# Effect of Internal Jugular Vein Compression on Intracranial Hemorrhage in a Porcine Controlled Cortical Impact Model

Brian Sindelar MD; Julian E. Bailes MD
NorthShore Evanston Hospital

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## Introduction

Internal jugular vein (IJV) compression has been shown to reduce pathological markers of traumatic brain injury (TBI) in both pre-clinical and clinical models (6,10,11). However, this novel preventative approach to managing TBI raises concerns of worsening hemorrhage due to the resultant venous congestion. This study aims to test the hypothesis that IJV compression increases hemorrhage after controlled cortical impact (CCI) injury in the swine model.

## Methods

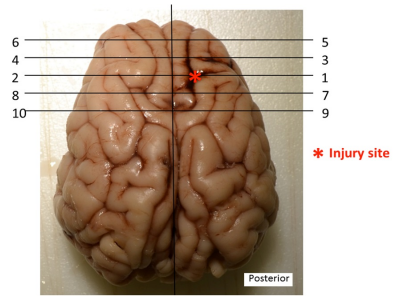
12 swine were randomized to placement of a bilateral IJV compression collar or no collar (control) prior to a right frontal CCI injury (5). Proper placement of the collar was determined by a left parietal ICP monitor. A histological grading of the extent of subarachnoid hemorrhage (SAH) and intraparenchymal hemorrhage (IPH) was performed in a blinded manner by two neuropathologists.

### Custom made IJV compression collar

### Histological sectioning:

The brain was sectioned into 10 pre-defined locations +bilateral thalami and stained by H&E. Frontal locations were chosen as to avoid iatrogenically induced hemorrhage from ICP monitor placement. Due to a more diffuse superficial hemorrhage (non spherical) seen grossly on a subset of animals, the standardized approach to volumetric measurements of injury was not feasible (1,2,4,7). Therefore a semi-quantitative scoring system for SAH and IPH was determined: 0-not present, 1-mild, 2-moderate, 3-severe.

### Location of Histological Sectioning



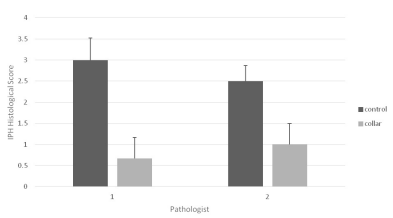

## Results

Following euthanasia five hours after injury, the collared (c) animals exhibited a significant reduction in total subarachnoid hemorrhage score from the control (uc) animals ( 1st pathologist, uc: 7.1 +/- 2.2 versus c: 3.4 +/- 2.0, p=0.026 and second pathologist, uc 12.0 +/- 3.0 versus c: 7.2 +/-3.0, p=0.024) and intra-parenchymal hemorrhage score (1st pathologist, uc: 3.0 1.3 versus c: 0.7 11.2, p=0.03 and second pathologist, uc: 2.5 +/- 0.9 versus c: 1.0 +/-1.2, p=0.05). There was no statistically significant difference in scoring for the other markers of TBI (APP, neuronal degeneration, cerebral edema, or inflammatory infiltration).

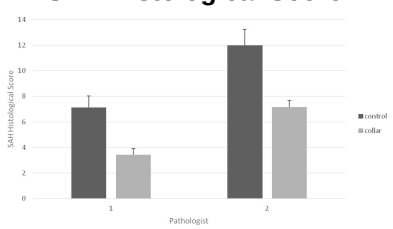
**Table 2: Control and Collared Swine Hemorrhage Histological Scoring**

| Pathologist | | Control n=6, mean +/-SD | Collared n=6 Mean +/-SD | P-Values |
|---|---|---|---|---|
| 1 | SAH | 7.1 +/- 2.2 | 3.4 +/-2.0 | 0.026 |
| 2 | SAH | 12.0 +/-3.0 | 7.2 +/-3.0 | 0.024 |
| 1 | IPH | 3.0 +/-1.3 | 0.7 +/-1.2 | 0.033 |
| 2 | IPH | 2.5 +/-0.9 | 1.0 +/-1.2 | 0.05 |

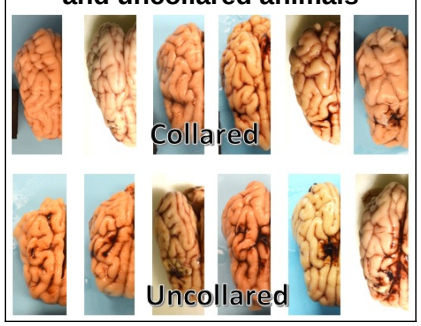
### IPH Score




### SAH Histological Score




### Gross hemorrhage in collared and uncollared animals




## Conclusions

-IJV compression did not increase the propensity for hemorrhagic extension but was actually shown to reduce hemorrhage

-This novel approach through venous engorgement and decreased brain compliance is intriguing in its capacity to address the multiple different mechanisms of TBI on a microscopic (diffuse axonal injury) and macroscopic (hemorrhage) level that lead to morbidity and mortality in all grades of TBI (3,8,9)

## References:

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