A. G. TIMBRELL FISHER: ARTHRITIS AND NEOPLASM PRODUCED BY RADIUM.

FIG. 1.—Left knee joint of rabbit. Tube containing 0.0382 mg. of radium fixed in contact with inner margin of condyle. Growth of cartilage after nineteen weeks. (Experiment 20, old series.)

Right knee.

Left knee.

FIG. 2.—Rabbit A. 2.44 mg. of radium bromide were introduced into the left knee-joint. Animal died eleven months later. A subacute arthritis is present with a mixture of degeneration and marked bony hypertrophy. The articular ends are greatly enlarged, and below and internal a large detached osteophyte is present. Associated with the degeneration of the central poorly nourished portion of the articular cartilage is definite proliferation of the better nourished lateral portion. (Experiment 1, new series.)

FIG. 4.—Osteo-arthritic changes in knee-joint of rabbit. (Experiment 5, old series.)

FIG. 3.—Periosteal sarcoma growing from the lower end of the femur. Sagittal section of knee-joint (natural size). (Experiment 4, new series.)

M. R. DRENNAN: THE AURICULO-VENTRICULAR BUNDLE IN THE BIRD'S HEART.

FIG. A.—Photograph of the A-V bundle, between the auriculo-ventricular openings (ostrich heart). P.=Pulmonary artery. A.=Aorta. R.O.=Right auriculo-ventricular orifice. B.=Bundle. L.O.=Left auriculo-ventricular orifice.

FIG. B.—Photograph of the right side of the dissected ostrich heart, showing the A-V bundle.

FIG. C.—Photograph of the left side of the dissected ostrich heart, showing the termination of the left branch of the A-V bundle in a complex network under the endocardium.

cartilage were similar to those seen in osteo-arthritis, particularly in the more localized "traumatic" forms.

In the second series of experiments, with larger quantities of radium contained in platinum tubes, a striking fact was the severity of the reaction. Although scrupulous aseptic technique was used, suppuration occurred in a large proportion of cases. It is probable that the suppuration was not introduced at the time of the operation, but was due to auto-infection, for it is known that bacteria settle in damaged tissues.

In Experiment 2 (new series) the total quantity of radium in the three platinum tubes introduced into the left knee-joint of the rabbit was 2.21 mg., and acute destructive arthritis of fulminating type supervened.

In Experiment 1 (new series) one tube containing 2.44 mg. of radium was inserted into the joint, and at the end of eleven months a marked degree of chronic arthritis or "rheumatoid arthritis," with a combination of destruction and hypertrophy, was found.

In Experiment 4 (new series) two platinum tubes containing a total quantity of 0.46 mg. of radium were inserted. At the end of fourteen months a localized abscess was found combined with a large sarcomatous growth.

We have already noted that in the experiments with radium contained in glass tubes changes akin to localized osteo-arthritis accrued. In the three experiments with radium in platinum tubes the results may be summarized as follows:

Experiment 2: Acute suppurative arthritis.

Experiment 1: Subacute arthritis of mixed type similar to "rheumatoid arthritis."

Experiment 4: Localized abscess and sarcoma.

It would be rash to form conclusions from a small series of experiments, but it would appear that the smaller quantities of radium contained in the glass tubes caused proliferative changes only. The larger quantities of radium contained in the platinum tubes caused destructive changes, whereas the smaller quantity in Experiment 4 caused the marked and irregular proliferation of a malignant growth. The resistance of the animal and the time factor are, of course, important.

THE AURICULO-VENTRICULAR BUNDLE IN THE BIRD'S HEART.

(With Special Plate.)

BY

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In fishes, amphibia, and reptiles the muscular wall of the auricles of the heart is continuous with that of the ventricles. In mammals the muscular continuity is almost completely interrupted by the fibrous auriculo-ventricular rings. The very attenuated auriculo-ventricular bundle (bundle of His) is the only direct neuro-muscular connexion between the auricles and the ventricles. The existence of this structure, in a more or less definite form, has now been demonstrated in the whole mammalian group.

In the heart of the bird, however, the presence of the bundle of His has not, so far as I am aware, been established. Keith and Flack (1907), in an important paper dealing with the "Muscular connexions of the primary divisions of the vertebrate heart," seemed to have no doubt that there was an auriculo-ventricular bundle in the birds' hearts which they examined. On the other hand, Mackenzie and Robertson (1910), in a paper dealing with "Recent researches on the anatomy of the bird's heart," state emphatically that "in the bird's heart there is no bundle of His, or other specialized form of muscle tissue connecting the auricles with the ventricles." These same authors state that "Tawara's monograph leaves the impression that the bird's heart resembles the mammalian heart in the possession of a special muscle system. He refers to fibres of the Purkinje type in the region of the blood vessels (of the bird's heart)." Dr. Alexander Morison (1912), in his paper "On the innervation of the sino-auricular node," states in his argument that in birds "most investigators have failed

to find the auriculo-ventricular bundle; not that this fact proves its absence."

The presence or absence of this structure in the bird's heart would seem, therefore, to be "not proven." Yet it seems to me that it is very important that an attempt should be made to decide this question. If the bird's heart can dispense with a bundle of His, it suggests that the physiological importance of the bundle is perhaps being overrated in the mammal. On the other hand, if the bundle can be proved to be present, it brings this heart and its contractile phenomena more into line with that of the mammal, and adds to the significance of this structure in cardiology.

Most workers hitherto have relied on the findings from a microscopical investigation of the hearts of small birds, but it would appear that such an examination is unsatisfactory from the fact that the bundle fibres, if they exist, appear to be little differentiated from the ordinary heart muscle. Keith and Flack¹ state that in birds they "have been unable to find any differentiation of fibres in the bundle; the guide to it being its position and its definite demarcation by fibrous tissue. In the birds' hearts examined (sparrows and goldfinch) the A-V bundle arises from the auricular ring and dives at once into the inter-ventricular septum."

FIG. 1.—Scheme of the distribution of the A-V bundle in the human heart.

FIG. 2.—Scheme of the distribution of the A-V bundle in the ostrich's heart.

I have recently dissected five ostrich hearts with a view to determining whether any trace of a bundle could be detected with the naked eye. The size of these hearts—they are as big as a small ox heart—gave promise that, if there was a bundle, it would be of tangible size. In all of these hearts I have been able to demonstrate a structure which is probably homologous and analogous to the auriculo-ventricular bundle in the mammal.

This structure is not so easily defined as the auriculo-ventricular bundle in the ox, but it is nevertheless as definite as the auriculo-ventricular bundles which I have been able to trace out in the human heart. It arises in the same region as the mammalian bundle, but there is no sign of any definite auriculo-ventricular node at its commencement. In several of the hearts, however, I was able to make out a rich nerve supply to this region from the right coronary plexus. At its commencement this structure is pale and delicate, varying in thickness in the different hearts examined. It is best made out by approaching it from behind, by separating the right and left atrial walls in the region of the interauricular septum (see Plate, Fig. A). It passes through the medial aspect of the right auriculo-ventricular fibrous ring, just under the endocardium, to which it is adherent. As soon as it reaches the interventricular septum it plunges deeply into its substance (see Plate, Fig. B), and runs obliquely towards the left side of the septum. Here, on the septal wall of the left ventricle, it divides at once into a large number of branches, which form a network just under the endocardium (see Plate, Fig. C). The distribution of this part of the avian bundle is very similar to that of the left branch of the mammalian bundle.

In the ostrich heart there is no branch of this bundle tissue having a distribution similar to that of the right

branch of the mammalian bundle—namely, running down the right side of the interventricular septum to the moderator band, etc. (see Fig. 1). There is a branch, however, which is analogous to this one, but it takes a very different course. As the avian bundle passes through the interventricular septum it gives off a branch, which runs in a curved direction to the left, then upwards and to the right, to end in that wonderful single muscle valve which in the bird's heart takes the place of the mammalian tricuspid (see Fig. 2). This avian muscle valve consists of a wedge-shaped mass of muscle, which extends from the upper limit of the right auriculo-ventricular opening to its lower part. It is situated on the lateral aspect of the opening, and it becomes closely applied to the septum when the right ventricle is in systole. It has no chordae tendineae nor muscoli papillares. This marked difference in the arrangement of the right auriculo-ventricular valve in the bird, as compared with the mammalian tricuspid, accounts for the very different course taken by the right branch of the bundles in the two hearts. On the other hand, the similarity between the avian and the mammalian mitral valves, and the almost identical distribution of the left branches of avian and mammalian bundles, has its significance. From the above considerations it looks as if the avian and the mammalian bundles have a similar function.

The general naked-eye characters of the auriculo-ventricular bundle vary very much in different mammals, and even in different individuals of the same species. In the ox heart the bundle is relatively thick, smooth, and rounded, and more like muscle tissue than the human bundle, which is thin, ragged, and pale, like a fine nerve fibre. In the ostrich heart the bundle is more like glistening fibrous tissue. This shiny appearance is more marked on the left side of the bundle than on the right, and on this aspect the bundle is easily separated from the heart muscle. Elsewhere the bundle is adherent to the muscle fibres, and it presents a ragged appearance when dissected out. Within the septum the bundle tissue gives off several fine white branches to the heart muscle in addition to the curious right branch already described. The individual variations of the several bundles dissected out in the five ostrich hearts are very considerable, especially as regards size and definition of the bundle system.

CONCLUSION.

The ostrich heart presents a system of fibres which is somewhat similar to the auriculo-ventricular bundle of the mammalian heart. The distribution of this system is such as to indicate that it has a similar function to the bundle of His—in short, that it constitutes a true avian auriculo-ventricular bundle.

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THE OSTEO-PERIOSTEAL GRAFT IN DANGLE-FOOT.

(With Special Plate.)

BY

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In *Surgery, Gynecology and Obstetrics* for February, 1926, Professor Rutherford Morison and Dr. William Mackenzie describe an "operation for dangle-foot" in which they use osteo-periosteal grafts to stabilize the ankle-joint. These grafts are taken from the patient's tibia, and are implanted to form osseous ligaments between the tibia and fibula above, and the astragalus and os calcis below. Two procedures are described:

(1) *Posterior grafts*—extending from the back of the tibial and fibular epiphyses to the sides of the os calcis below.

(2) *Lateral grafts*—stretching from the outer aspects of the malleoli above to the peroneal area of the os calcis externally, and to the inner aspect of the astragalus and os calcis below.

During the last year I have been associated with the authors at the W. J. Sanderson Home for Crippled Children at Gosforth, and I have had repeated opportunities of examining the efficacy of these procedures in fixing the ankle and subastragaloid joints, and of extending the principle in other directions. Time has shown that uniformly good stabilization is secured, and evidence is accumulating to demonstrate the superior value of the method.

In a number of cases of flail-foot astragalectomy had been performed to produce fixation, but the results were generally disappointing. It was found that there was a marked tendency for the foot to become fixed in a varus position, due partly to the over-development of the os calcis externally, partly to the irregular development of fragments of cartilaginous bone in place of the astragalus, and partly to the natural shortening of the longitudinal arch of the foot on the inner side after astragalectomy.

Other operations in which bone is removed to shorten the tarsus, and to arthrodese the astragaloid joints, are apt to leave the patient with feet that are unequal in size, and to present to him the ever-recurring problem of getting boots for feet which are not neighbours.

The paralytic foot is already often smaller than its fellow, and its bony tissue is thin and largely decalcified. For this reason alone it would seem to be better to fix such a foot by introducing bone, which may at the same time exert an osteogenic stimulus, than by removing it.

The illustrations show how remarkable is the growth of bone from the thin osteo-periosteal shavings which were used as grafts in these cases. The purpose of this communication, however, is to draw attention in this operation to the importance of accuracy in the process of embedding the grafts, and to illustrate the interesting though undesirable results which occurred in one case where the graft extended beyond the tibial epiphysis and gained an attachment over the epiphyseal cartilage to the diaphysis.

The case is that of a boy, aged 14 years, who had a paralytic dangle-foot on the left side. For this disability two posterior osteo-periosteal grafts were implanted on January 19th, 1925. Radiographic examination showed the grafts in position but reaching up over the epiphyseal "line." After fixation for six months the plaster-of-Paris casing was removed and the foot was again radiographed. Fig. 1 shows the two posterior grafts behind the ankle and subastragaloid joints. Their upper limits appear as bony shadows beyond the tibial and fibular epiphyses, the lower ends are seen to be blending with the bony texture of the os calcis. It is important to notice that the long axis of the tibial shaft is at right angles with the plane of the "epiphyseal" cartilage.

The boy was now (July 1st, 1925) permitted to walk about on this foot with no other support than the grafts. Fig. 2 is a radiogram taken six months later (December 9th). It shows how the grafts have become consolidated, and how the bones have increased in density. The upward extension of the grafts beyond the epiphysis is clear. Clinically, there was good fixation at the ankle, but a mild degree of equinus deformity. The radiogram shows this distinctly: the shaft of the tibia no longer makes a right angle with the plane of the epiphyseal cartilage, but is inclined backwards from it in a manner which is comparable to the inward deviation of the femoral shaft to its lower epiphysis in cases of genu valgum. This can only be due to the freer growth of bone at the front of the tibial epiphyseal cartilage, the posterior region having been fixed down, as it were, by the binding pressure of the grafts.

The ultimate result in this case would naturally be spoilt by the further development of this bony deformity causing a fixed equinus. Indeed, it is possible that the amount of equinus already present was enough to cause this boy to jar his foot and fracture one of the grafts two months later. Attention was called to the fact by his complaint of pain at the back of the ankle, and the third radiogram (Fig. 3) shows this condition (February 11th, 1926).

The presence of pain and the fracture in the graft are recorded as interesting features of this case, since radiographic examination of other cases occasionally shows clear areas in the graft without there being any history of pain in the neighbourhood. It is not yet certain that these areas of rarefaction are fractures; they may be, but it is fortunately true that their appearance has not interfered with the clinical results. The radiogram shows very clearly the increasing tibial deformity. Professor Morison's instruction that the grafts should extend up to but not over the