Dynamics of fibroblastic sleeve formation on port-catheters: An experimental study on pigs

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Introduction:

The fibroblastic sleeve (FS) is a frequently described cause of long-term central venous catheter dysfunction. According to the available literature, histologically it is a layer of connective tissue that forms around intravenous catheters as a foreign body reaction by the organism. Although fibrin and thrombus deposit on the catheter in the early stages, a mature sleeve is a structured tissue composed primarily of collagen, fibroblasts, and smooth muscle cells, covered by a layer of endothelium. The pig model represents an accepted large-animal model for cardiovascular processes and pathologies similar to those in human.

Material and Methods:

Five domestic female pigs were used for the study. A 5-F polyurethane port catheter (Dignity, Medcomp) was inserted under general anesthesia via the jugular and femoral veins with ultrasound navigation. The port catheters were introduced through the jugular veins, and the tip position was checked by iECG. The remaining catheters were introduced via the femoral veins and secured in the subcutaneous tissue. The animals were sacrificed in 24 hours, 7 days, 14 days, 1 month, and 3 months after implantation. Samples of the catheter and adjacent venous walls were collected for light and electron microscopy.

Results:

A total of 10 port catheters with chambers were inserted via the jugular veins, and 9 catheters were inserted via the femoral veins. Histological changes observed in the tissue specimens:

After 24 hours: A blood coagulum, including fibrin, was present on the catheter surface. The venous wall showed no significant changes (Fig 1).

After 1 week: The blood coagulum was infiltrated by inflammatory cells, predominantly neutrophils. In some cases, the venous wall also exhibited inflammatory changes with mild thickening (Fig. 2).

After 14 days: The catheter was surrounded by tissue still containing numerous immune cells, fibroblasts and smooth muscle cells. In three cases, significant thickening of the venous wall occurred (Fig. 3).

After 1 month: A sleeve of fibrous character had formed around some catheters. In certain segments, we noted a change in the venous endothelium (Fig. 4).

After 3 months: A fibroblastic sleeve was fully formed around the catheters. Angiogenesis (black arrow) was evident within the fibroblastic sheath (Fig. 5).

Conclusion:

The catheters were surrounded by a discontinuous layer of acellular material infiltrated by immune cells over time, forming an interstitial-like tissue with angiogenesis by the end of monitoring time. Our findings implicate the need for catheter surface enhancement to suppress these changes.

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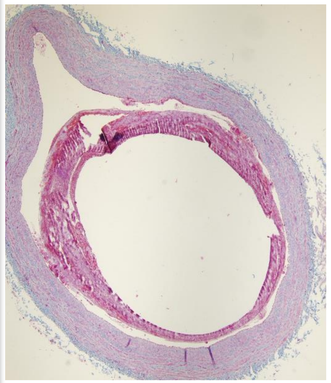

Fig. 1 Histological findings after 24 hours

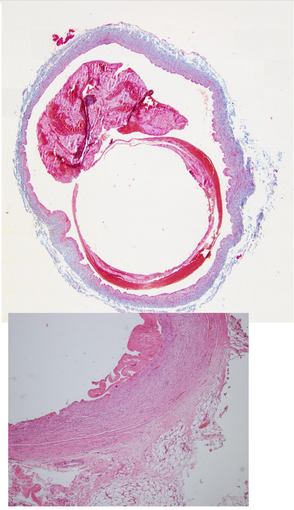

Fig. 2A,B. Histological findings after 1 week.

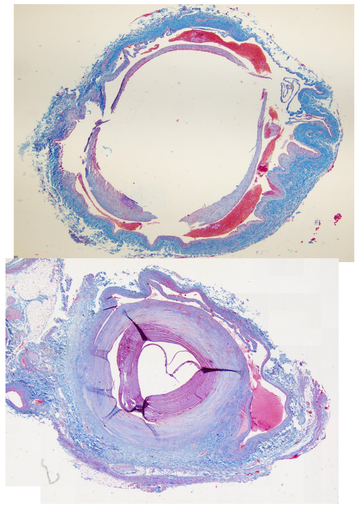

Fig. 3A, B. Histological findings afters 2 weeks.

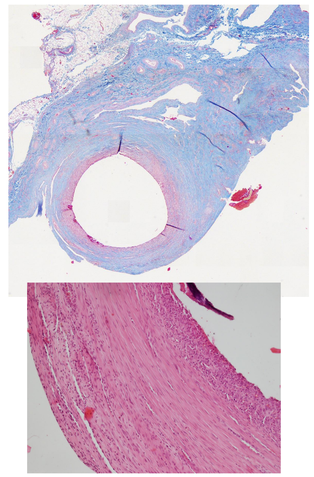

Fig. 4 A,B. Histological findings after 1 month.

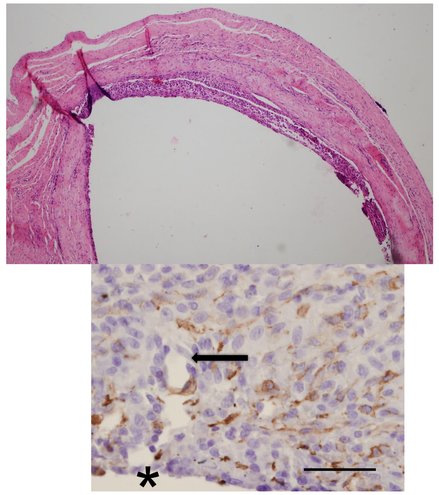

Fig. 5A,B. Histological findings after 3 months.