A MIXTURE OF HYALURONIC ACID AND PHOSPHOLIPID PREVENTS POSTOPERATIVE ADHESION FORMATION ON FLEXOR TENDON

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Introduction: Complications relating to the clinical management of flexor tendon injuries within zone 2 are known to be common. The effectiveness of exogenous administration of hyaluronic acid (HA) in the flexor tendon on reduction of postoperative adhesions has been reported (1), though this effect is as yet inconclusive. In contrast, there have been some negative reports regarding the effects of HA (2). Dipalmitoyl phosphatidylcholine (DPPC) is a highly surface-active polar lipid and the most abundant type of phospholipid in synovial fluid (3) and it has been implicated in previous studies as a potential boundary lubricant for synovial joints. We added DPPC into the HA solution in order to improve the protective effect against postoperative adhesion on flexor tendon.

Methods: These experiments were reviewed the Committee on the Ethics of Animal Experiments in Graduate School of Medical Sciences, Kyushu University, and concluded under the Guidelines for Animal Experiments in the Graduate School of Medical Sciences, Kyushu University, and the Law (No.105) and Notification (No.6) of the Government. Japanese white rabbits weighing 3.0 to 4.0 kg were used. Four procedures, namely injury to the tendon, tendon sheath and gliding floor, and cast immobilization, were used as the standard adhesion model. A proximal tenotomy of both flexor tendons was performed above the ankle. The third digit in each hindpaw was opened by means of a longitudinal plantar incision and the flexor tendon sheath was incised longitudinally over the middle phalanx with pulleys left intact. The flexor digitorum superficialis tendon was resected and the medial half of the FDF tendon was severed. The excursion surface of the middle phalanx was scratched with a scalpel. The tendon sheath was closed with 7-0 nylon. Then 0.3ml of saline (saline group, n=9), HA (HA group, n=9) or the mixture of DPPC plus HA (PHA group, n=9), in 0.3ml of saline, were injected into the left third tendon sheath (HA and DPPC was provided by Seikagaku corporation, Tokyo, Japan). Nothing was injected into the right tendon sheath. The ankle was mobilized and the metatarso-phalangeal (MTP) joints, the proximal interphalangeal (PIP) joints and the distal interphalangeal (DIP) joints were immobilized in full extension by the plastic cast. Three weeks after the tenotomy, the rabbits were sacrificed by an overdose of pentobarbital sodium. The skin was removed, and all structures of the third digit were divided at the level of the metatarsal. Then the work (W) that was expended to tear off the adhesion were examined using the testing device. The specimen was mounted on the testing device (Fig.1). The PIP joint was fixed at 90 degree of flexion and the MTP joint at a neutral position. The distal phalanx was pulled in a distal direction in order not to alter these angles. The proximal end of the FDF was clamped and connected to a copper plate, on which strain gauges were placed. An actuator provided 12mm of transfer to the copper plate at a speed of 1mm/second. Then the tendon was moved toward the direction of flexion, and its tensile load was stored in a personal computer at a sampling rate of 100Hz.

The measurement was repeated twice. The integrated area of the first measurement minus the second measurement represents the work that was expended to tear off the adhesion, since the second measurement represents the resistance that was required to flex the DIP joint. The value was used for a quantitative comparison of adhesion.

Results: There was no significant difference in W of the right digit between saline, HA and PHA group (Fig.2). As for the left digit, there was a significant difference only between the saline group and the PHA group. In the saline group, there was no significant difference between the right digit and the left digit (p = 0.998). In the HA group, however, there was a tendency for W to be smaller in the left digit, but not significantly so (p = 0.171), whereas in the PHA group, there was a significant difference between the two (p = 0.027).

Discussion: The adhesion model which we created was successful, since there was no significant difference among W in the right digit groups. A tendency to reduce adhesion was found by the administration of HA alone, but the findings were not significant. We showed that the mixture of DPPC plus HA reduced adhesion formation significantly in an animal model. We were unable to show how the mixture of DPPC plus HA affects adhesion, although we presume that one of the reason depends upon the structural role of DPPC. Considering DPPC and HA as a barrier to prevent adhesion formation, HA only exists between surfaces, whereas DPPC adsorbs on surfaces to form a boundary-lubricating membrane. The two different barriers may synergistically prevent adhesion. Further studies with regard to its functional role should be carried out to clarify the detailed role of DPPC on tendon cells and the synovial membrane.

Reference

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