# Membrane or implant that mimic healthy subchondral bone microarchitecture for treating joint-related diseases

Scientist at the University Medicine Göttingen, Germany developed a method for determining the health-state of a joint (e.g. in osteoarthritis) by analyzing subchondral bone microarchitecture. The invention not only allows diagnosis, but also the design of a biocompatible membrane and/or an implant for the replacement and finally regeneration of damaged subchondral bone allowing regeneration of cartilage and joint function.

## Challenge

Articular cartilage and subchondral bone interact cooperatively and synergistically through a complex interface, which influences the functionality and the degree of health of the whole joint. Joint diseases such as osteoarthritis are diseases affecting both the articular cartilage (AC) and the microstructure of the subchondral bone (SB).
The SB has previously been found to comprise microchannels. It is thought that these microchannels play a crucial role in the nutrient transport to the overlying cartilage, as well as the waste disposal from the joint and synovial efflux. Thus, cartilage nutrition and drainage appear to be highly dependent on the presence and functionality of microchannel structures within the SB, i.e. the microarchitecture of the subchondral bone seems to have a huge impact on cartilage vitality and longevity.
However, in diseased conditions this interplay between SB and cartilage appears to be impaired, ultimately leading to cartilage destruction and finally joint failure (osteoarthritis).

## Our Solution

Based on the above findings, the inventors are able to describe the architectural features that constitute a healthy SB microarchitecture. This can be used as for determining the health-state of a joint. The invention further provides a design for a biocompatible membrane and/or an implant based on this architectural specification allowing for the replacement and finally regeneration of the damaged subchondral bone leading to healthy cartilage structures.

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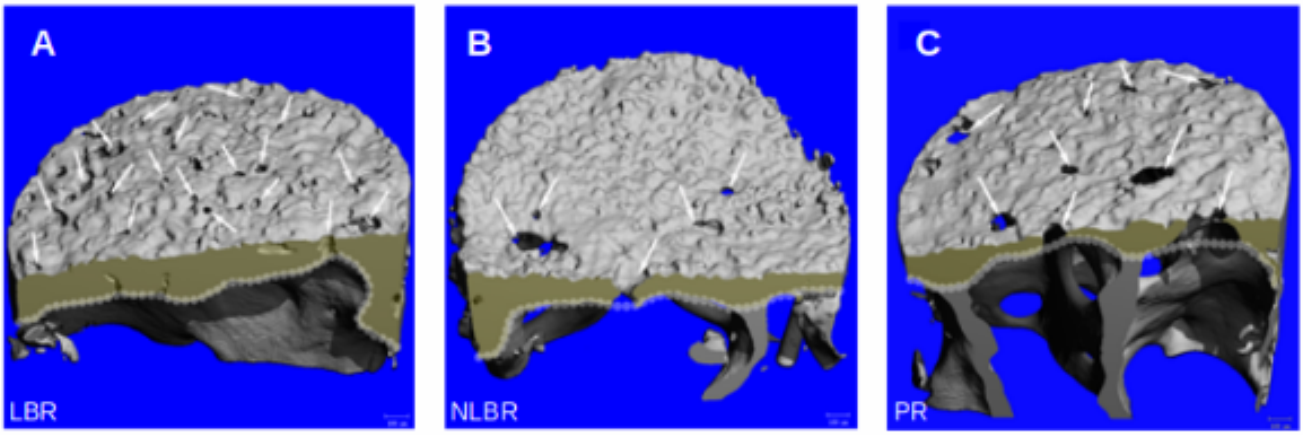


Figure 1 depicts the microstructure of samples of human hip joint bone with specific focus on microchannel morphology (arrows). The surface of human hip joints was divided into zones based on the loading history and analyzed by micro-CT imaging (A: load bearing region (LBR); B: non load bearing region (NLBR); C: peripheral region (PR)). Source: US16/282,444.

## Advantages

- biocompatible membrane or implant comprising microchannels for treatment of joint diseases.
- microchannels are arranged in a size and distribution that correspond to the physiological pattern of the healthy joint
- theranostic concept possible.

**Different Membrane Configurations**

**Healthy SB**

**Pathological SB**

**Pathological SB after Microsurgery**

**Membranes on Pathological SB**

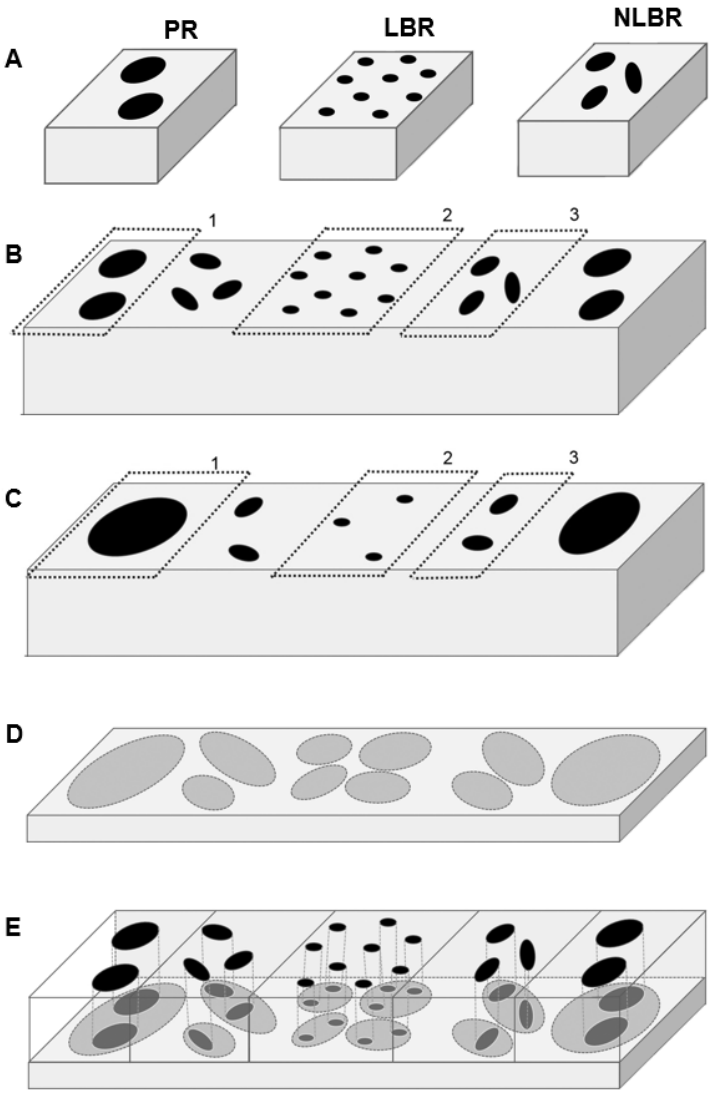


Figure 2 shows a scheme for implantation of preferred embodiments of membranes in different areas (peripheral rim (PR, 1), load bearing region (LBR, 2), non-load bearing region (NLBR, 3)) of a knee joint. A) Membranes with different channel structures corresponding to the respective SB areas are available. B) In healthy subchondral bone, channel configuration differs in the different areas of the joint (see also Fig. 1). C) Pathological channel configurations differ from that present in healthy bone (as shown B). D) shows a layer of pathological SB. Removal of pathological SB reveals underlying SB structures with increased number and cross-sectional area of microchannels. E) Corresponding membranes are fixed on the microsurgically pretreated SB to reinstate a physiologic size/number of channels (reflecting healthy SB microarchitecture). Source: US16/282,444.

## Applications

Surgical treatment of joint diseases using special biocompatible membranes or implants comprising microchannels.

## Patent Status

A US priority patent application has been filed (applicant: Georg-August-Universität Göttingen Stiftung Öffentlichen Rechts, Universitätsmedizin).

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