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CARTILAGINOUS METAPLASIA OF CONNECTIVE TISSUE IN CLINICAL SKIN ARTHROPLASTY

By

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Animal experiments show that the epidermis of a whole-thickness skin graft used as interposition material in arthroplasties becomes destroyed and that the connective tissue undergoes a metaplastic development into cartilage (6). Up to the present time the skin graft arthroplasty method has been applied at our Clinic in 122 operations carried out on different joints (5, 4). In connection with later arthrotomies performed on two skin arthroplasty joints tissue samples were obtained of such joint surfaces for microscopy. These samples revealed cartilaginous metaplasia similar to that which occurred in the animal experiments. The findings present an opportunity for interesting comparison between animal and human arthroplasties.

Case 1: The patient is a farmer's daugther, aged 18. At 8 she developed tuberculosis of the right knee joint resulting in almost total stiffening of the joint. A skin arthroplasty was carried out in the knee joint by Professor Kallio. The patela was found to be free and movable and the joint surface showed arthrotic changes. The cartilage of the tibial the joint surface, which was relatively well preserved, was left intact. The most marked changes were observed in the femoral joint surface from which the remains of the joint cartilage were removed carefully, after which it was covered with a whole-thickness skin graft obtained from the skin of the abdomen. The joint surface of the patella was likewise freshened and invested with subcutaneous connective tissue. Four weeks after the operation the patient was discharged from the hospital with an active mobility of the joint from 170 to 130 degrees. There was no further improvement of mobility after this, which was accounted for by the shortening of m. quadriceps from immobilization. A new arthrotomy and allongation of the tendon of m. quadriceps was therefore carried out seven months after the skin

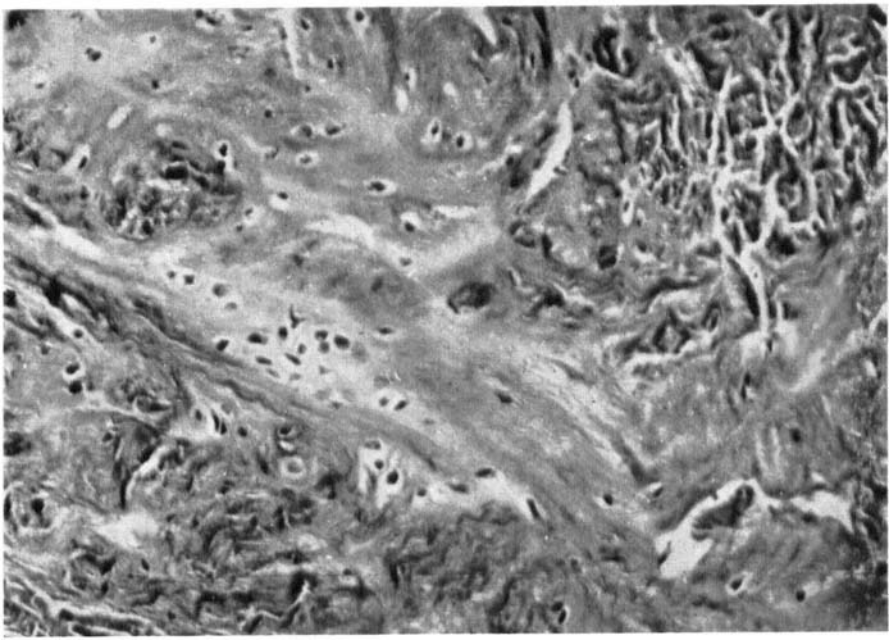

Fig. 1.
Sample from the femoral joint surface, from the weight-bearing area of the joint. Incipient cartilaginous metaplasia in the centre of the picture. Dense fibrous connective tissue of the skin graft around the cartilaginous area. Weigert-van Gieson. 150 ×

arthroplasty. The joint cavity was found to be below normal in size. No intra-articular adhesions were seen. The patella was free. The amount of synovial fluid was less than normal. The joint surface of the tibia was covered by a cartilaginous layer of hyaline type. The femoral joint surface, which had been invested with the skin graft, was covered by a continuous tissue layer which on the weight-bearing area of the joint macroscopically bore a resemblance to fibrous cartilage. The articular surface of the patella was also covered by tissue resembling fibrous cartilage. Macroscopically there was nothing indicative of epithelial cysts.

For a histological examination samples of tissue were obtained from the articular surface of the femur both from the weight-bearing and non-weight-bearing areas of the joint. The samples were fixed in 10 % neutral formalin and the preparations were stained by Weigert-van Gieson, toluidine blue and periodic-acid-Schiff (P.A.S.) methods (8, 7, 2).

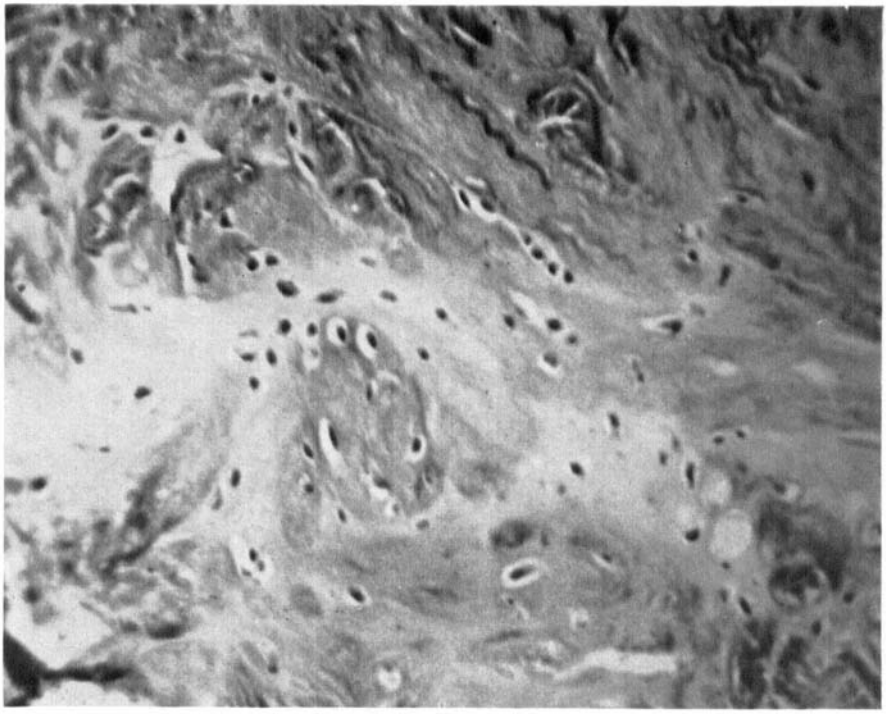

Fig. 2.
Connective tissue undergoing metaplasia, from the femoral joint surface. At the top of the picture collagen bundles which have broken up into undulating fibrils. In the centre and below metaplastic cartilage of fibrous and hyaline type.
Weigert-van Gieson. 320 ×

In the tissue sample obtained from the weight-bearing area of the joint surface of the femur all the phases typical of cartilaginous metaplasia were in evidence. The tissue covering the articular surface was partly dense fibrous connective tissue while some areas had undergone a metaplastic development into cartilage. In the areas in which the metaplastic process first set in, the collagen bunches broke up into thin undulating fibrils which seemed to merge with the increased ground substance of the connective tissue. The metaplastic cartilage consisted mainly of fibrous cartilage, but there were also areas with hyaline type cartilage in the samples (Figs. 1, 2). No signs of inflammation, epidermal cells or epithelial cysts could be seen.

The tissue samples obtained from the non-weight-bearing area of the femoral joint surface showed no signs of cartilaginous metaplasia. The tissue consisted of dense fibrous connective tissue. Here,

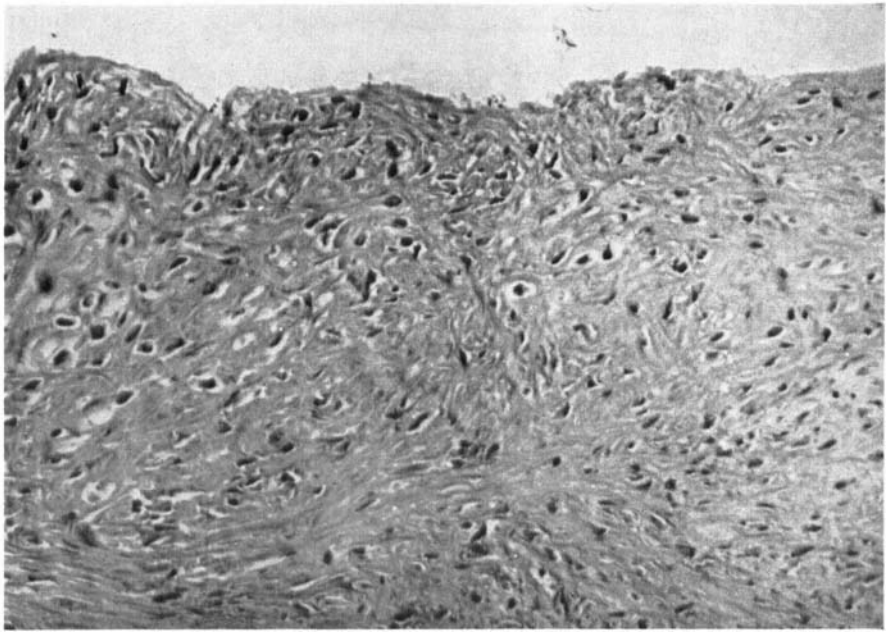

Fig. 3.
Sample from the humeral joint surface. Metaplastic fibrous cartilage. Weigert-van Gieson. 150 ×

likewise, nothing indicative of epidermal cells or epithelial cysts was apparent.

The tissue samples obtained from the joint surface of the patella exhibited the same different phases of metaplastic development into cartilage as those obtained from the articular surface of the femur.

Increased metachromasia and P.A.S. positivity was revealed by toluidine blue and P.A.S. staining in the ground substance of the connective tissue undergoing metaplasia.

Case 2: The patient is a married women, aged 51, who had been subjected to a severe intra-articular fracture of the right elbow joint 2 years before, which resulted in a stiffening of the joint to a 90 degree flexion. Skin arthroplasty was carried out by Professor Kallio. Both joint surfaces were remodelled and the remains of articular cartilage were carefully removed from the articular surfaces of both the ulna and the humerus. The joint surface of the humerus was invested with a full-thickness graft made of abdominal skin while the joint surface of the ulna was left bare. Four months after the operation the mobility of the joint was from 145 to 90 degrees. Roentgenography revealed as

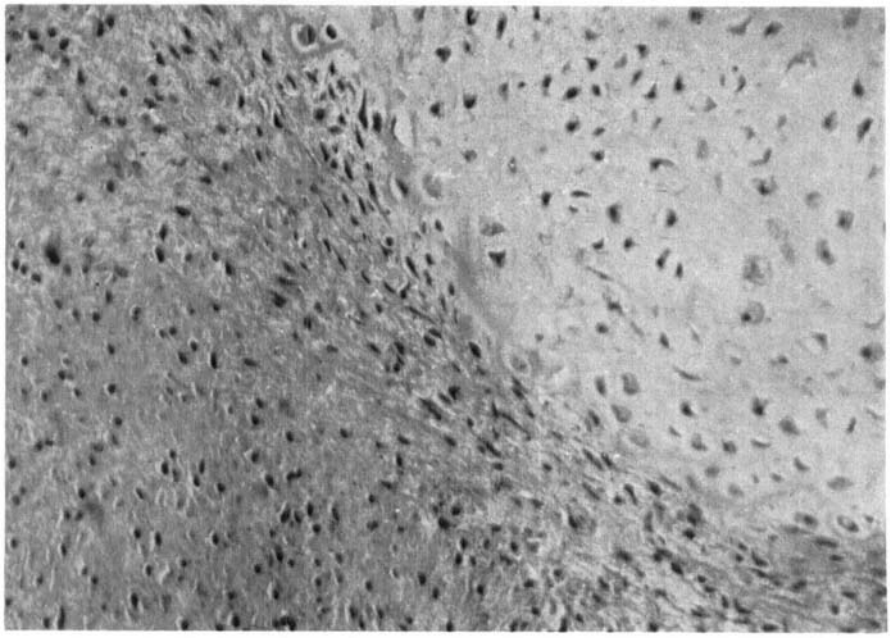

Fig. 4.
Tissue from the joint surface of the humerus. On the left metaplastic fibrous cartilage and on the right new cartilage of hyaline type. Weigert-van Gieson. 250 ×

the cause of the flexional restriction exostosis projecting from the edge of the ulnar joint surface. Because of this arthrotomy was carried out and the exostosis was removed. The joint surface of the humerus and the ulna were found to be covered by continuous tissue macroscopically resembling fibrous cartilage. No intra-articular adhesions were seen. Tissue samples were taken from both joint surfaces for a histological examination. The samples were prepared by the same method as in Case No. 1.

The samples obtained from the joint surface of the humerus which had been covered by the skin graft partly consisted of dense fibrous connective tissue, partly metaplastic cartilage. The new cartilage was mainly fibrous cartilage but cartilage of hyaline type also occurred in places (Figs. 3, 4). No epidermal cells or epithelial cysts were present.

The ulnar joint surface, likewise, which had not been covered by a skin graft, showed new cartilage of fibrous or hyaline type (Fig. 5).

The ground substance of the metaplastic cartilage revealed increased metachromasia and P.A.S. positivity.

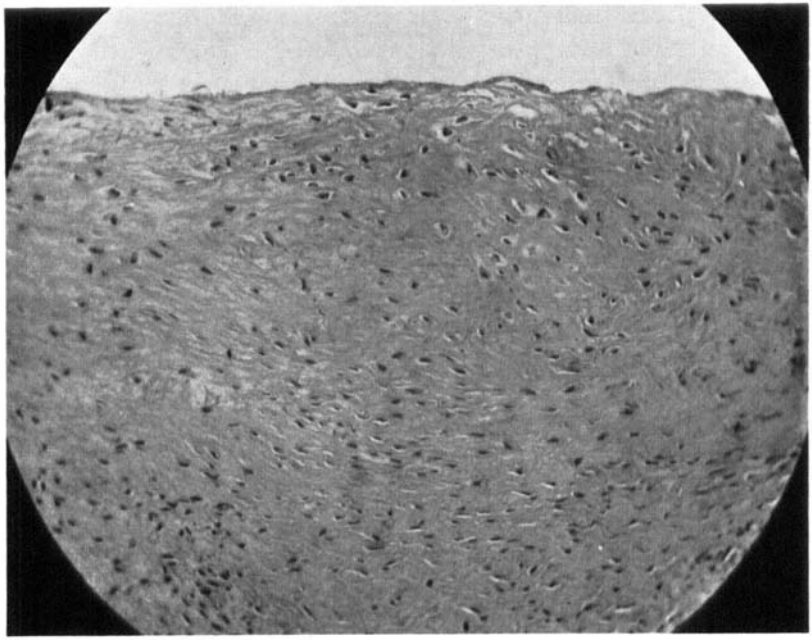

Fig. 5.
Sample from the ulnar joint surface. Metaplastic fibrous cartilage. Weigert-van Gieson. 150 ×

DISCUSSION AND CONCLUSIONS

Animal experiments showed that the organism tolerates well a skin graft used as interposition material in arthroplasties (6). Moreover, the clinical cases described in the foregoing revealed no signs of intra-articular irritation. The epidermal cells had become destroyed and no epidermal cysts had formed.

The cartilaginous metaplasia of connective tissue occurring in these two cases corresponded in all its phases with the results obtained in the animal experiments (6). The necessary condition for the metaplastic process was articular weight-bearing. In their absence no metaplasia took place. With full justification, therefore, we may speak of functional cartilaginous metaplasia of connective tissue in clinical material.

In case No. 2, in which the ulnar joint surface was not covered with a skin graft, the granulation tissue growing from the joint surface retained its vitality and underwent a metaplastic development into cartilage. It therefore seems evident that if the articular cartilage comes to

be removed from both articular surfaces, investing only one of the articular surfaces with interposition material is sufficient.

Histochemically increase of acid mucopolysaccharides in the ground substance of connective tissue was noted. The new cartilage was of either fibrous or hyaline type. These findings are in agreement with those obtained in animal experiments.

In the literature the view has been put forward that animal experiments are of no significance in arthroplasty studies (1, 3). The macroscopical and microscopical findings obtained in the clinical cases described in the foregoing are in full agreement with animal experiments and thus refute this view.

The following concusions seem justifiable:

The human organism tolerates a full-thickness skin graft used as interposition material well. The epidermis of the skin graft becomes destroyed and no epithelial cysts form.

In the connective tissue used as interposition material a metaplastic development into cartilage takes place when this tissue is subject to joint function. The new metaplastic cartilage is either fibrous or hyaline in type.

The observations made in clinical material are in full agreement with results obtained in animal experiments and therefore confirm the experimental studies which have been carried out.

The biological process present in arthroplasties can be elucidated by means of animal experiments.

SUMMARY

The writer describes two clinical cases of skin arthroplasty in which a new arthotomy was carried out later. In connection with the operation tissue samples were obtained from the joint surfaces for a histological examination. The connective tissue used as interposition material showed a cartilaginous metaplastic development. The new cartilage was of either fibrous or hyaline type. The findings obtained in clinical patients were in complete agreement with the results of animal experiments. The writer concludes that the biological process occurring in arthropasties can be elucidated by means of animal experiments.

RESUME

L'auteur décrit deux cas cliniques d'arthroplastie de la peau dans lesquels une nouvelle arthrotomie a été pratiquée plus tard. En relation

avec l'opération, des échantillons de tissue ont été prélevés sur les surfaces de l'articulation et soumis à un examen histologique. Le tissu conjonctif utilisé comme matérial d'interposition montrait un développement métaplastique cartilagineux. La nouveau cartilage était ou bien fibreux ou bien du type hyalin. Les trouvailles obtenues en clinique chez les malades correspondaient entièrement aux résultats des expériences chez les animaux. L'auteur en conclut que le processus biologique apparaissant dans les arthroplasties peut être éclairci au moyen des expériences sur les animaux.

ZUSAMMENFASSUNG

Der Verfasser beschreibt zwei Fälle von Hautgelenksplastik in denen eine neue Arthrotomie später ausgeführt wurde. In Zusammenhang mit der Operation wurden Gewebsproben von den Gelenksoberflächen erhalten und histologisch untersucht. Das als Interpositionsmaterial verwendete Bindegewebe zeigte eine knorpelige metaplastische Entwicklung. Der neue Knorpel war entweder fibrös oder hyalin. Die Befunde, welche man bei Patienten erhob, waren somit in vollständiger Übereinstimmung mit den Ergebnissen von Tierexperimenten. Der Verfasser schliesst daher, dass die biologischen Vorgänge nach Gelenksplastiken mittels Tierversuchen klargelegt werden können.

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