LETTER

The effect of thoracic aortic balloon occlusion during hemorrhagic shock on spinal cord and visceral organ damage

Dear Editor,

Hemorrhage after injury is a frequent cause of death. Treatment of vascular trauma in certain anatomical regions is challenging due to the difficult access necessitating emergency operation. An alternative for massive bleeding control is the resuscitative endovascular balloon occlusion of the aorta. We conducted a study using two groups of six Yorkshire swine each in order to determine the minimum time required for aortal occlusion to restrict occurrence of ischemia while maintaining hemodynamic stability. Pigs were subjected to type IV hemorrhagic shock by exsanguination through the common femoral artery (CFA) whereas blood was collected in a transfusion bag. An aortic balloon was inflated close to the left subclavian artery, for a 30-minute-period, at a constant (group A) or an interrupted (group B) manner. Under general anesthesia, a 14F, sheath (Cook Medical Inc., Bloomington, USA) was inserted at the right CFA. Then a 0,035", guidewire (Terumo Medical Corp., Elkton, USA) and a stent-graft balloon 12F, 100 cm (Medtronic Inc., Minneapolis, MN, USA) were advanced at the first pig fluoroscopically. To achieve accurate placement of the materials (wire-balloon catheter) without fluoroscopy, they were placed externally on animal's body (top was placed at the top of the sternum and the remaining part extended down to the CFA). It was proved that the length of the materials beyond the CFA was the same as with the fluoroscopy and having measured the length needed to remain outside the sheath, we advanced them in each case accordingly. We measured potassium, sodium, creatinine, urea, creatine phosphokinase, serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvic transaminase, amylase, lactate dehydrogenase, phosphorus, and blood gases at t1 (initial), t2 (above the inflated balloon in 29th minute), t3 (below the inflated balloon in 29th minute), t4 [five minutes after balloon's decompression in 30th minute], and t5 (24 hours post procedure). Seven minutes after decompression each pig was transfused with the previously collected amount of blood.

During occlusion, all pigs survived. At the end of the experiment, all pigs of group B and five out of six of group A survived. All pigs presented paraplegia. Mann-Whitney testing for renal, liver, and intestinal function recorded a significant difference for potassium ($p = 0.017$) at t4, for SGOT ($p = 0.017$) and phosphorus ($p = 0.049$) at t1. Wilcoxon testing indicated that group B presented the fewest deviations in the particular time periods, while the acid-base homeostasis of group A presented the fewest deviations in the particular time periods. Group B prevailed in pCO_2 levels. In all pigs, an increase of blood pressure (BP) was recorded right after balloon's inflation. Histological examination revealed that the extent of necrosis was smaller in group B.

Our finding are in accordance to White et al regarding the improvement of BP, but they had a lower rate of paraplegia[1]. Morrison et al reported an increase in the concentration of interleukin in the group with the longer occlusion, fact that justifies the appearance of a higher percentage of ischemia in group A[2].

In conclusion, endovascular occlusion close to the left subclavian artery without fluoroscopy is feasible, and can temporarily control hemorrhagic shock. An occlusion at an interrupted manner causes less damage to the visceral organs, as well as in pCO_2 levels. However, it does not protect the spinal cord from ischemia and the appearance of paraplegia.

References

1. White JM, Cannon JW, Stannard A, Markov NP, Spencer JR, Rasmussen TE. Endovascular balloon occlusion of the aorta is superior to resuscitative thoracotomy with aortic clamping in a porcine model of hemorrhagic shock. Surgery. 2011; 150: 400-409.
2. Morrison JJ, Ross JD, Markov NP, Scott DJ, Spencer JR, Rasmussen TE. The inflammatory sequelae of aortic balloon occlusion in hemorrhagic shock. J Surg Res. 2014; 191: 423-431.

Conflict of interest

None.

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