Summary

Osteoarthrosis (synonym: Arthrosis Deformans) of the temporomandibular joint, in literature usually described as pain dysfunction syndrome, is a common disorder accompanied by clicking, pain and limited motion. The course of the disease, the roentgenology and the results of conservative treatment are well-known. The underlying processes which cause articular cartilage destruction and other degenerative changes observable in case of osteoarthrosis of the temporomandibular joint are still obscure. Research on the cause of osteoarthrosis, especially regarding the hip- and kneejoint, has indicated that the initial osteoarthrotic changes occur in the collagen fibrils of the articular cartilage matrix. The collagen fibrils, which create a network, probably lose their cohesion, thus allowing the groundsubstance, which consists of proteoglycans, to leave the collagen network of the articular cartilage matrix. In this way, the articular cartilage becomes loaded in an unfavourable manner (compression forces instead of tensile forces in the collagen fibrils), is unable to function normally, and finally degenerative changes occur.

One of the aims of this investigation is to obtain more insight in the pathogenesis of osteoarthrosis. The starting point for this investigation of the fibrocartilage of the mandibular condyle was the hypothesis of Freeman and Meachim (1979), which states that collagen network fragmentation initiates the articular cartilage destruction which appears in osteoarthrosis. Previously the fine structure of fibrocartilage of the temporomandibular joint was scarcely described. For that purpose scanning and transmission electron microscopy were used during this investigation for the first time on such a large scale.

The spatial arrangement of collagen fibrils in articular cartilage from healthy mandibular condyles, obtained at necropsy, was studied by light microscopy and scanning electron microscopy. The results of this study were compared with those of a light and scanning electron microscopic study on articular cartilage from osteoarthrotic mandibular condyles. These condyles were obtained either at necropsy or from patients treated with a high condylectomy. All material from patients was also studied by transmission electron microscopy to describe the ultrastructure of cells and matrix of osteoarthrotic articular cartilage from the mandibular condyle. The ultrastructural features were compared with those of articular cartilage from healthy mandibular condyles resected during a hemimandibulectomy because of a malignancy in the mandibular ramus.

In literature, the past years a lot of attention has been paid to form, position and function of the articular disc of the temporomandibular joint. Therefore, the collagen network of the articular disc was also studied by scanning electron microscopy. The relationship between articular disc position and osteoarthrosis was studied by light microscopy of 22 temporomandibular joint autopsy specimens, prepared in a standardized way.

To detect possible differences between fibrocartilage and hyaline cartilage, the collagen network of the articular cartilage of the femoral head was compared with that of the mandibular condyle. Healthy as well as osteoarthrotic articular cartilage was investigated.

The results of this thesis are now summarized, according to the contents of the successive chapters.

Chapter 1 describes the state of the art concerning articular cartilage and osteoarthrosis, and the aims of this investigation.

Chapter 2 reviews knowledge on structure and function of the articular cartilage of the temporomandibular joint. The cartilage components - cells, collagen fibrils and proteoglycans (groundsubstance) - are discussed. Literature about this subject of the temporomandibular joint is scarcely available.

Chapter 3 describes the spatial arrangement of collagen fibrils in the articular cartilage of the mandibular condyle, deduced from light microscopic and scanning electron microscopic observations. In this study it is shown for the first time that the collagen fibrils in the articular cartilage of the mandibular condyle are organized in layers or sheets and bundles. The layer formation, in which collagen fibre bundles organized in thin bands of interwoven fibrils are observed, is found in the articular zone of the articular cartilage. The bundle-like organization is found in the deeper zones of the articular cartilage. It is concluded that the collagen fibrils create a three-dimensional network with a special system in each of the four distinguishable zones of the articular cartilage. Because of the interdependence of form and function, the differences in cartilage structure per zone probably indicate the presence of different functions of each cartilage zone. However, the essence of these differences is not clear.

Chapter 4 describes the spatial arrangement of collagen fibrils in the articular disc of the temporomandibular joint, deduced from light microscopic and scanning electron microscopic observations. The collagen fibrils are organized in bundles creating a three-
dimensional network nearly everywhere in the disc. Only in the superficial layers an anteroposterior orientation is detectable. The collagen network of the articular disc is able to resist compression forces due to loading.

Chapter 5 describes the organization of collagen fibrils and other morphological aspects of articular cartilage of osteoarthrotic mandibular condyles studied by light microscopy and scanning electron microscopy. Features of progressive and regressive remodeling respectively and splitting of the deeper zones of the articular cartilage are observed. The collagen network has lost its normal organization. The collagen fibrils are disordered. Thick coiled fibrils at the joint surface and numerous osmiophilic globules scattered throughout the collagen fibrils, are found. The globules represent lipidic debris due to cell necrosis. It is concluded that collagen fibre network disintegration and fatty degeneration comprise the osteoarthrotic changes of the articular cartilage of the human mandibular condyle. Both phenomena, present in the osteoarthrotic mandibular condyle, have not previously been described.

Chapter 6 describes the ultrastructure of articular cartilage from healthy and osteoarthrotic mandibular condyles studied by transmission electron microscopy to obtain more insight in the pathogenesis of osteoarthritis. The ultrastructural features of cells and matrix of the articular cartilage of these condyles are compared with the results of other transmission electron microscopic studies regarding osteoarthrotic fibrocartilage as well as osteoarthrotic hyaline cartilage. The healthy mandibular condyles (aged 53 to 88 years) show some slight degenerative changes, probably due to ageing. The osteoarthrotic condyles (aged 18 to 48 years) show several degenerative changes in the articular cartilage. Degeneration or necrosis of the chondrocytes is frequently found especially in the deeper zones of the articular cartilage. The remaining cellular debris is fatty, resulting in an increase of matrix vesicles and lipid globules. An increased number of elastic fibres and the presence of giant collagen fibrils are also noted. The collagen fibrils at the articular surface disintegrate into filamentous and fine granular material. The mechanical capacity of the osteoarthrotic articular cartilage matrix is impaired by this collagen fibril fragmentation and by the presence of elastic fibres and giant collagen fibrils. Both cells and matrix of the articular cartilage appear to be affected by osteoarthritis. Unfortunately, cause and effect could not be distinguished from each other. The degenerative changes might occur simultaneously, enzymatically induced from the synovial fluid.

The degenerative changes of osteoarthrotic fibro-cartilage of the mandibular condyle show a striking similarity with those found in osteoarthrotic hyaline cartilage from other synovial joints. Therefore, it is concluded that osteoarthritis is a synovial joint disease without differentiation between fibrocartilage and hyaline cartilage. This statement has never been made before.

Chapter 7 describes the relationship between osteoarthritis and displacement of the articular disc of the temporomandibular joint, studied by light microscopy of 22 randomly selected autopsy specimens (aged 54 to 92 years). Prior to dissection, the lower jaw was placed in the intercuspal position and the temporomandibular joint was deep frozen. The frozen specimens were sawed into five-mm thick sagittal slices. Disc position remained unchanged. The obtained slices were fixed, contact-radiographs were exposed and seven-μm thick serial sections were prepared. Normal disc position is seen in eight joints, partially anteriorly displaced discs in eight joints, completely anteriorly displaced discs in five joints; and one joint shows a perforated disc. Partially displaced discs are only displaced in the lateral part of the joint or in the lateral as well as in the central part of the joint.

Degenerative changes, such as lipping due to osteophyte formation, sclerosis of the subchondral bone, subchondral cysts, erosions of the articular surfaces, deformation of the mandibular condyle, flattening of the fossa and reduction in temporomandibular joint size are macroscopically observable. Horizontal splitting of the articular cartilage at the level of the uncalcified-calciﬁed interface, clustering of chondrocytes and fibrosis of the bone marrow are only microscopically detectable. The articular zone usually remains unaffected. The degenerative changes appear to occur especially in the deeper zones. The articular zone appears to adapt to these changes. All joints with a displaced disc, except three, show severe degenerative changes, especially located in the lateral part of the joint. However, four of eight joints with normal position and form of the articular disc also show degenerative changes. It is concluded that displacement of the articular disc appears to be a sign of osteoarthritis of the temporomandibular joint and appears not to be the cause of osteoarthritis.

Chapter 8 describes the organization of collagen fibrils of the articular cartilage of healthy femoral heads, deduced from light microscopic and scanning electron microscopic observations. The purpose of this study was also to reveal possible differences between fibrocartilage and hyaline cartilage. The collagen fibrils of the femoral head articular cartilage are randomly arranged and regularly organized throughout the tissue. Underneath the articular sur-
face the collagen network in the superficial zone shows a tighter appearance when compared with the homogeneous collagen network in the deeper zones. It is concluded that in hyaline cartilage, in contrast to the fibrocartilage, the collagen fibrils are not organized in bundles or in sheets. The collagen fibrils create a homogeneous, three-dimensional network.

Chapter 9 describes the degenerative changes and morphological characteristics of an osteoarthrotic femoral head, studied by light microscopy, scanning and transmission electron microscopy. Several degenerative changes are presented. The presence of elastic fibres in osteoarthrotic hyaline cartilage has never previously been described. It is concluded that disintegration of the collagen network and fatty degeneration of the matrix are the essential mechanisms in the pathogenesis of osteoarthrosis.

In Chapter 10, the General Discussion, the differences between articular fibrocartilage and hyaline cartilage are discussed. The organization of collagen fibrils in healthy fibrocartilage differs from that in hyaline cartilage. However, the osteoarthrotic changes at an electron microscopic level show a striking similarity. In contrast with most other synovial joints, the relationship between ageing and osteoarthrosis is not so clear for the temporomandibular joint, because the onset of osteoarthrosis of the temporomandibular joint mostly occurs in the third decade. In general it is assumed that osteoarthrotic articular cartilage shows defects at the articular surface with light microscopic observations. However, the temporomandibular joint articular zone seems to be unaffected with light microscopic observations. Therefore our study proposes to broaden the definition of osteoarthrosis by including the degenerative changes of the deeper zones of the articular cartilage and the subchondral bone, whereas at first the articular zone may remain unaffected. In our opinion, partial and total displacement of the temporomandibular joint disc are part of the osteoarthrotic process.