Restorative properties of a new tissue glue in meniscal lesion treatment

Supervision: René van Donkelaar

ABSTRACT

Meniscus lesions occur frequently as a result of recreational or professional sporting activity (Frizziero et al. 2012). Often surgical treatment is required because of the low self-reparability due to the low vascularization of the tissue (de Albornoz & Forriol 2012). Circumferential tears occur in the direction of the natural collagen reinforcement of the meniscus, and are commonly repaired by suturing (Thoreux et al. 2006). The main shortcomings of suturing are the creation of new holes in the tissue for the suture thread, and only partial closing of the lesion. It would be beneficial to develop a biomaterial that can not only restore strength to the tear region but also to promote biological repair and regeneration.

In this study, a new treatment using a tissue glue consisting of a novel isocyanate-terminated block copolymers based on trimethylene carbonate (TMC) is tested on strips of meniscal tissue with an induced lesion. This treatment is compared to the native tissue, and to lesions repaired with the golden standard of suturing, fibrin glue and Dermabond® glue. The techniques are analysed on type of failure, force and strain at failure, stiffness restoration, lesion opening and occurrence of local peak strains.

The physiological strain rate of a human meniscus is estimated to be 12% strain in axial and radial direction (Tissakht & Ahmed 1995). It is found that some lesions repaired with the TMC glue fail before this strain is reached, and the glue is therefore deemed insufficient to function under physiological conditions. The samples with lesions repaired with Dermabond® were found to withstand the highest stresses and strain, and the sutured tissue was found to have the highest occurrence of peak strains. The stiffness of the samples did not significantly differ between the native-, suture repaired-, Dermabond® glue- or TMC glue group. Reopening of the lesions was seen either suddenly after glue-tissue interface failure in the Dermabond® glue group or gradually after glue-glue failure in the fibrin glue group.

Though Dermabond® outperformed the TMC glue in maximum stress and maximum strain, it is not a viable option for meniscal lesion treatment because of its cytotoxicity. It can be concluded that meniscal lesions repaired with TMC glue in the manner as done in this research are not guaranteed to hold under physiological strain. Nonetheless, the lower prevalence of local peak strain in TMC repaired tissue compared to the golden standard of suturing indicates a lower risk of additional damage of the tissue surrounding the repaired lesion. Therefore, tissue glue would be a promising alternative to the suturing in the treatment of meniscal lesions, if the glue is able to function under physiological strains and is non-cytotoxic.