# Rethinking Autoregulation in Traumatic Brain Injury: A Majority of Patients with Disruptive Dynamic Autoregulation Do Not Respond to an Elevated Cerebral Perfusion Pressure 

Eric C. Peterson MD, MS; Kathleen Tozer MD; Wendy Cohen; Arthur M. Lam; Randall Matthew Chesnut MD

## Introduction

Based on dynamic testing, it has become widely accepted that cerebral pressure autoregulation (CPA) is often disrupted after severe traumatic brain injury (sTBI) and that cerebral perfusion pressure (CPP) augmentation is routinely indicated. However, static CPA (tonic CBF response to CPP augmentation) has not been systematically evaluated in such patients. We hypothesized that routinely determining the status of dynamic and static CPA in sTBI patients might be useful in individualizing CPP management.

## Methods

We conducted autoregulation testing on a consecutive series of severe TBI patients. Patients underwent dynamic testing with TCD (thigh-cuff method) and static autoregulation testing with CT perfusion and TCD methods. Static CPA testing was performed at a baseline CPP and then repeated at a CPP pharmacologically elevated by 20 mmHg . The two CTP blood flow maps or TCD MCA velocities were compared to assess the cerebrovascular response to the CPP challenge.


23 year-old with severe TBI. CT Perfusion shows unchanged perfusion after blood pressure augmentation, consistent with preserved static autoregulation. By TCD testing however, the patient had disrupted autoregulation.

## Results

Autoregulation testing was performed in 78 patients. $84.6 \%$ were performed in the first 48 hours, and $56.4 \%$ in the first 24 hours. Three patterns of CPA disruption emerged: intact static CPA but disrupted dynamic CPA (59\%), disrupted static and dynamic CPA (34\%), and intact static and dynamic CPA (7\%). The pattern of disrupted static and intact dynamic CPA was not seen.


Graphic summarizing the types of autoregulation disruption in patients tested with both static (via CT Perfusion) and dynamic (via TCD) methods. Note that the majority of the patients had disrupted autoregulation by dynamic testing with TCD (which is how most trauma centers measure autoregulation) yet had no response to blood pressure augmentation because their static autoregulation was intact (as measured by CTP).


29 year old with severe TBI. CT perfusion demonstrates marked increase in perfusion after blood pressure augmentation, consistent with disrupted static autoregulation.

## Conclusions

The results of routinely testing both dynamic and static CPA in the same patient suggests that these two methods are not interchangeable, and that dynamic CPA disruption is much more common than abnormal global static CPA. Since the CBF response to CPP augmentation depends on static CPA, static testing should specifically be done if desired to guide CPP manipulation. We hypothesize that the latency of the autoregulatory response (dynamic CPA) may be more sensitive to sTBI than the capacity of autoregulation to respond to changes in CPP (static CPA ).

## Learning Objectives

Role of autoregulation testing in traumatic brain injury

Lack of improved perfusion in patients with disrupted autoregulaiton

