EFFECT OF HYALURONIC ACID GEL SHEET AS A BIORESORBABLE BARRIER ON ADHESION PREVENTION

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[Introduction] Adhesion formation, that is, the development of abnormal attachments between tissues and organs, is a generalized phenomenon which occurs in response to surgery or trauma. Adhesion is a major problem in the field of orthopaedics because it often causes impairment of joint motion and tendon sliding. Functional disorder leads directly to the poor results of surgery in the field of orthopaedics, and for this reason, several approaches have been attempted in an effort to reduce adhesion formation. As well as improvement in surgical techniques, applying adjuvant, biochemical agents or a barrier in order to separate the traumatized surfaces, is a major strategy for adhesion prevention. Numerous materials have been widely studied, however, few are in common use. Hyaluronic acid (HA) has been examined both as a biological gel and a physiological barrier to prevent adhesion, and the effectiveness of exogenous administration of sodium HA for adhesion prevention in the case of flexor tendons has been demonstrated in many studies. However, it is difficult to retain the sodium HA as a physiological barrier at the traumatized surfaces in the joint cavity for periods of up to a few weeks after adhesion formation. Recently, hyaluronic acid-carboxymethylcellulose (HA-CMC) combined into a resorbable membrane has been used in the fields of gynecological surgery or abdominal surgery and a reduction in adhesion formation has been shown in some clinical studies in those fields. HA-CMC is a non-toxic, non-immunogenic and biocompatible hydrophobic gel, but it contains carbodiimide as a chemical reagent and is thus not the same as naturally occurring HA. Now, a new product, HA gel sheet, has been developed, which is obtained from HA solution and which is composed of HA alone. The aim of this study is to examine the effectiveness of these materials in preventing adhesion in vivo. For this purpose, the biomechanical and histological characterizations of adhesion were evaluated in a rabbit knee model.

[Materials & Methods] Thirty Japanese white male rabbits were operated to produce an intraarticular adhesion model as follows. Under general anesthesia, the left knee was opened up through a medial parapatellar approach, and decortications in the medial and lateral sides of the femoral condyle, abrasion around the suprapatellar pouch using a dental bar and knee immobilization at 90 degrees of flexion using an external fixator were produced as the adhesion formation protocol. For adhesion prevention, HA gel sheets (obtained from DENKI KAGAKU KOGYO K.K., Tokyo, Japan, HA group, n=10) or HA-CMC (SeprafilmTM, CMC group, n=10) were placed on both the decortication areas and the suprapatellar pouch in twenty rabbits. No treatment for adhesion prevention was given for the remaining 10 rabbits (adhesion group, n=10). As a sham operation, only excision and immobilization of the knee joint were undertaken in another 10 rabbits (sham group, n=10). Finally, 40 rabbits of similar weight (about 3.5 kg) were used in this study. Animals were sacrificed four weeks after the operation. All 40 knees were isolated by dissecting the soft tissue except for that around the knee joint and then they were removed by cutting the femoral and tibial shaft with a reciprocating saw, and the external fixator was gently removed. Care was taken that the knee joints were fixed at 90 degrees of flexion through out these procedures so as not to extend until the time of biomechanical measurements. Five specimens of each group were mounted on the testing device to measure the work required to extend the knee joint from 90 degrees of flexion to full extension. The measurement was repeated twice and the difference between the two sets of measurement data was evaluated as the work required to tear off the adhesion. The remaining 5 specimens of each group were prepared for histological evaluation.

[Results] The representative measurement data of the adhesion group are shown in Figure 1. Adhesion formation was successful in the present model and a quantitative comparison of adhesion using the work needed to tear off the adhesion, which is represented by the slanted line area in Figure 1, is shown in Figure 2. The HA group revealed that little work was required, as was also found with the sham group, and there were significant differences between the HA group and the CMC group or adhesion group.

[Discussion] The adhesion model used in the present study was successful; decortication in the femoral condyles, abrasion around the suprapatellar pouch and immobilization for 4 weeks all contributed to adhesion formation because the adhesion group required more work to extend the knee joint than the sham group, which indicates that the sham operation alone failed to successfully result in adhesion formation. The slanted line area in Figure 2 represents the work required to tear off the adhesion; all of the specimens in the groups required less work to extend the knee joint in the second measurement than in the first measurement, and so it would seem that the adhesion was torn off by manipulation during the first measurement. The work required in the HA group was significantly less than in both the adhesion group and the CMC group, but there was no significant difference between the HA group and the sham group. Therefore, it can be said that the HA gel sheet effectively reduced intraarticular adhesion formation in the animal model. This study showed the effectiveness of HA gel sheets in reducing adhesion formation, and accordingly the usage of HA gel sheets for the prevention of postoperative adhesion can be expected in all surgical fields.