Microenvironment modulation of chronic wounds influenced by the collagen wound dressing Suprasorb®C - effect on platelet-derived growth factor and coagulation factor XIII

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Introduction

Non-healing wounds show a lack of essential growth factors [1], e.g. the platelet-derived growth factor (PDGF) and the coagulation Factor XIII. This is due to increased proteolytic degradation by proteases. Because of the imbalance between degradation and remodeling processes, chronic wounds persist in the inflammatory phase of the normal healing process and often remain non-healing for months or even years. It was shown that topical application of factor XIII could accelerate the healing rate of venous leg ulcers [2]. In order to support the normal wound healing process, an efficient protection of growth factors, especially of factor XIII, is required. Within the presented study we investigated the ability of Suprasorb® C (a special wound dressing composed of collagen type I) to protect PDGF-BB and factor XIII from proteolytic degradation.

Material and methods

Suprasorb® C was obtained from Lohmann & Rauscher GmbH & Co. KG, Rengsdorf, Germany. A combination of oxidized regenerated cellulose (ORC) and bovine collagen as well as bacterial cellulose and a control group (sample without any material) were included in the study as reference material. Wound dressings were cut into pieces by means of punch biopsies (8 mm diameter, corresponding to 0.5 cm^2). Each specimen was taken in a final volume of 1 mL of either PDGF BB (500 pg/mL) or factor XIII solution (human plasma 1:10 diluted). Samples were incubated up to 2 h at 37°C on a plate mixer. After incubation samples were collected, immediately frozen and stored at -20 °C until testing. The concentration of unbound PDGF BB could be determined by means of an ELISA (R&D). The quantification of factor XIII was carried out by means of the Berichrom Assay (Dade Behring). After incubation wound dressings were washed for 1 h with 1 M NaCl at 37°C on a plate mixer to recover bound growth factors. A 0.5 mU/mL plasmin solution was used to simulate chronic wound fluid.

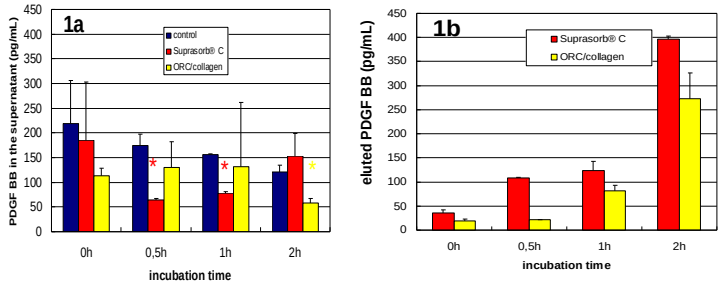

fig 1a: Binding of PDGF BB by Suprasorb® C (red bars) and ORC/collagen (yellow bars). fig 1b: Eluted PDGF BB from the wound dressing.

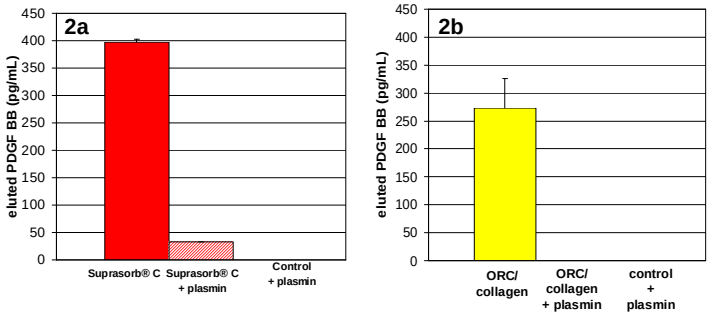

fig 2: Recovered PDGF BB after 2h from Suprasorb® C (a) and ORC/collagen (b) in the absence and presence of plasmin

Results

Suprasorb® C is able to bind growth factors. Compared to reference and control samples, after 30 minutes of incubation, a significant ($p<0,05$) decrease of the PDGF-BB concentration could be found out (fig. 1a). PDGF BB could completely be recovered from Suprasorb® C (fig. 1b). In the presence of plasmin, a characteristic component of chronic wound fluids, the elution rate was only about 10 percent (fig. 2a). However, the ORC/collagen dressing did not release PDGF BB in the presence of plasmin (fig. 2b). Additionally, Suprasorb® C binds significant quantities of factor XIII (fig. 3a), which can be recovered (fig. 3b).

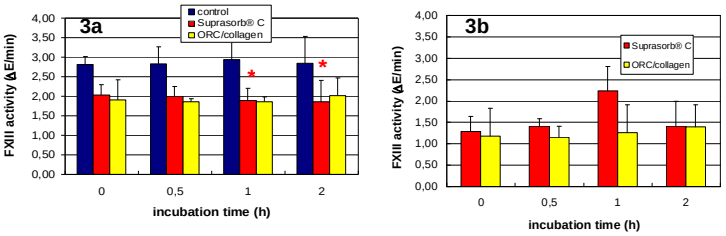

fig 3a: Binding of faktor XIII by Suprasorb® C (red bars) and ORC/collagen (yellow bars). fig 3b: Eluted factor XIII activity from the wound dressing.

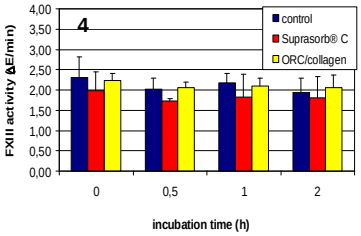

fig. 4: Binding of factor XIII by Suprasorb® C and ORC/collagen in the presence of 0.5 mU/mL plasmin.

As shown in fig. 4, factor XIII showed only a minor susceptibility to proteolytic degradation by plasmin.

Discussion

Because of its porous structure (fig. 5), collagen has a considerable capillary activity and is able to absorb large quantities of fluid [3]. As our data confirm, Suprasorb® C absorbs not only fluids, but can also bind the platelet-derived growth factor BB as well as the coagulation factor XIII and release them successively into the wound fluid. Due to the binding, PDGF BB was partly protected from proteolytic degradation. Despite the result that factor XIII was not degraded by plasmin, we assume that factor XIII could also be protected from destruction by other proteases. Consequently, the binding of growth factors would retain them in the wound fluid. So it could so be beneficial in wound healing disorders.

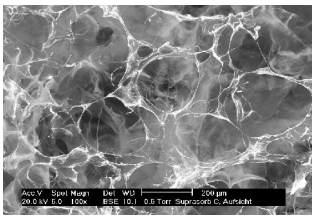

fig. 5: Scanning electron micrograph of Suprasorb® C

References

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