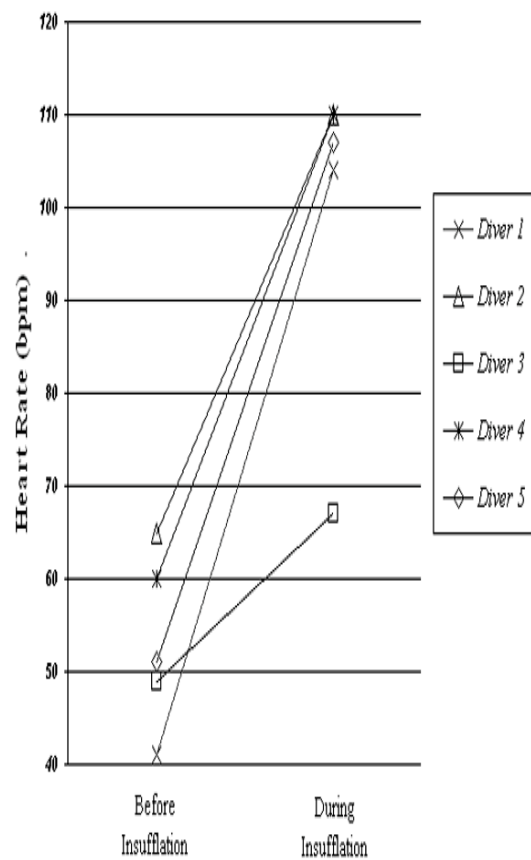
Parameter	At Rest		Insufflation		p-value	
Heart rate (beats per minute)	53 ±	9.4	100 ±	18.4	0.005	
Systolic blood pressure (mmHg)	112 ±	12.8	52 ±	8.4	0.002	
Diastolic blood pressure (mmHg)	75 ±	9.5	0 ±	0	<	0.001
<u>Left ventricular measures</u>						
End-diastolic area (cm ²)	29.1 ±	4.3	15.7 ±	3.6	<	0.001
End-diastolic volume (cm ³)	103.5 ±	23.8	30.7 ±	12.2	<	0.001
End-systolic area (cm ²)	17.0 ±	1.9	11.8 ±	3.8	0.005	
End-systolic volume (cm ³)	41.3 ±	11.1	21.8 ±	10.0	0.005	
Ejection fraction	0.60 ±	0.07	0.30 ±	0.16	0.012	

Right ventricular measures

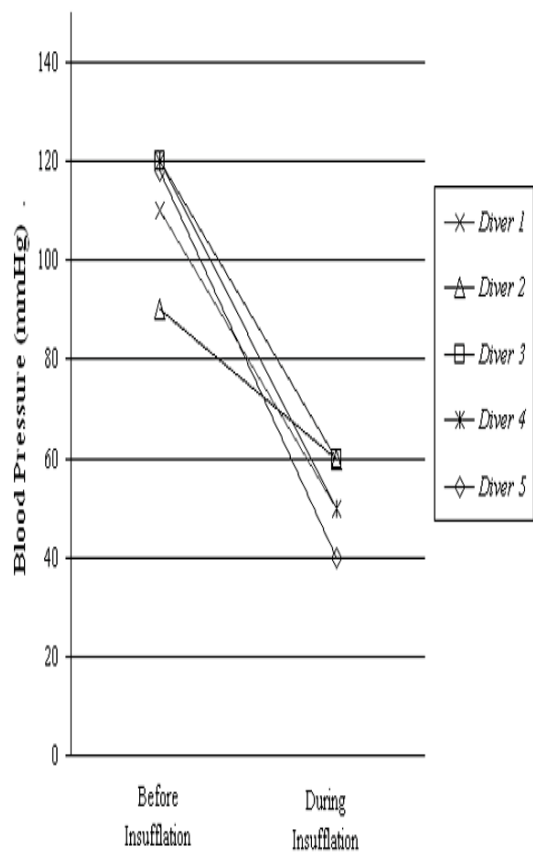
End-diastolic area (cm ²)	12.3 ± 4.6	18.3 ± 4.2	0.16
End-diastolic volume (cm ³)	20 ± 13.4	52 ± 19.7	0.078
End-systolic area (cm ²)	5.2 ± 2.8	14.0 ± 4.2	0.01
End-systolic volume (cm ³)	5.4 ± 4.4	30.7 ± 14.3	0.019
Ejection fraction	0.75 ± 0.11	0.39 ± 0.18	< 0.001

Values are means ± SD

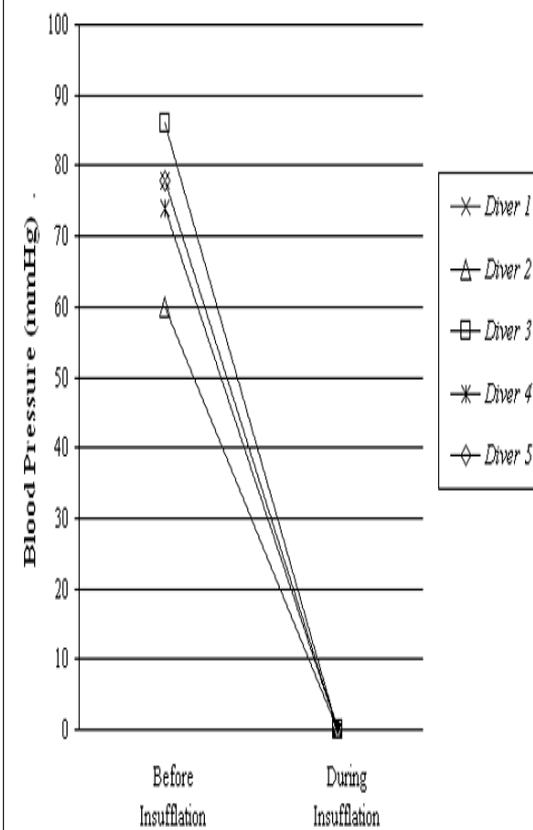
Heart Rate Before and During Glossopharyngeal Insufflation

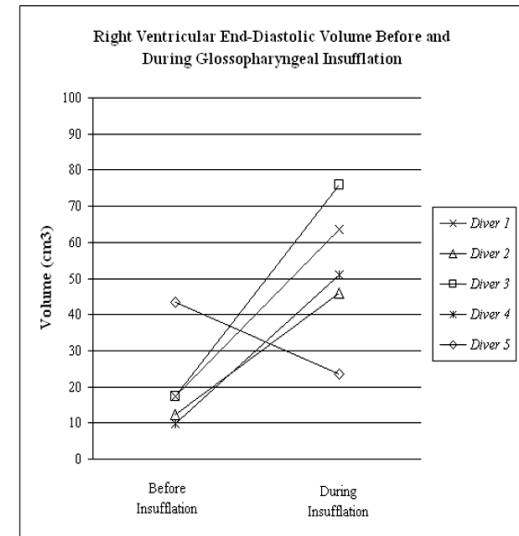
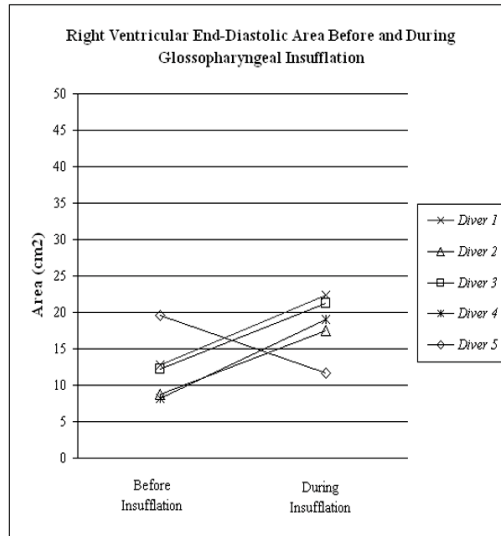
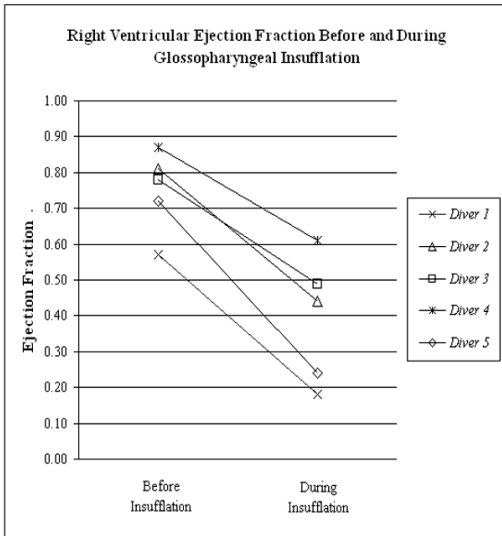
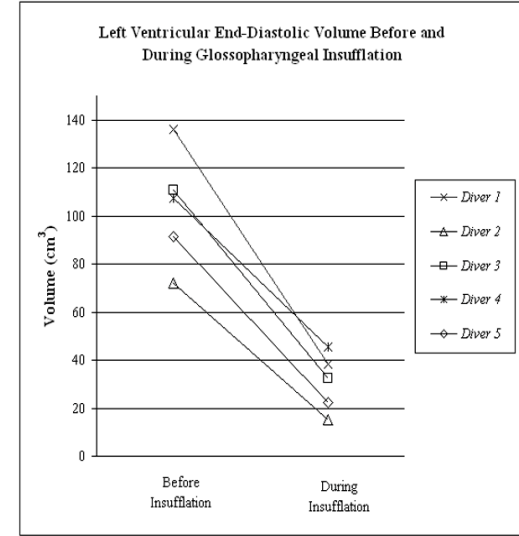
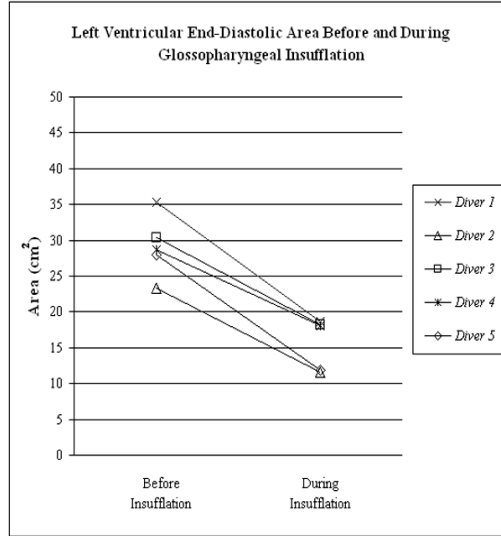
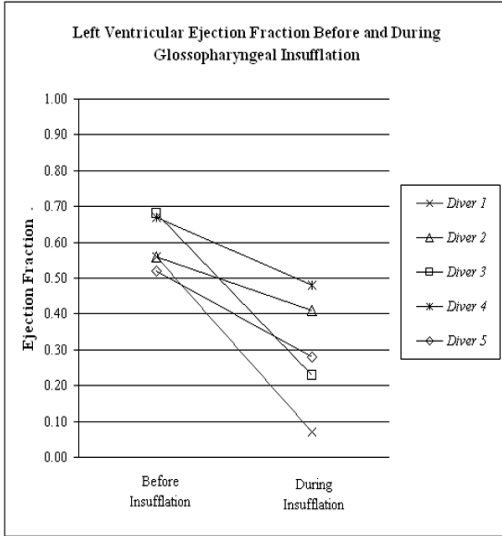


Systolic Blood Pressure Before and During Glossopharyngeal Insufflation



Diastolic Blood Pressure Before and During Glossopharyngeal Insufflation



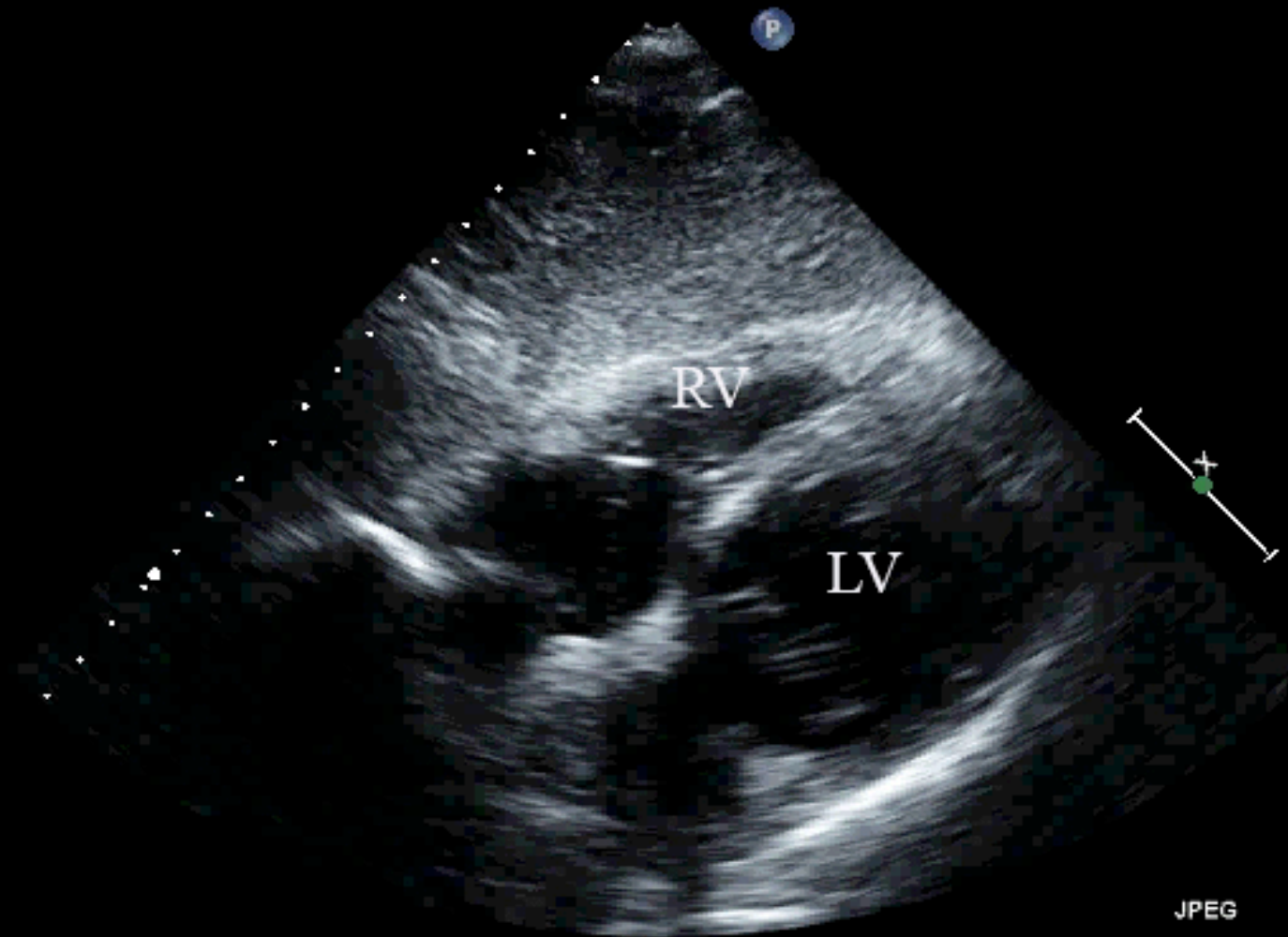


BEFORE GLOSSOPHARYNGEAL INSUFFLATION

FR 39Hz
19cm

2D
64%
C 50
P Low
HGen

M3



JPEG

48 bpm

FR 39Hz

19cm

2D

64%

C 50

P Low

HGen

DURING GLOSSOPHARYNGEAL INSUFFLATION

M3



P

RV

LV

JPEG

67 bpm

RESULTS

- Neither diver had prior pulmonary problems, symptoms or abnormalities on exam at the time of chest imaging.
- Previously measured lung volumes:
- Diver 1- pre packing VC 7.01 (L) post VC 10.3 (46%)
Diver 2- pre packing VC 5.73 (L) post VC 7.31 (31%)

CHEST CT SCANS IN BOTH DIVERS
DEMONSTRATED PNEUMOMEDIASTINUM

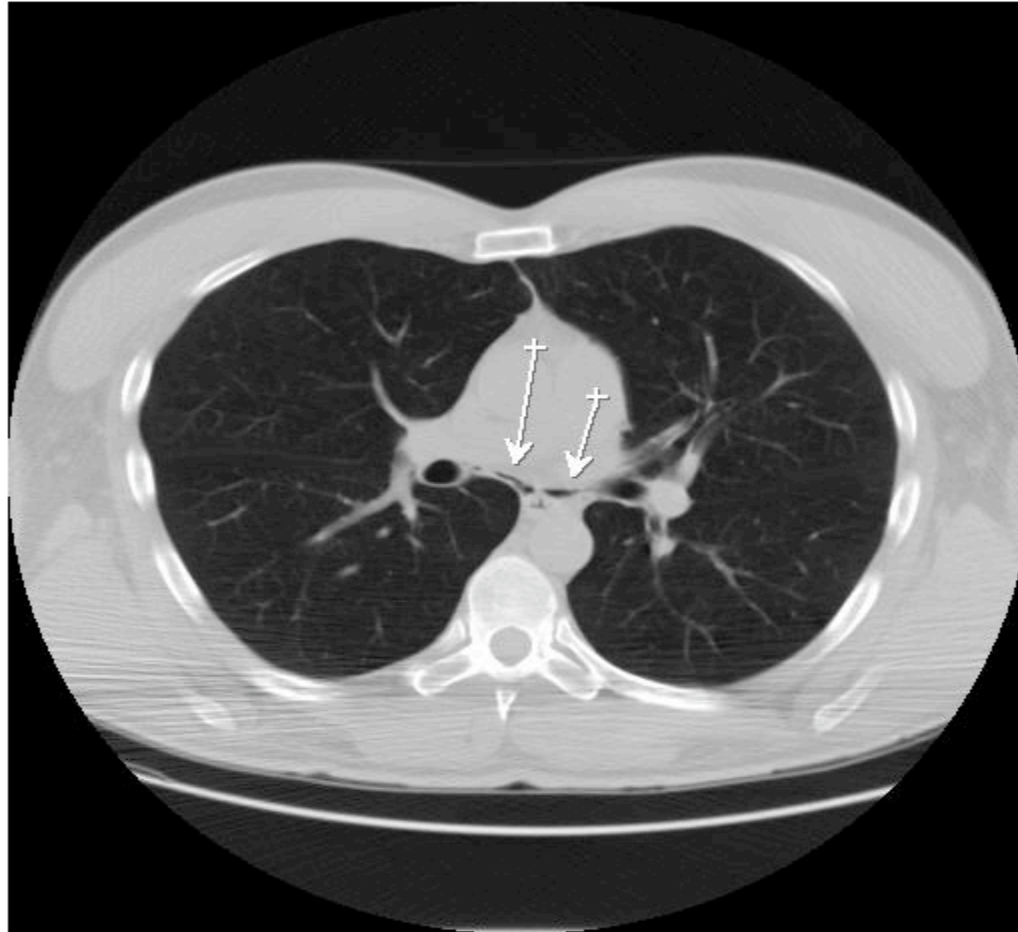
Pneumomediastinum Diver 1

arrows point to mediastinal air anterior to left mainstem bronchus



Pneumomediastinum Diver 2

arrows point to mediastinal air anterior to the esophagus



CONCLUSIONS

- Hypotension during GI is associated with acute biventricular systolic dysfunction.
- The echo pattern of right ventricular systolic dysfunction is consistent with acute pressure overload.
- Left ventricular systolic dysfunction is likely due to ventricular interdependence

CONCLUSIONS

- Glossopharyngeal Insufflation may induce pulmonary barotrauma as demonstrated by pneumomediastinum in asymptomatic breath-hold divers and could potentially result in air embolism. THE SAFETY OF THIS PRACTICE WARRANTS FURTHER INVESTIGATION.

