# Expandable Nanofiber Foams for Management of Junctional Hemorrhage

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**Statement of Purpose:** In modern warfare the time required for extrication of a wounded warfighter from the battlefield with transport to a hospital can extend to 6 h or longer.[1] Under these conditions, effective therapies are urgently needed to stabilize patients with marginally compressible junctional hemorrhage long enough to get them to the hospital alive; implementation of such therapies should improve outcomes from potentially survivable traumatic injury. We aim to develop efficacious therapies for these difficult hemorrhagic scenarios; these therapies would be intended for the prehospital setting to stabilize patients with potentially survivable traumatic injury.

**Methods:** Electrospun PCL nanofiber mats were fabricated following our previous studies.[1] Two grams PCL beads were dissolved in 20 ml DCM and DMF mixed solvent at a ratio of 4:1 (v/v). After PCL solution was transparent, 50 ml PCL solution was pumped at a flow rate of 0.7 ml/h using a syringe pump while a potential of 18 kV was applied between the spinneret and a grounded collector. Around 1 mm thick aligned PCL nanofiber mat was collected. PCL nanofiber mats were cut into small rectangular pieces (1 cm × 1 cm × 1 mm) in liquid nitrogen. Those small pieces were subsequently immersed in 1 M $NaBH_4$ solution, which was gently shaken for 24 h. After expansion, the PCL nanofiber peanuts were transferred into distilled water and exposed to a vacuum for 10 s, repeated this process for 3 times. Finally, distilled water was removed, and the PCL nanofiber peanuts were exposed to a vacuum until it froze then freeze dried. Then the PCL nanofiber peanuts were coated with 0.5% gelatin.

**Results:** We tested the capability of blood absorption for nanofiber peanuts.[1] Figure 1a shows the photographs of different hemostatic materials before and after blood absorption. The color of blood could remain the same after absorption for Gauze, Gelfoam®, and 0.5% gelatin-coated nanofiber peanuts. However, the blood absorbed on the Surgicel® gave rise to black color. Similarly, nanofiber peanuts showed the highest blood absorption among the tested hemostatic materials (Figure 1b). Nanofiber peanuts with thrombin immobilization and Surgicel® displayed the best and comparable whole blood clotting efficacy and hemoglobin binding efficiency among the tested materials (Figure 1c and 1d).

**Conclusions:** We have developed a novel means to generate injectable and shape re-expandable nanofiber peanuts for junctional hemorrhage control.[1,2]

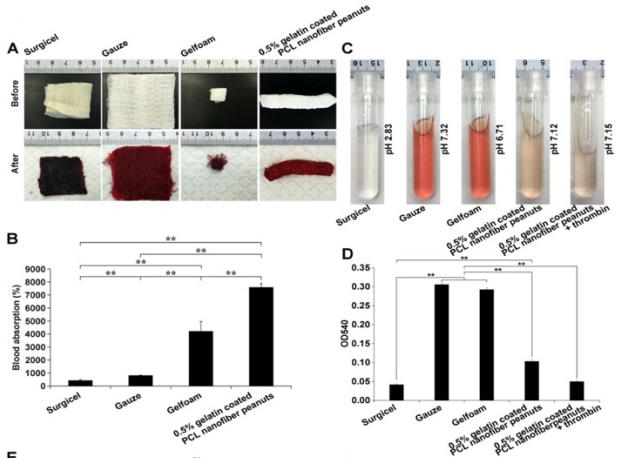


**Figure 1.** *In vitro* hemostatic efficacy test. (A) Photographs showing the hemostatic materials before and after blood absorption. (B) The blood absorption of 0.5% gelatin-coated PCL nanofiber peanuts, commercial Gauze, Gelfoam®, and Surgicel®. $^{**}p < 0.01$. (C) The whole blood clotting assay of Surgicel®, Gauze, Gelfoam®, 0.5% gelatin coated PCL nanofiber peanuts, and thrombin-immobilized, 0.5% gelatin coated PCL nanofiber peanuts and the pH value of each group after whole blood clotting assay. (D) The hemoglobin binding efficiency of Surgicel®, Gauze, Gelfoam®, 0.5% gelatin coated PCL nanofiber peanuts, and thrombin-immobilized, 0.5% gelatin coated PCL nanofiber peanuts. $^{*}p < 0.05$, $^{**}p < 0.01$.

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**References:** 1) Chen S. *et al. Biomaterials* **2018**, 179, 46.; 2) McCarthy A. *et al. Nano Select* **2021**, doi: 10.1002/nano.202000284.