BACKGROUND: Unvented chest seals (CSs) are currently recommended for the management of penetrating thoracic injuries in the battlefield. Since no supporting data exist, we compared the efficacy of a preferred unvented with that of a vented CS in a novel swine model of pneumothorax (PTx).

METHODS: An open chest wound was created in the left thorax of spontaneously air-breathing anesthetized pigs (n = 8). A CS was applied over the injury, then tension PTx was induced by incremental air injections (0.2 L) into the pleural cavity via a cannula that was also used to measure intrapleural pressure (IP). Both CS were tested on each pig in series. Tidal volume (V(T)), respiratory rate, IP, heart rate, mean arterial pressure, cardiac output, central venous pressure, pulmonary arterial pressure, venous and peripheral oxygen saturations (SvO2, SpO2) were recorded. Tension PTx was defined as a mean IP equal to or greater than +1 mm Hg plus significant (20-30%) deviation in baseline levels of the previously mentioned parameters and confirmed by chest x-ray study. PaO2 and PaCO2 were also measured.

RESULTS: PTx produced immediate breathing difficulty and significant rises in IP and pulmonary arterial pressure and falls in V(T), SpO2, and SvO2. Both CSs returned these parameters to near baseline within 5 minutes of application. After vented CS was applied, serial air injections up to 2 L resulted in no significant change in the previously mentioned parameters. After unvented CS application, progressive deterioration of all respiratory parameters and onset of tension PTx were observed in all subjects after approximately 1.4-L air injection.

CONCLUSION: Both vented and unvented CSs provided immediate improvements in breathing and blood oxygenation in our model of penetrating thoracic trauma. However, in the presence of ongoing intrapleural air accumulation, the unvented CS led to tension PTx, hypoxemia, and possible respiratory arrest, while the vented CS prevented these outcomes.