A Lecture

ON

A NEW MATERIAL (DURALUMIN) FOR
SURGICAL APPLIANCES.DELIVERED AT THE MEDICAL GRADUATES' COLLEGE
AND POLYCLINIC,

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By the term "surgical appliance" I understand all sorts of instruments of the surgeon's art which are applied to the patient's body in the treatment of deformity, disease, or injury.

Such appliances have been used as far back as the history of civilization takes us. Recent excavations in Egypt have revealed to us wooden splints still *in situ* on the mummified broken limb, and even the blood stains on the bandages have been preserved by the dry and sterile sand of the desert. In Italy many bronze appliances have been found, and artificial limbs, strengthened with plates of that metal. No doubt, iron was used in surgery very soon after its use in the arts was discovered, but, if so, oxidation has long ago removed all traces of the appliances which may have been made of that metal. The process of tempering steel was certainly known as early as the ninth century B.C., for Homer describes it, and an iron implement has been found imbedded in the pyramid of Kephron, in Egypt, which is probably as old as 3500 B.C.

I have already referred to the use of wood in ancient times in Egypt. This material remains the best material for many splints and for artificial limbs, but many other substances have been and are used for various purposes, such as leather, gutta-percha, celluloid, poroplastic felt, pasteboard, paraffin, glue, waterglass, and plaster-of-Paris, to mention some of them.

Iron and its properties are so familiar to us that we hardly realize what a remarkable metal it is. It is difficult to conceive our civilization without it. To take one of its properties only, its capability of being magnetized, how many of the modern applications of electricity would be possible without it?

Yet iron in a pure state unalloyed with other elements is a chemical curiosity. Carbon is the element with which it is commonly combined, and the various characteristics of wrought iron, steel, and cast iron depend upon the amount of carbon which they contain.

Steel, strictly speaking, is that form of iron which, containing more carbon than wrought iron and less carbon than cast iron, possesses the valuable property of becoming hard when, being heated to a red heat, it is suddenly cooled. The degree of this hardening depends on the temperature of the steel just before it is cooled, and this process of hardening is known as tempering. It is this property which has given to steel its great value in the arts, and this it is which makes it so useful for surgical appliances. "Mild steel" is really only a pure form of wrought iron incapable of being tempered.

Steel has held the field almost unchallenged for hundreds of years. The demand for offensive and defensive armour stimulated improvement in the production of the metal and in the skill of the craftsmen who made armour, until by the sixteenth century these latter knew pretty well all that was knowable of their business.

One armourer at least turned his attention to the making of orthopaedic appliances. Skatt (or Schacht?) of Utrecht, in the middle of the seventeenth century, won a European reputation and a large income by his treatment of deformities with steel "harness." In that delightful work, *The Memoirs of the Verney Family*, a good deal is to be found about him, a summary of which appeared in the BRITISH MEDICAL JOURNAL some years ago.¹

An eighteenth century instance of the use of steel supports is to be seen in the last picture of Hogarth's series of *Marriage à la Mode*, in which the child wears "irons" on its legs. A famous inventor of instruments

of the end of the eighteenth and the beginning of the nineteenth century was Robert Chessher, a surgeon who devised many appliances, and is referred to by Mrs. Taft in *Middlemarch*, Book V, chapter xlv, thus: "I remember Mr. Chesshire (*sic*), with his irons, trying to make people straight when the Almighty had made them crooked."

Chessher died an old man in 1832, when orthopaedic surgery scarcely existed, and it is since that time that the increased attention given to deformities has led to the production of many ingeniously devised and skilfully made instruments, some of which I had the honour of recommending to the notice of the Polyclinic in a lecture a year or two ago. Into the construction of nearly all these instruments steel enters largely, and leather is used as a covering and for the manufacture of surgical boots.

Despite the great advantages of steel, its strength, its adaptability, and its elasticity when used in the shape of springs, it has certain disadvantages, and of these the two chief are its weight and its liability to corrosion.

Weight.

Many of the cases in which instruments are needed are the results of anterior poliomyelitis. In such the wasted muscles often find themselves severely handicapped by the weight of the appliance which is necessary to enable the limb to be used advantageously. It becomes, therefore, a great object to save every ounce of weight that can be spared.

Corrosion.

Corrodibility becomes a drawback in practice only when the steel is exposed to the moisture of the body, and especially so when it is covered by padding, as those parts of an instrument which are in actual contact with the body necessarily must be. In that case not only is the steel rusted and weakened, but the oxide formed increases the corrosive effect of moisture on the leather and on the padding.

Thus, in a walking instrument the steel plate which is riveted between the inner and outer soles of the boot, and by which the uprights are attached to the boot, is very apt to perish and crack, being corroded as much by the perspiration which soaks through the inner sole as by external moisture. Still, steel has held its ground, although for a few appliances, such as flat-foot plates, aluminium bronze has been used. Although not so easily corroded, its specific gravity is as high as that of steel, for it consists of 90 per cent. copper and is much heavier for the same strength.

When the electrolytic method of preparing aluminium was discovered and that metal was first obtainable at a moderate price, hopes were entertained that it might be used for surgical appliances, and some were made of it, but although very light and not easily corroded it was found not to be stiff enough if pure, and when alloyed it was brittle.

DURALUMIN.

Thus matters remained till a year or so ago, when Messrs. Vickers, Ltd., put on the market a new alloy, which is called Duralumin, and was used in the construction of the naval air ship, which, through no fault of its material, was wrecked at Barrow.

This metal is an alloy of aluminium slightly heavier than that element. It has a specific gravity of 2.8, while aluminium is 2.7 and steel 8, so that it is rather more than one-third the weight of steel. Its strength, however, is about the same as that of mild steel of the same bulk. Like brass it can be made stiffer by hammering, and it is supplied in varying degrees of hardness, according to the purposes for which it is required.

It is practically non-corrodible, being scarcely affected by prolonged exposure to a concentrated solution of sodium chloride, ammonium sulphate in 10 per cent. solution, ammonia, sulphuric or nitric acids, sulphuretted hydrogen solution, or sea water. Caustic alkalis, however, attack it quickly.

Duralumin takes a high polish, which is scarcely dulled by prolonged exposure to the air, even to the air of London. It cannot be brazed, but it can be soldered; as soldering has an annealing effect on it, it is not often advisable to use solder. Nor can it be tempered like steel, but the hardening effect of hammering or rolling takes the place of tempering to some extent.

Having these qualities, duralumin seemed to me to be likely to be useful as a material for orthopaedic instruments, and I asked Mr. Albert Evans to procure some, and to experiment for me at the National Orthopaedic Hospital. The first appliance was supplied about six months ago; since then a number of instruments have been made and used, and have given me satisfaction.

Among those appliances which have been tested by actual and often rough wear, and of which specimens are now shown, are Thomas's hip and knee splints, double Thomas's splint for Pott's disease, spinal supports, walking instruments for paralysis and for severe flat-foot and flat-foot plates. It will be noticed how light they all are. One of these plates which I now show has been in use for some months during last summer and was necessarily exposed to a great deal of perspiration, yet, as is seen, the surface is not in the least corroded. The under surface of this plate, however, is roughened from friction against the sole of the shoe.

All of these instruments have been made for me by Mr. Albert Evans of Fitzroy Street, W. Their cost is the same as that of steel instruments of the same quality, so that hospital patients are able to profit by the good qualities of duralumin.

Duralumin might very well replace wood for many splints, especially for use in countries where white ants are found. It is easily shaped, and it has the advantage over wood that it can be sterilized by boiling without injury.

I have also found another important use for it in combination with gypsum for splints when an *x*-ray picture is wanted without removal of the splint. This often happens in the treatment of congenital dislocation of the hip-joint. An attempt at reduction is made, and the limb at once fixed in plaster-of-Paris while the patient is anaesthetized. If it is then desired to ascertain the exact position of the parts by *x* rays, it is found that without dangerously weakening the splint by cutting away plaster it is impossible to get a satisfactory picture.

By using a duralumin splint, or by merely applying plaster to the thigh and the upper part of the pelvis and connecting these separate segments by strips of sheet duralumin a perfectly firm appliance results, and as the *x* rays are able to penetrate the duralumin easily a good picture of the hip can be obtained. The *x*-ray prints which Mr. Stanley Melville, Radiographer to the Royal National Orthopaedic Hospital, who suggested this use of duralumin, has been kind enough to take for me show that the image is improved rather than the reverse when the rays have passed through a thin sheet of duralumin of No. 14 B.W.G.—that is, of about $\frac{1}{16}$ in. thickness.

It seems probable that a great sphere of usefulness lies before the alloys of aluminium, and no doubt further improvements will be made in them, and this metal, of which the supply is practically inexhaustible, will enter more and more into our daily life, although I will not go so far as an American authority, Professor Marion Hew of Columbia University, who has expressed the opinion that "at some remote day" (when iron has become scarce) "aluminium, or one of its alloys, may become the great structural material, and iron be used chiefly for those objects for which it is especially fitted, such as magnets, springs, and cutting tools."

REFERENCE.

¹ The Treatment of Spinal Curvature 250 Years Ago, BRITISH MEDICAL JOURNAL, 1903, vol. ii, p. 89.

THE German Balneological Congress will hold its thirty-third annual meeting at Berlin in March (7th-11th). The general secretary is Dr. Brock, Berlin, N.W. 52, Thomasiusstrasse, 24.

THE Berlin Society of Urology was formally instituted on January 16th. Professors Carl Posner and L. Casper were elected presidents; Professor Kutner, vice-president; Professor Rumpel, secretary; Dr. Mankiewicz, treasurer; and Dr. S. Jacoby, librarian.

THE President of Venezuela, we learn from our American contemporary *Science*, has issued a decree creating a National Bureau of Sanitation. Under its auspices will be inaugurated an Institute of Hygiene, which will be composed of a laboratory of bacteriology and of parasitology, a veterinary department, and a central station of disinfection. The staff of the bureau will be composed of a director, a subdirector, a bacteriologist, an engineer, a biologist, a veterinary surgeon, an inspector-general, two technical aids, a secretary, and two laboratory assistants.

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A NOTE ON THE VALUE OF ANCHORED DRESSINGS IN SURGERY.

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THE methods of keeping dressings on by means of bandages, strapping, and collodion, are neither satisfactory nor suitable in certain regions, because reliable protection from infection of the line of the operation wound is not guaranteed nor rendered approximately safe by such means.

In order to get over this difficulty in operations upon these regions, thus unfortunately handicapped in a surgical sense, namely, the perineum, the buttocks, and the upper-inner regions of the thigh, I began anchoring the dressings in the fashion indicated in this paper about eighteen months ago. For example, in a case of subcutaneous sarcomatous tumour involving the vulvo-vaginal region, with secondary growth extending downwards along the course of the gracilis, it was necessary, in the first place, to make

a long antero-posterior incision close to the junction of the skin and the vulvar mucous membrane, and a second incision extending at a right angle from its centre downwards along the inner side of the thigh for about four inches. In this situation none of the ordinary methods of applying and keeping on dressings were either trustworthy or practicable. However, I found that a carefully planned anchoring of a T-shaped dressing to such a wound gave every satisfaction.

The experience gained by anchoring dressings to the surgically handicapped areas proved so welcome that I have for the last fifteen months extended the principle to other regions where any of the ordinary methods gives satisfaction, chiefly on account of its simplicity and efficacy and comfort to the patient. I have used the anchoring method for operations such as those upon the Gasserian ganglion, the face, in laminectomy, operations on the kidney, liver, and uterus, and in other abdominal operations.

I use neither bandages nor wool but confine the protection of the wound to the simple anchored dressings, with the addition of bismuth and xeroform paste to the skin incision, and of vaseline around the contact area of the skin, and gauze dressing. During the tropical heat of last summer such a dressing was very agreeable to patients.

The diagram, kindly made for me by my friend Dr. Owen Ll. Rhys, indicates clearly the method adopted, and the principle involved in the application of the dressing. In an operation for the radical cure of umbilical hernia, for example, in a very fat patient, the sutures of the anchored dressing are passed through the skin and adipose tissue right down to the fascial buried sutures, and are placed fairly close to each other in order that the dead space of the approximated surfaces of the subcutaneous fatty tissue may obtain positive pressure, and so prevent exudation of blood or serum, and also obviate the necessity of drainage. The general appearance of the dressing when finished resembles, according to a friend's opinion, that of a cracker.

SCHEMA OF AN ANCHORED DRESSING.

The vertical line indicates the skin incision and its suture; a, b, c, d, e, f, g, indicate the anchoring sutures of the gauze dressing. Note the relative positions of a and g to the ends of skin incision.