

# ARTHROPLASTY

By

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## PREFACE

UNTIL thirty years ago the teaching regarding the surgical treatment of arthritis dealt with drainage of joints, splinting of limbs and consideration of the correct position in which a joint should be allowed to ankylose so as to permit of the best function. As a rule reconstructive surgery was delayed for a year or so after subsidence of any symptoms and signs of active disease. Then and only then was a surgical procedure considered advisable, and this was directed to relieve pain and provide function sufficient at the least to enable the patient to earn a livelihood. Undoubtedly many patients were grateful to their surgeons. There has been a gradual development of ideas and projects which were originated in the last century, so that more useful limbs have been provided by the recent methods and the many failures have been avoided. Credit should be given to those who realized years ago the necessity to relieve pain, for certainly such alleviation brings to the patient an appreciation of the benefit of surgery. The failure to relieve pain or the production of more pain, or a different type of pain, will bring discredit to the surgeon and to the procedure he has employed.

During this century there has been a very obvious desire by the patient to accept surgical treatment for a painful and distorted joint, and the number seeking the surgeon's assistance has been so large because of the frequency of chronic arthritis—particularly the monarticular arthritis—and of the injuries resulting from two World Wars and the mechanization of industrial plant and transport. From the surgeon's viewpoint his scope has been greater, as improvements have taken place in operative technique and ancillary treatment. In recent years infection has been largely eliminated by antibiotic and allied drugs.

It is no exaggeration to say that there is a vast accumulation of scientific material on this subject, but it is noteworthy that the individual experience of few workers is large. This is shown by the study of the literature. Many articles are based on experience of one or two patients only.

Whilst preparing a lecture on Arthroplasty to commemorate Robert Jones, it became evident that it was not possible to report on all aspects of this subject in the allotted time. Circumstances permitted me to study more widely my own work and that of others, and in this monograph an attempt is made to analyse the problem of the painful and disabled joint. The indication for operation and

principles of operation and post-operative treatment are discussed and reviewed critically. The object is twofold: To review the work of fifty years, particularly in America and Great Britain, and to give a lead to those who are reviewing their own work and to the younger surgeons who are beginning their professional career in orthopaedic surgery.

It is impossible to express adequate thanks for the help and criticism given by all those who have assisted me in operations on joints during my surgical career. Likewise in recent years many friends have given me the benefit of their experience in discussion or letters.

I appreciate particularly the letters from surgeons of other countries, who have recorded willingly the results of their work, as a review of the work in one country is too limited to-day.

I owe much to William Waugh, an assistant in recent years, who has helped me by his very critical review of the work I did during the last few years. His enthusiasm encouraged me to proceed with the task of collecting the subject matter of the book. He was the joint author of Chapters 6 and 7, which are little altered from the form in which they were published in the *Journal of Bone and Joint Surgery*. My thanks are due to the Editor and Publishers for their permission to include this material in the book. I wish to acknowledge my gratitude to the Editor and Publishers of the *Annals of the Royal College of Surgeons of England* for permission to reproduce illustrations and some paragraphs from my article on arthroplasty.

The charts for pre- and post-operative assessment, pain and operation, were devised by William Waugh for the study of patients who had an arthroplasty of the hip. They provide for a thorough record and have been used in Canada as well as in England.

It is hoped that Miss Kidd's writing on physical treatment will be useful as a basis for a post-operative programme.

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## CHAPTER 1

### HISTORICAL

As a result of examining this subject I consider it is proper to give credit to many who during their lifetime have provided information which, in due course, has assisted others. By doing this one is able to study the development of the operation of arthroplasty (the operation of mobilizing a joint) and the surgical treatment of ankylosis. Hence it is intended to review here the methods employed by many surgeons and an attempt will be made to indicate the value of each advance.

J. Rhea Barton of Philadelphia (1827) is credited as being the first to attempt arthroplasty for ankylosis of the hip. His name is commemorated in the University of Pennsylvania, as the professorial chair carries his name. In 1826 he performed an osteotomy through the trochanteric region and part of the femoral neck. Union was prevented by active movements. Some success appears to have resulted from the operation, in that some movement was restored and there was good weight bearing for six years. The principle was used later by Rodgers of New York (1840), Robert Jones of Liverpool (1908) at the hip, by Esmarch, Rizzoli, and Murphy (1905) and McIlhenney (1901) for the jaw, and so established the practice of osteotomy adjoining an ankylosed joint. Fergusson (1861) carried out at King's College Hospital what he called an excision of the knee with only partial removal of the patella. Mobility remained and the patient could jump off a chair and run upstairs. He said that "the result of this operation put an end to the factious opposition of persons, who knew nothing on the subject and yet declared that no good result could be obtained unless ankylosis occurred and this was so rare that the operation must, therefore, be considered inadvisable."

Ollier's work, published in book form in 1885, made history. The physiology of joints was well known to him. He invented and used instruments suitable for joint surgery; he developed the technique of muscle implantation in arthroplasty which had been employed by Verneuil (1860) and was used later by Helferich (1894). He described the effects of movement after operation. The muscle flap arthroplasty attracted attention, particularly for the jaw (Hoffa, 1906; Mikulicz, 1895). In the latter part of the last and the early part of this century the method was employed for many joints. Its

use for some of these (e.g. superior radio-ulnar) has since been proved to be unnecessary. (Quénu, 1902, 1905; Nélaton, 1905; Hoffa, 1906; Schanz, 1904; Huguier, 1909.) Of the many who carried out the earlier operation of this type Delbet (1903) and Murphy (1913) are well known.

John B. Murphy's life history is recorded by Professor Loyal Davis in *Surgeon Extraordinary*. In Chicago at the N.W. University Hospital and Medical School he did much of the clinical and experimental work known to surgeons during and since his lifetime. Intestinal anastomosis ("Murphy's button"), pulmonary surgery and arthroplasty attracted his attention in particular. He began investigations into arthroplasty in July, 1901, and later did experimental work on dogs (1905). He was able to produce movement in a joint after interposition of flaps of fascia and muscle covered with a layer of adipose tissue. A new capsule formed, within which there was fluid which he called intra-articular collagen fluid. At this time he operated on hip, knee, elbow, and temporo-mandibular joint. In 1905 he published a long paper, which at that time was regarded as being of great importance. He devised his instruments for joint surgery and laid stress on the importance of fat and fascia or muscle being placed between the bones after division at suitable level. He was not averse to fixing the bones with wire after operation. There was no pretence that every operation was a success. He contended that the failures resulted from, or were contributed to by—

- (a) insufficient or defective excision of synovial membrane capsule or ligaments;
- (b) insufficient interposition of fat and aponeurosis or of fat and muscle between the surfaces;
- (c) infection;
- (d) sensitiveness to pain on motion after operation.

At this time he considered his work was the first systematic production of new and practically normal articulations.

By 1913 his experience was sufficient for him to say that arthroplasty was no longer a dream. Fortunately his optimism did not deter him from employing newer methods. He recorded that the flaps of interposed material should cover the articular surface of both bones but be fixed to one only. He considered that if sepsis occurred, particularly in a haematoma, the procedure was likely to be useless. He was encouraged in the hip operation by the use of his reamers. After-treatment was organized and consisted in double abduction after hip operation with 20 lb. weight extension. Passive movements were used after seven to ten days and the patient got up in three to four weeks. Illustrations show that exercises were employed at that time.



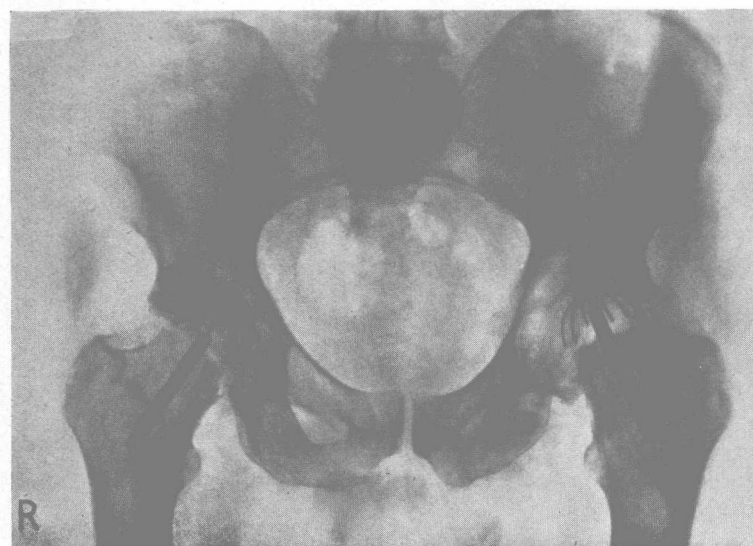


FIG. 1. (*Upper*) Bilateral osteo-arthritis in a man aged 53. (*Lower*) Radiograph seven months after second arthroplasty, using a Judet type prosthesis with umbrella pattern head. Two years after operation he had active movement to the extent of  $45^{\circ}$  flexion at each hip, no abduction of right but  $15^{\circ}$  abduction of the left hip. Sixteen inches separation between the ankle malleoli was possible.

He was pleased with elbow operations and reported the difficulties of six knee cases.

Charles H. Mayo (1908) reported the success of his method of surgical treatment of bunion. He gives credit to Murphy for his work on arthroplasty on other joints. During the eight previous years Mayo operated on sixty-five patients, carrying out bone section and inserting the bursa in the space produced. He made the point that the under surface of the joint floor was not disturbed, so that the cushion and sesamoid bones were left intact.

Robert Jones (1908) related his experience. He reminded us that Gluck made "ivory joints" in the last century, but found that after

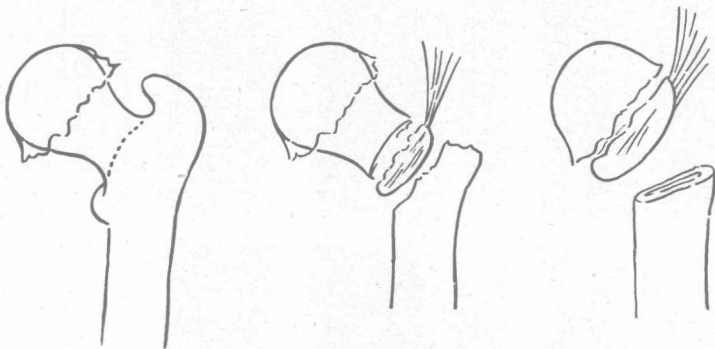


FIG. 2. Diagram of the original Robert Jones hip arthroplasty for osteo-arthritis. In the one type, after osteotomy of the femur through the intertrochanteric line, the great trochanter is divided from the femur, with the muscles attached to it and then fixed to the base of the femoral neck. In the other type, after removal of the neck (or if this had absorbed), the trochanter is fixed to the subcapital area.

a few months the foreign body was extruded. This work was repeated later by Hey Groves (1923).

Robert Jones had placed gold foil between the bones as far back as 1895 and later used this in conjunction with soft tissues. He found his best results followed free removal of the bone, but that if the removal was excessive a flail joint sometimes developed. In 1908 he published his experience of a hip arthroplasty based on the principle suggested originally by Barton. The steps consisted of—

- (a) removal of the great trochanter;
- (b) osteotomy of the neck;
- (c) fixation of the great trochanter to the neck below the head;

or completion of (c) after removal of the neck and trochanteric region.

In 1913 the International Congress of Medicine took place in

London and attracted leaders of the profession from many parts of the world. A discussion on ankylosis of joints was held, doubtless because arthroplasty was being practised by a number of surgeons. It is most suitable to consider the reports after an interval of forty years. By this time there was an appreciation of asepsis, the value of radiography in bone and joint surgery was recognized and not a few surgeons limited their work to the surgery of the locomotor system.

William S. Baer (1913) of Johns Hopkins Hospital, Baltimore, considered six methods of treatment of ankylosis—

- (a) brisement forcé, which we should call manipulation;
- (b) arthrolysis, which might be the injection of fluid into the joint cavity or an operation producing separation of the ankylosis with or without the insertion of oil or other sterile fluid followed by active and passive movement, carried out as continuously as possible;
- (c) the formation of a pseudarthrosis (false joint) in the neighbourhood of the ankylosis, usually by excision of a ferrule or cylindrical portion of bone (Jones, 1908; Esmarch, quoted by Murphy, 1905; Sayre, 1869; etc.).
- (d) resection, that is removal of the ends of the bones forming the joint, such as the lower end of the humerus, head and neck of radius and upper end of ulna, including the olecranon and coronoid process. The principle was a reliance on maintenance of the separation of the bones. (Defontaine, 1887; Helferich, 1894; Kirkaldy-Willis, 1948.)
- (e) Transplantation of an entire joint, as carried out by Lexer (1908) on the knee (two cases) and on a finger (one case) and by Herndon and Chase (1952).
- (f) Arthroplasty, which was intended to provide a joint such as nature made. Ankylosis of the jaw causing difficulty in eating, was treated by arthroplasty, several types of operation being devised.

Baer referred to Chlumský (1900), who reported on animal experiments, and he considered that a suitable material for interposition must be found. Hence he tried tin, zinc, silver, celluloid, rubber, collodion, plates of decalcified bone, and of magnesium, and said that the last was the best.

He thought this work of importance but said that fascia, free or as a flap, was becoming popular since it was advocated by Murphy. He classified academically the substances that could be used into

*organic* and *inorganic* and an *absorbable* material. The advantages of using a material that would absorb were—

- (a) that the joint would remain as near its normal size and shape as possible;
- (b) that the operation was simpler than using a fascial flap;
- (c) that the stability of the joint was little destroyed;
- (d) that there was less chance of infection;
- (e) that the after-treatment was less painful;
- (f) that after sixty to one hundred days the inserted foreign body had been absorbed.

It is customary to state these first five advantages, when any new operation is devised. Those who have studied this subject will know that he reported fifty-two cases, using as his absorbable material chromicized pig's bladder! It is interesting to note that he operated on nineteen knee and twenty-three hip joints. Of the latter only two were affected by osteo-arthritis, the remainder having ankylosis after tuberculosis or gonorrhoea. After three weeks immobilization in plaster of Paris, passive movement was employed for a week and followed by active movements. The patients were mostly under the age of 20 and many between 9 and 14 years of age. The results were encouraging.

His observations on the elbow would be considered basic principles at this time. He realized that resection of bone is the important factor, not the interposition of muscle, metal, fat, or fascia. Weight bearing is not required and stability is not of prime importance.

Osgood (1911) reported Brackett's work and he was satisfied with the use of Baer's membrane.

Allison and Brooks (1913), and Phemister and Miller (1918), carried out experimental work, which showed the reaction of the surrounding tissues to interposed soft structures and that free or pedunculated flaps would break down. The observations of Phemister and Miller went further, as they believed that surviving interposed structures have nutrition through the adhesions to surrounding parts. Perhaps too little interest has been taken in their findings that the coverings of new joint surfaces are derived from exposed marrow spaces of denuded bone and that fascia plays only a secondary role in the construction of new joint coverings.

It appears that most of the operations up to World War I were carried out on joints previously infected by blood-borne organisms. Putti (1921), who had performed arthroplasty for the first time in 1911, was subsequently in a position to report on his valuable work. He paid homage to Murphy and with quite uncalled-for humility said he could only present a modest contribution of facts. This



PLATE 1. The late V. Putti



included general principles, technique and his considerable experience of the operation. The indications for operation he considered absolute when there was ankylosis of the jaw, of both hips, of the elbow in extension, and of many joints in the same limb. However, the general condition of patients less seriously affected must be investigated—as regards general health—including the general risk, age, work, social and mental conditions. He considered the operation unsuitable for children and old people.

In the first group of 113, two patients died. He found that arthroplasty was most satisfactory for elbow and then knee, jaw and hip in that order. He preferred to carry out knee operations on patients between the ages of 20 and 50 and considered a good result more likely at 55 than at 15. It was essential that the patient gave active co-operation to the surgeon. It is noticeable that in one group of ten patients, the oldest being 29 and the youngest 16, all knees had a range of movement greater than  $50^{\circ}$  but less than  $100^{\circ}$  after operation.

Putti was an advocate of careful after-treatment. Many limbs were immobilized in plaster for ten days, sometimes with a traction apparatus also, after which movements were started using a pulley. Hot-air baths were employed, often for a number of months.

He considered that the prognosis was better after operation on an injured joint (such as after a fracture into or near a joint, or a gunshot wound) than on a previously infected joint. He realized the necessity of postponement of operation until the acute phase was past. In addition his experience indicated that arthroplasty was more likely to be successful if performed for chronic arthritis than after an acute arthritis.

At that time a divergence of views began to appear, regarding the interposition of soft parts. Putti approved of Baer's procedure or the use of Cargile's membrane, but favoured free flaps after accurate reconstruction. He did not employ drainage. His experience taught him that—

- (a) it was advisable to remove completely all intra-articular structures;
- (b) after operation there was a hypertrophy of tissues, so that the knee usually remained larger than the other one;
- (c) operation too soon after an acute inflammation had subsided meant failure;
- (d) great gentleness of physical treatment was required subsequent to operation after a gonorrhoeal infection.

It is likely that the last two observations are no longer of importance owing to advances of antibiotic treatment.



Prior to the World War I surgeons of this country had made no contribution to our knowledge of arthroplasty. During the war Robert Jones organized orthopaedic centres, at which there was ample opportunity to study the treatment of ankylosis, as it was so frequently a sequel to local infection following gunshot wounds of the limbs. I had the privilege of being a junior member of a team doing reconstructive surgery from 1919 to 1922 in one of these special hospitals.

Hey Groves (1923) reported the British work at the Congress that year, but Verrall (1920) had published a brief and lucid account of his work, which merits consideration.

He felt it was not possible to ensure that a joint after arthroplasty had the stability of a natural joint. This made him conservative, and he advised that the special indication for arthroplasty on knee and hip was double ankylosis, but considered that a partial arthroplasty often assisted the patient. He was an advocate of this operation between patella and femur, which was popular before removal of the patella attracted attention. He promised fair results in an elbow and used a fascial bag over the lower end of the humerus, as he did over metacarpal heads.

Verrall was a pupil of Elmslie (1919) who wrote *The After-treatment of Wounds and Injuries*, in which there is some reference to arthroplasty and its after-treatment. At that time he advocated that the operation on the elbow should be done in two stages, the second being on the radio-ulnar joint, because he said there was less stability if it was made a one-stage operation. He used pedicle fascial flaps. He lays greater stress on the skin incision than on the approach to the joint surface. All who worked at that time would appreciate what a strong advocate he was of active movements and functional re-education. His opinion was greatly respected and he certainly was a great teacher regarding the after-treatment of orthopaedic operations.

At the International Congress of Surgery (1923) held in London, this subject was fully discussed. It was an opportunity to take stock. Surgeons from the United States, France, Italy, and Great Britain spoke at length. MacAusland (1923) of Boston read and later published a long paper, which records the history and reports his own methods of restoring movement to an ankylosed joint. It is likely that this influenced many surgeons for twenty or more years. From 1923 onwards, it is noticeable that surgical papers are of similar pattern—a statement regarding progress, the author's methods and why they indicate originality and progress, and case histories with better end results than others recorded. If particular comparison is popular, there may be tables showing points by figures, graphs, bricks or some recent method.

It has been my aim to find out if the basic principles have changed since the days of Murphy. MacAusland (1923) is helpful because he wrote and illustrated in a practical way. Santy (1923), from Lyon, employed the methods for joint resection outlined by Ollier. This means that an uninterrupted subperiosteal resection of the joint and ends of the bones was carried out—(this is not the method of to-day because of reformation of bone in muscular attachments). A neoarthrosis of the shoulder was examined four years after operation. He says a capsular ligament and synovial membrane were found, but there is no microscopic report. It is likely that the French surgeons at that time were inclined to follow Ollier, avoiding original thought and the experience of others. Santy had little experience of hip or knee arthroplasty and considered resection for ankylosis a secondary method suitable if arthroplasty failed.

Hey Groves departed from the usual pattern of the surgical reporter of that time by discussing information collected from all British surgeons who had been doing operations to mobilize joints in England. He obtained reports on only 182 cases including his own (elbow 94, hip 69, and knee 19). He was interested in mechanical advances and it is well known that he spent much time and energy on the technique of an operation. Hence it is not surprising that he looked for methods by which he could avoid the instability that followed many operations at that time. His replacement of the femoral head by beef bone was well known in this country, but the results were not promising. One observation he made which is common knowledge to-day is that osteo-arthritis (implying the existence of the pathological changes called erosion of cartilage and lipping) did occur in a pseudarthrosis following un-united fracture. He had considerable experience of the osteotomies of neck and subtrochanteric area advocated by Robert Jones, but he placed a flap between the bony surfaces.

In analysing the problem of arthroplasty Groves considered it important to shape the ends of the bones after making sufficient gap. He found that the technique varied in regard to covering the bone ends. The provision of a lubricating fluid appeared necessary and no oil or other extraneous fluid served the purpose of synovial fluid. It seemed important to remove capsular structures to provide free and painless movement, but this had to be balanced against the resulting loss of stability. He agreed that it was advisable to make too loose rather than too tight a joint. In the case of an unstable knee after arthroplasty he operated a second time in three to six months to repair the ligaments.

Experience in the U.S.A. was growing, and is recorded in a number of papers by Fred Albee (1919, 1928, 1933, a and b) and Willis