INTRODUCTION
The temporomandibular joint (TMJ) is the joint between the mandibular condyle and the glenoid fossa of the temporal bone. A disc of fibrocartilage placed between condyle and fossa provides frictionless sliding action. Besides systemic diseases, inappropriate mechanical loading can be cause of cartilage degradation. In order to study static, cyclic loading or shear stress effects on cartilage explants different systems have been developed. Moreover, like in other body joints, TMJ cartilage is subjected to a quite complex combination of forces. The aim of the present study was to evaluate the biological response of cartilage explants to plowing. In order to mimic the complex loading occurring in the TMJ, a rolling/plowing explants test system (RPETS) was developed. RPETS is a computer-controlled electromechanical system enabling to simulate the rotational and translational movements of the condyle on cartilage. The parameters (pressure, speed) used during the dynamic loading are determined from “dynamic stereometry” which provides in vivo data acquisition of TMJ strains and indirectly stresses.

METHODS
Under sterile conditions, control cartilage explants (20x30x2) (LxWxH) and cartilage strips (60x17x2mm) (LxWxH) were harvested from bovine nasal septum by means of a custom made cutter with two parallel blades. Cartilage strips were glued by the extremities to a Plexiglas support and plowed for 2 hours at 37°C by means of a cylindrical indenter (∅25 mm; aluminium) with tangential speed of 10 mm/s. The applied normal forces were of 50 or 100 N (corresponding to applied pressure of 1.65 and 2.5 MPa respectively) and the post-loading samples equilibration time were of 2, 4, 24 or 48 hours. Gene expression for cartilage proteins such as aggrecan (Agg), collagen type-I (Coll1), collagen type-II (Coll2), fibronectin (Fn) and for the catabolic enzyme stromelysin-1 (MMP-3) and its inhibitor TIMP-1 has been measured by means of real time quantitative polymerase chain reaction (RT-qPCR).

RESULTS
RT-qPCR showed that plowing at a velocity of 10 mm/sec at either 50 or 100 N leads to up-regulation of MMP-3. More in detail, cartilage strips (n=3) loaded at the lower force showed up-regulation of MMP-3 up to 5 fold while strips (n=3) loaded at higher force showed MMP-3 expression increase of 6.5 fold. Furthermore only the plowing at 100 N caused down-regulation of the Agg gene (2.5 fold). All other analyzed genes did not show regulation. The above mentioned MMP-3 up-regulation displayed a sustained decrease over time, reaching the minimum (not regulated) at 48 hours for both applied normal forces. Agg down-regulation occurring after plowing at 100 N showed to be stronger at 48 hours. These results could be explained as reactions leading to a mechanically induced remodelling process.

DISCUSSION
Plowing of cartilage according to in vivo acquired data from TMJ dynamic stereometry induces significant mechanobiological effects. The findings about altered gene expression might serve as a basis for the study of the effect of combined dynamic loading on cartilage explants. A further exploration of combined metabolic pathways will be important for a better overview of the scenario of dynamic cartilage loading.


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