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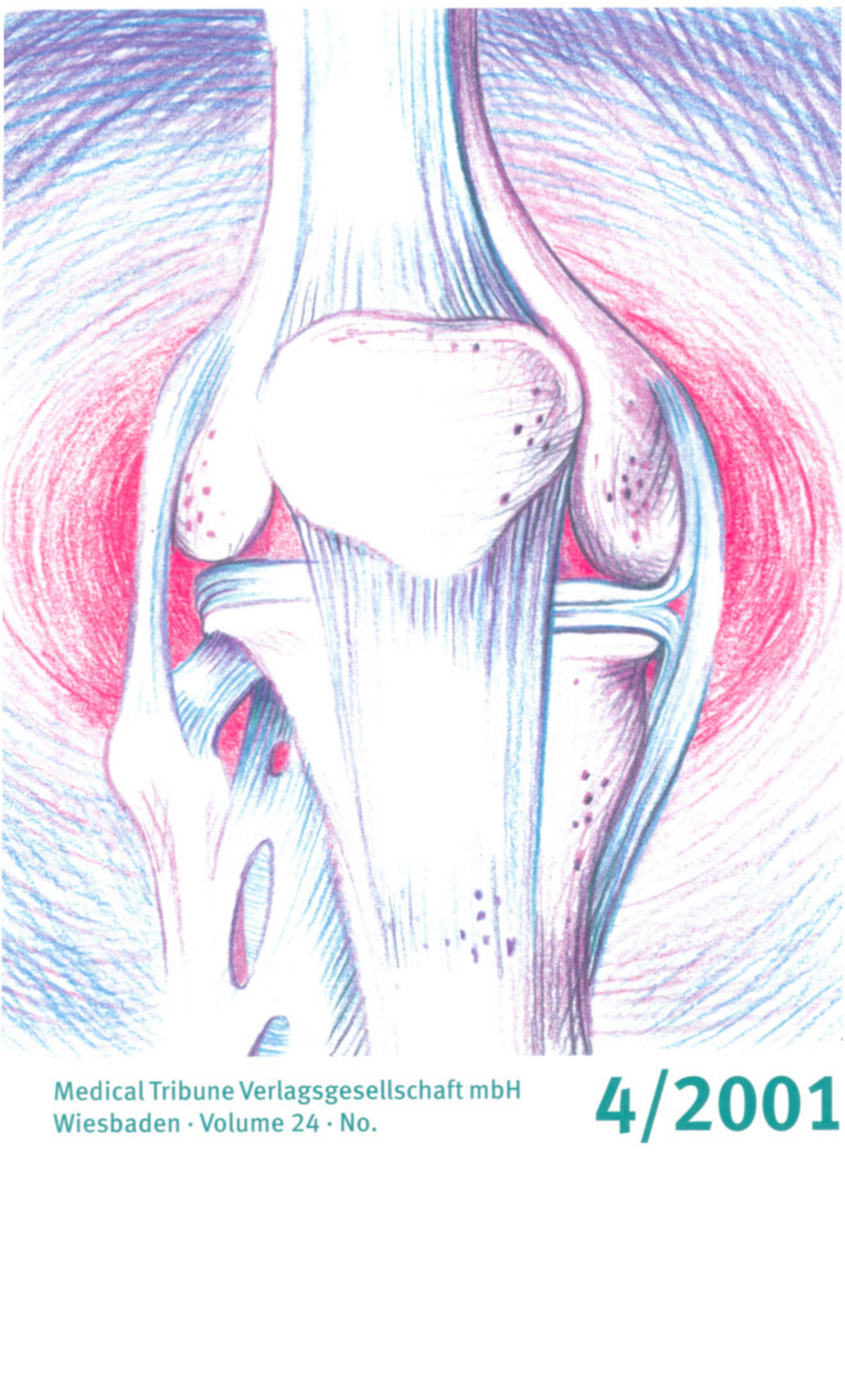

Change in the Properties of Tissue Through the Administration of Gelatine

A Biomechanical In-Vivo Pilot Study

Medical Tribune Verlagsgesellschaft mbH
Wiesbaden · Volume 24 · No. 4/2001

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A Biomechanical In-Vivo Pilot Study

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Collagen fibers determine the firmness of tissue and hence influence the disposition to numerous diseases. The goal of this study was to investigate how and to what extent the mechanical stability of tissue can be influenced by gelatine, itself a substance that consists of collagen fractions.

The study involved 24 persons; these were administered 10 g of gelatine per day over a period of 6 months. Both before and after administration, the biomechanical tissue properties were determined using a computer-controlled finger hyperextensometer, an apparatus specifically developed for measuring biomechanical tissue characteristics.

After 6 months, a reduction in the relative integral area of the force angle regression curve ($p < 0.001$) was observed, particularly in those persons with finger joint hyperextension. This indicates a reduced degree of deformation, i.e. increased firmness of the tissue. The results indicate that administration of gelatine can influence the mechanical quality of tissue by increasing its firmness.

Theoretical aspects

Tissue consists of pressure-absorbing proteoglycanes and tension-absorbing collagen fibers (Brinkmann and Groetenboer, 1991). The mechanical properties are determined by the elasticity of the fibers and by the water-binding capacity of the proteoglycanes. In practical terms, *in-vivo* measurements have never been made.

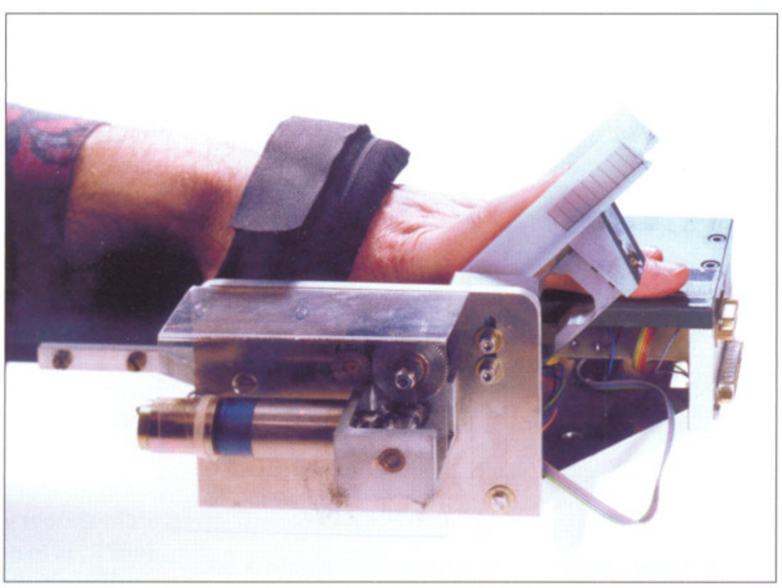

Fig. 1: Computer-controlled MCP II Hyperextensometer. The guide rail flexes the index finger dorsally and cyclically and simultaneously registers torque and angle.

Gelatine is manufactured from animal bones and hide. Proline and glycine are two of the components. Both of these amino acids are important building blocks of connective tissue and hence of skin, cartilage and bone. For this reason, gelatine could well be suitable as a provider of replacement tissue, a sort of depot. It has already been shown to have a positive influence on the growth of hair and nails (Morganti and Randazzo, 1984; Pfaff, 1989). Empirical and clinical studies have also been carried out; these indicate that products containing gelatine play a supportive therapeutic role and relieve pain in degenerative joint disease (Adam, 1991).

Goal of the Study

It can be assumed that the firmness of the collagen fibers have some influence on the disposition to numerous orthopedic conditions. For this study, a special computer-controlled finger hyperextensometer was developed; this apparatus operates cyclically and measures and analyzes the force-angle curves, the influence of time and hence the viscoelastic properties of tissue *in-vivo*. The goal of the study was

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to determine the changes in the biomechanical characteristics of tissue subsequent to the administration of gelatine.

The study was conducted on 24 volunteers aged between 24 and 65 (mean: 46.9 years). Persons showing any dysfunction of fingers or hands were not allowed to participate.

Method

Over a period of 6 months, all volunteers were administered 10 g of gelatine-hydrolysate (DGF STOESS AG).

The sequence of measurements carried out with the finger hyperextensometer were:

1. Measurement prior to administration of gelatine
2. Measurement after 3 months
3. Measurement after 6 months.

The finger hypoextensometer used in this study is a further development of the apparatus developed by Jobbins et al. (1979) and Dubs et al. (1984). The essential aspect of the instrument used here is the computer-controlled measuring technology that allows the simultaneous recording of force and angle at constant angular velocity (fig. 1, page 12). The apparatus comprises an arm rest and a swiveling guide for the index finger. The index finger, when placed in a special hemispherical guide, can be hyperextended within its basic joint, the lower arm or wrist being fixed in position by a belt. The entire process is computer-controlled. In the study, the finger pressure was measured using a strain gauge coupled with a Wheatstone bridge circuit. The hyperextension angle was measured using a linear rotary potentiometer. All the measured data obtained during the experiment were stored in the computer.

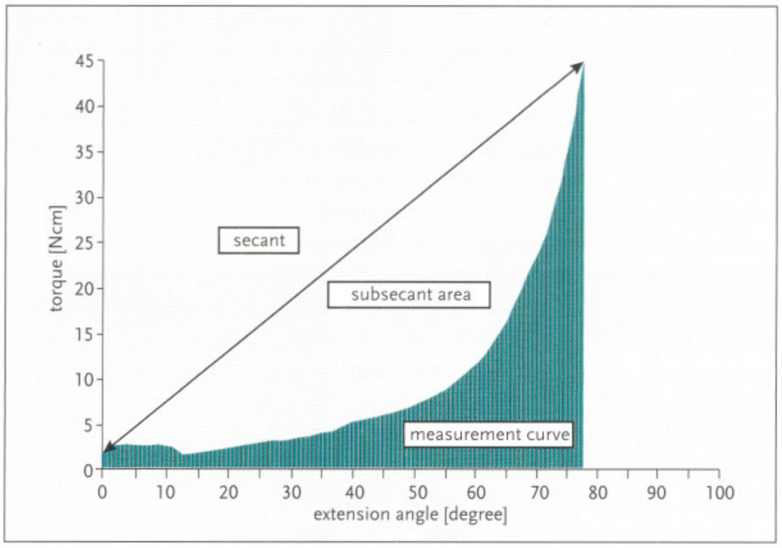

Fig. 2: Force-angle diagram. The parameters evaluated were: extension angle (degree), max. achieved angle (at a torque of 45 Ncm) and the integral of the regression curve. This is representative of the work involved in hyperextending the finger.

The volunteer was seated in front of the apparatus at 45° abducent shoulder joint angle, the elbow joint at 90°, leaned back and as relaxed as possible. He was asked to avoid exerting any muscular counter pressure and not to move at all. The lower arm was fixed to the rest and the index finger placed in the finger guide. With the help of the computer, 20 cycles of dorsal extension were performed on the finger joint. The velocity was 7.5 sec/ 90° and the maximum torque 45 Ncm. A five-minute pause was taken and the extensions then repeated ten times. The values obtained were

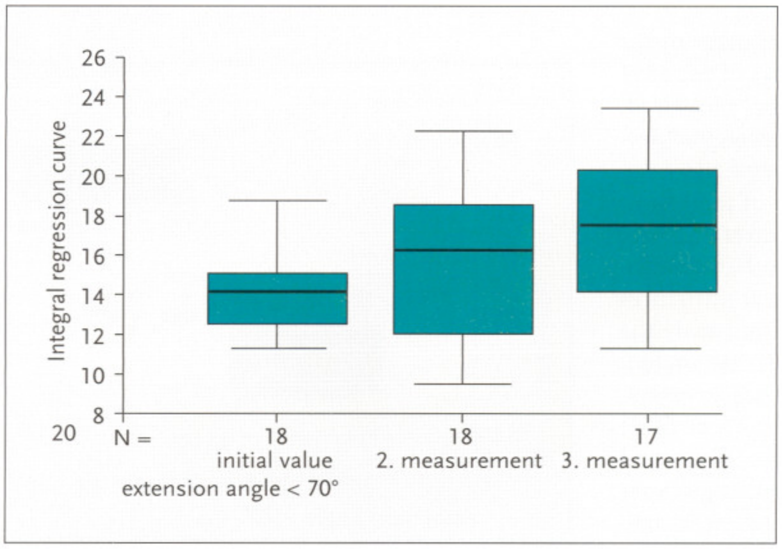

Fig. 3: Integral of the regression curve with high degree of connective tissue firmness (initial hyperextension angle < 70°), as measured prior to administration of gelatine, interim measurement after 3 months and final measurement after 6 months. The firmness of the tissue was higher after administration of gelatine.

stored in the computer. The maximum achieved angles and the integrals of the force-angle curves (relative, based on the angles) were evaluated. The force-angle curves obtained were then processed using the regression technique.

The following values were determined:

- Maximum achieved angle: max. angle on the 20th cycle.
- Relative integral of the regression curve: Integrals of the force-angle curves divided by the maximum angle. This value represents a parameter for the work/degree of angle necessary in hyperstretching the finger within the joint.

Results

The maximum extension angle changed to an insignificant extent during subsequent measurements. The integral of the regression curve increased substantially on the 2nd and 3rd measurements ($p < 0,001$). This was especially obvious in the case of those with initial values < 70° hyperextension angles (figs 3 and 4).

Discussion

The finger hyperextensometer enables the firmness of tissue of an individual to be measured. The correlation between achievable angle at any specified torque and general degree of joint firmness is high (Beighton et al., 1984). In this case, the mechanical characteristics of several structures are measured simultaneously: the joint capsule MCP II, the tendon, the skin and, to a far lesser extent, the musculature. In all of these tissue types, collagen fibers and the water-binding proteoglycanes can be seen as being representative models (Beighton et al., 1984). The procedure demonstrated here for the first time allows the visco-elastic properties of individual tissue types to be determined – up to now not possible *in-vivo*.

Assessment of the results leads to the assumption that, subsequent to the administration of gelatine, the tissue becomes more firm whilst undergoing some deformation. The differences in the results achieved in the volunteers with initial low and substantial connective tissue firmness indicates that the tissues react to different degrees to the administration of gelatine. It was shown that, particularly in the group with low initial values (hyperextension angle >70°), firmness is increased. The reason for this is possibly an increased requirement for collagen synthesis in this particular group.

As to whether the increased firmness of the tissue results from an increase in collagen density or thickness is still an open question. It is quite possible that through the administration of gelatine, the enzymatic and/or mechanical formation and release of irritation factors (pieces of tissue) and inflammation factors are reduced. The administration of gelatine could also give rise to the formation of an amino acid pool within the body (Adam, 1991) that could in turn enable the fibrocytes to increase the generation of connective tissue. In view of the enormous importance of connective tissue weakness as a disposition factor in numerous orthopedic conditions (osteoarthrosis, discogenic diseases etc.), these results are highly interesting. However, further comparative studies are necessary.

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Literature available from the author.

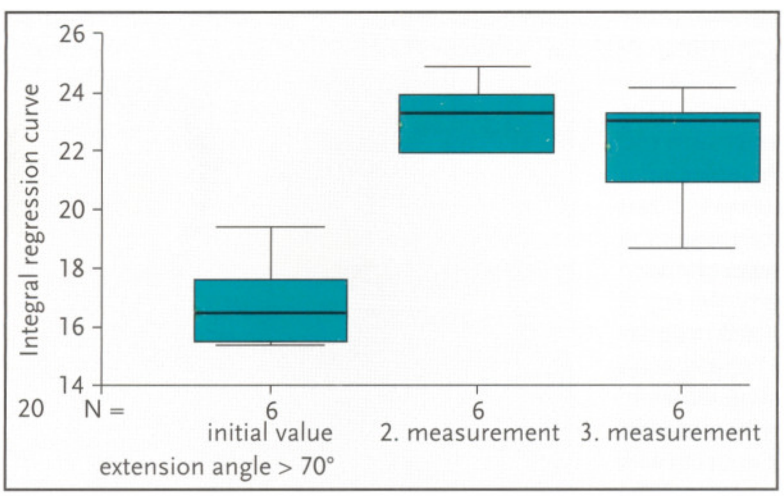

Fig. 4: Integral of the regressions curve at low connective tissue firmness (initial hyperextension angle > 70°), as measured prior to gelatine administration, after 3 months and after 6 months. The firmness of the tissue was considerably higher after gelatine administration than in the group with firmer tissue firmness (fig. 3).

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