

Systemic Neutrophil Homeostasis Is Not Affected by Reaming Techniques for Intramedullary Nailing in a Standardized Porcine Polytrauma Model

Michel Teuben MD; Sascha Halvachizadeh MD; Yannik Kalbas MD; Zhi Qiao MD; Nikola Cesarovic DVM; Paolo Cinelli PhD; Roman Pfeifer MD; Hans-Christoph Pape MD; TREAT Research Group MD
University Hospital Zurich, Zurich, Switzerland

Purpose: Increased incidences of inflammatory complications have been found in polytrauma patients treated by intramedullary nailing (IMN). Dysregulation of polymorphonuclear neutrophils (PMNs) is believed to play an important role in the development of posttraumatic inflammatory complications. We hypothesized that polytrauma is associated with increased systemic neutrophil occurrence and activation. Secondly, we hypothesized that the systemic neutrophil response is affected by applied fracture fixation strategy.

Methods: A standardized experimental polytrauma (liver/thoracic trauma plus hypovolemic shock and a femur fracture) was induced in an acute model in pigs. Thereafter they were exposed to different protocols of IMN. One group underwent IMN without reaming, a group was treated with conventional reaming + IMN, and a group was composed of animals treated with reamed irrigation and aspiration (RIA) prior to nailing. Blood was collected at baseline, prior to fracture fixation and after 6 hours. Immune cells were isolated and studied by flowcytometry. Cell activation was determined by Mac-1/CD11b expression FcyRIII/CD16 and CXCR-4/CD184-receptor expression was measured to determine neutrophil mobilization.

Results: Mac-1 expression on blood PMNs instantly increased after polytrauma (62.3% rise [P = 0.01] versus 29.3% rise [P = 0.2] in sham group). No differences in systemic CD16 and CD184 expression levels on PMNs were seen between polytrauma and sham groups prior to surgical fracture fixation. Upon IMN, the percentage of PMNs in blood rose significantly from 43.2% to 71.0% (P <0.01), neutrophil CD16-expression dropped significantly (by 38.3%; P <0.01), and additional morphological analysis demonstrated increased appearance of banded neutrophils in circulation. After fracture fixation, systemic PMN-CD16 levels on blood neutrophils further decreased in all conditions, whereas CD11b remained unaltered. No differences between study groups were found.

Conclusion: This standardized porcine polytrauma study demonstrates that polytrauma evokes enhanced neutrophil appearance in blood, as well as increased integrin signaling on circulatory neutrophils. Furthermore, the utilized IMN technique (unreamed, reamed, or RIA) does not affect the systemic neutrophil response. The findings suggest that in polytrauma the initial insult dictates the systemic neutrophil response, rather than applied fracture fixation strategies.