Without entering on the debatable ground of statistics, I am prepared to state definitely that fewer recurrences take place after this operation than after any other method of which I have experience. In hernia, as in other operations, the results depend largely on the selection of cases, and probably any experienced surgeon could operate upon a number of hernia cases by any method with only a small percentage of failures if allowed to choose his cases.

The Operation.

We perform this operation under local anaesthesia as a routine measure. Local anaesthesia possesses great advantages over general anaesthesia for hernia operations. A half per cent. solution of novocain, to which a small quantity of adrenalin is added, is used. The needle of the analgesia syringe is entered at a point midway between the anterior superior iliac spine and the spine of the pubes half an inch above Poupart's ligament. The whole anaesthesia is conducted through this puncture without withdrawing the needle. An incision from half an inch to an inch in length is made over the needle puncture and carried down to the aponeurosis of the external oblique. The fibres of the external oblique are split for a distance of half an inch. The opening in the external oblique should lie directly over the spermatic cord. The cremasteric and spermatic fascial coverings of the cord are drawn through the aperture of the external oblique. The cremasteric fibres are separated and the spermatic fascia incised; the sac is then found lying inside these coverings. Two pairs of fine haemostatic forceps (Halstead's mosquito forceps) are placed upon the edge of the sac, and an incision, half an inch in extent, made between them by a snip of a pair of scissors. The two layers of the sac forming the lips of the aperture are now clipped with haemostatic forceps. The aperture can now be held open by four pairs of forceps, and four incisions are made, one between each pair of forceps, enlarging the aperture sufficiently to display the interior. If omentum lies in the sac it is drawn out, ligatured, and cut off. The interior of the sac presents for examination two apertures, one the internal ring passing into the abdomen, the other passing down the inguinal canal. These apertures are separated from one another by a process of peritoneum, the "crista," and in a well-marked case the apertures resemble the muzzle of a double-barrel shotgun.

The process of peritoneum called the crista corresponds to the internal margin of the internal ring. Forceps are clipped on to the crista in one or two places. It is now necessary to separate the important tube of peritoneum leading into the abdomen (the neck of the sac) from the unimportant tube leading down the inguinal canal. This is done by cutting along the crista to the mesial side of the forceps, and dividing one layer of peritoneum with scissors. As the result of this incision the neck of the sac now lies clear, held by the forceps on the crista on its mesial side, and the forceps on the outer side of the sac. The neck of the sac has in this way been completely exposed and freed without dissection. A gauze swab is gently passed down the outer and inner side of the sac. A gentle pull is made upon the neck of the sac whilst it is ligatured as high up as possible. It will be remembered that the crista corresponds to the internal ring, and by separating the crista forming the neck of the sac in the manner described above, and pulling upon the sac, it has become possible to ligature the peritoneum, forming the neck of the sac, about two inches above the internal ring. It is unnecessary and undesirable to perform any displacing manoeuvre to the neck of the sac. When the sac is cut off distal to the ligature, the elasticity of the peritoneum will displace the ligatured sac well behind the rectus muscle. In 90 per cent. of cases this is all that it is necessary to do, and the skin incision is sutured with silkworm gut passing down to, and taking up the edge of, the external oblique. In cases in which a large internal ring or very thin peritoneum renders a recurrence more possible, the conjoined tendon is drawn over the cord and sutured to Poupart's ligament without enlarging the wound. In exceptional cases it may be considered desirable for similar reasons to convert the operation into a typical Bassini operation. This can be done with ease by enlarging the split in the external oblique for another inch or more, lifting the cord, and suturing the compound tendon of the internal oblique and

transversalis beneath it to Poupart's ligament. Experience has shown that when a recurrence takes place it is usually an immediate recurrence. The recurrence occurring immediately the patient gets up is due to faulty ligature of the neck of the sac. The elastic peritoneum, released after ligature of the aperture, is very liable to slip the ligature. This cannot occur if the aperture formed by the neck of the sac is sewn in addition to simply tying the ligature.

The majority of herniae occurring in men of military age are small bubonocoeles or congenital herniae containing omentum.

I attach considerable importance to the removal of the prolapsed omentum, which is always of abnormal length, with a view to preventing recurrence.

Several sequelae follow hernia operations which are of more significance than recurrence. I refer to such conditions as hydrocele, retraction of testicle, thickening of the spermatic cord, painful scars, neuralgia, and enlargement of the testicle. These unpleasant and almost incurable results are due to damage to the spermatic cord, the delicate structures of which are adversely affected by much less disturbance than is usually supposed. In the operation described the only content of the cord which is either seen or touched is the sac.

I have found this operation of particular value when dealing with cases of recurrent hernia. The new operation is performed above the matted scar tissue of the old operation and completed by Bassini's method almost with as much ease as a primary operation.

MODERN ARTIFICIAL LIMBS AND THEIR INFLUENCE UPON METHODS OF AMPUTATION.*

GENERAL CONSIDERATIONS.

BY

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It may seem at first sight that the title of this paper implies a putting of the cart before the horse; that the artificial limb should be influenced by the amputation which calls it into being, and that the converse should not occur. But unfortunately we have to cut our coat according to our cloth, and the cloth in this case is limited by the mechanical possibilities at our disposal.

Artificial limbs have been used for many centuries, for a Roman artificial leg has been unearthed at Pompeii. The artificial hand of Götz von Berlichingen, made in 1509, is still in existence and in working order and has lately been described in detail in the *Zeitschrift des Vereines Deutscher Ingenieure*, December, 1916. With this hand it is said that Götz was able to strike a harder sword stroke than with his former natural hand. (*Credat Judaeus.*)

In order to produce good results the surgeon and the limb-maker must have some knowledge of each other's limitations.

On the one hand, it is undesirable for the surgeon to design and carry out an amputation, however successful surgically, if the resulting stump is one to which an artificial limb cannot conveniently be attached. On the other hand, it would be useless for a limb-maker to devise a limb, however perfect in theory, if it could not be borne by the patient's stump.

In this country of late years the questions connected with amputations have been of diminishing importance, thanks to Lister and the Employer's Liability Acts, etc. So that, as I learn from my friend Mr. Edred M. Corner, in 1913—the year before the war—out of 5,483 major operations at St. Thomas's Hospital there were only 34 amputations; a proportion of 1 in 161. The Royal Surgical Aid Society, which supplies appliances not only in London but also in the provinces, in 1913 supplied 529 artificial and peg legs and arms out of 41,483 appliances supplied in that year.

* Papers read at the meeting of the Medical Society of London, October 22nd, 1917.

In the United States of America it would appear that amputation was a much commoner operation, not because of any lack of conservative surgery, but because accidents were relatively and absolutely much commoner in that country. The large number of cases of amputation in survivors of the War of Secession gave an impetus to the design and manufacture of artificial limbs, which was sustained by the steady demand caused by accidents in civil life, and a large number of limb-makers get their living in the United States.

The Best Forms of Stumps.

The conditions of the problem differ in the upper and lower extremities.

In the lower extremity the functions of the lost part are crude compared with the delicate and nicely adjusted and co-ordinated movements of the upper extremity. Its chief duties are to support the weight of the body at rest and in motion and to act as the propellant force in the process of locomotion. End pressure and leverage are the strains to which it is most exposed.

The upper extremity is mostly employed in prehension and traction—functions to which the foot of boot-wearing man is a stranger, and end pressure, therefore, is not one of the most important strains to which it is exposed, while leverage is all-important. As the movements of the hand and fingers are highly co-ordinated and often very delicate, it follows that the problem here is a very difficult one. In fact the best artificial arm and hand is but a poor substitute for the living member, while the artificial leg can be made to do nearly everything that is required of its living predecessor—to do it, that is to say, more or less well, though not so well as the latter.

In both the upper and lower extremities provision has to be made to maintain the appliance in place when in action, and also when at rest, against the action of gravity.

Weight is borne in two ways, often or generally combined—

(a) By direct pressure of a part of the body downwards, such as the end of the stump, or of a convenient bony process such as the tuberosity of the ischium, or

(b) By oblique pressure, when the artificial socket forms a more or less conical cavity into which a conical portion of the body fits.

Leverage is exerted by the lateral surface of the stump pressing against the side of the surrounding socket.

It is necessary to state so much in order to understand what a stump should be, but I do not propose to go into the question of mechanics, because my colleague, Major Elmslie, may be trusted adequately to deal with that side of the question.

An ideal amputation stump would be as long as possible, it would be covered by sound movable soft parts, and the scar would be placed in a position where it would not be exposed to pressure, and it also would not be adherent to the bone. It would have enough muscles attached to it to move it with adequate force, and no inflamed or hypersensitive nerve ends would be palpable in it.

The end or ends of the bone or bones would be rounded so as not to hurt the soft parts under them, and the blood supply would be free and the skin well nourished.

Objections to Exarticulation.

At first sight it would appear that this ideal is most nearly approached by an exarticulation, which preserves the full length of the limb segment and does not involve any section of bone, with its possibilities of infection and necrosis. Further consideration and experience of modern artificial limbs lead to the conclusion that, except in the cases of the hip and shoulder, exarticulations are to be avoided, and that amputation through the limb segment above the joint is to be preferred.

The following weighty objections to amputations through joints have been made and, as I think, may be accepted as valid:

1. The articular enlargement, which is a prominent feature of all long bones, makes the resulting stump bulbous in form; a form which becomes more marked as atrophy of muscles goes on, leaving the dimensions of the bone unaltered. Such a bulbous stump, larger in girth at its lower extremity than at its middle, cannot be

closely fitted with a rigid socket, such as forms the best support. Also the artificial limb must be wider than the natural one by the thickness of the walls of the socket.

2. The artificial joint must either be fitted below its proper level or else it must be placed on the sides of the bone end and the limb must be still wider than its fellow and consequently unsightly.

3. To cover the articular enlargement extensive flaps are needed, and these must sometimes be of thin skin. Such flaps are often deficient in vitality and likely to slough.

Weight-bearing Stumps.

Before the war osteoplastic operations designed to produce stumps capable of bearing weight on their ends were getting more and more into favour. In this category must be included the Stokes-Gritti operation above the femoral condyles. The stumps so produced are excellent, but conditions favourable for their production are so rare in this war that we may put aside the consideration of these operations at present. I am sure that I am within the mark in saying that among some 5,000 amputations which have passed through my hands at Roehampton there have not been a dozen cases of the Stokes-Gritti.

In the lower extremity a stump capable of bearing some at least of the body weight on its end should be aimed at. Every pound of pressure here means less pressure on other parts, which in some cases do not bear it well.

There appears to be a diversity of experience and consequent opinion on this point. At the extraordinary meeting of the German Orthopaedic Society in February, 1916 (as reported in the *Zeitschrift für Orthopädische Chirurgie*, Band xxxvi, Heft 2/3), both Gocht and Dollinger stated as their experience that in this war hardly any stumps were fit to bear weight on their ends; but Ferdinand Seidler, of Vienna, at the same meeting, said that out of 500 stumps, 297, or nearly three-fifths, were fit to bear weight. Perhaps the discrepancy may be explained by supposing that Gocht and Dollinger meant "nearly all the weight," and Seidler meant "some of the weight" only.

I should premise that, in speaking of upper, middle, and lower thirds, reference is made to measurements of the bone and not of the length of stump available for application of a bucket. Limb-makers, however, generally refer to measurements taken from the fold of the axilla or elbow, the pubes, or the ham, which are obviously very different. It is the custom at Roehampton to measure the remaining bone as accurately as possible with a simple form of callipers, and not to trust to the eye to estimate length in thirds. The average length of a long bone being known, a simple division sum gives the correct result.

My own experience tallies with Seidler's. Thus—

An analysis of the records of 549 cases of amputation of the lower extremity seen recently at Roehampton shows that in 275 of these—almost exactly half—it was found advisable to fit an end-bearing pad. As might be expected, the proportion varied widely in the different regions. In the upper third of the thigh only 9 per cent. were thus fitted, in the middle third 32 per cent., in the lower third 77 per cent.

Cases fitted with End-bearing Pad.

Upper third of thigh	...	2 out of 22	=	9 per cent.
Middle third of thigh	...	75 " 235	=	32 "
Lower third of thigh	...	63 " 81	=	77 "
Through the knee-joint	...	5 " 6	=	83 "
Upper third of leg	...	42 " 74	=	56 "
Middle third of leg	...	64 " 98	=	65 "
Lower third of leg	...	6 " 14	=	43 "
Syme's amputation	...	12 " 14	=	86 "

Three Stokes-Gritti and two Pirogoff's amputations were all capable of bearing weight on the end of the stump.

The number of cases in some of these categories is too small for the formation of very definite conclusions, but the main facts which come out are that the stumps in the lower third of the thigh are much more sound than those in the upper and middle thirds, which latter region is the seat of nearly half of the total number (43 per cent.).

The surgeon who has to deal with many of these end results cannot fail to be struck by the prevalence of wide adherent scars in the upper two-thirds of the thigh. Some of these, not many, are unmodified guillotine operations; the majority are not, and many are the results of later operations in which attempts have been made in vain to produce a stump covered by sound skin. Some of these

unfortunate persons have suffered as many as seven amputations on the same limb.

In the upper extremity the question of end pressure does not arise, and here the condition of the lower part of the anterior and external surfaces of the stump is of most importance, because these surfaces have to take much of the pressure of the leverage action on the bucket. Many arm stumps with large adherent guillotine scars covering the end of the bone have been found to be quite satisfactory in practice.

The presence of osteophytes is rarely any hindrance. These are seldom large, except in the thigh, and then they are usually situated about the femoral insertions of the adductor muscles, which are not exposed to much pressure.

DIFFERENT SITES OF AMPUTATIONS.

The Upper Extremity.

A forequarter amputation gives no choice of flaps. The resulting scars will generally bear a properly moulded shoulder-cap and an artificial arm with some movements.

In exarticulation at the shoulder the lines of scar should avoid the clavicle and the prominent bony ridges of the acromion, etc., for on these the shoulder-cap must press.

Amputations in the upper third of the arm offer very little hold for the socket of an artificial limb. Owing to the arrangement of the muscular attachments around the joint the upper three inches of humerus, or even more, are unavailable, and as in the arm of average length the upper third is only a little over four inches long, very little is available even in an amputation at the junction of the upper and middle thirds. A good deal can be gained by removing wholly or in part the folds of the axilla, that is, the pectoralis major and the teres major. This has been done with good result and seems to be an operation worth doing in suitable cases. The latissimus dorsi has not been interfered with so far as I know. It is less in the way than the other two muscles.

A gain of one inch of stump here is of the very greatest value, and as large adherent scars covering the end of the bone are comparatively unobjectionable in the arm, the surgeon in amputating above the middle of the shaft of the humerus should save as much bone as possible, even though there may not be skin enough to cover it completely.

The drag upon the adherent scar, which gives trouble in the lower extremity, is seldom complained of in the upper, owing to the absence of much upward thrust.

The objections to amputations through joints in general apply to the elbow in particular force, owing to the shape of the bones. If it is impossible to get a forearm stump extending at least an inch and a half below the insertion of the tendon of the biceps, amputation above the condyles of the humerus is to be preferred.

Similar considerations are of weight here to those mentioned in discussing the shoulder region. The action of the biceps tendon, which tends to throw off the bucket when it contracts in flexion, is one of the chief difficulties in these short forearm stumps. Unfortunately, this tendon cannot be spared, and its removal is out of the question. The remains of the bellies of the flexor muscles, however, are of no use, and have been removed in some cases with more or less advantage, enabling a better grip on the stump to be obtained.

The middle third of the forearm gives good stumps, but the lower third is not a favourable site. Many stumps here are cold and cyanotic and the skin tightly stretched and adherent. Moreover, the ends of the bones are often tightly soldered together by fibrous tissue or even bone, and the movements of pronation and supination are lost.

It is true that the most directly acting pronator, the quadratus, is sacrificed if the lower third is removed, but experience leads to the conclusion that good voluntary movement is possible without it, if the ends of the radius and ulna are free. It takes some time and practice, however, to enable the patient to carry out these movements, even when fitted with a suitable arm. The tendency is to use the shoulder-joint instead of the radio-ulnar.

Below the wrist, if the carpus and base of the metacarpus can be saved, it is worth while, provided movement is preserved. The short stump thus formed can be used to actuate a movable thumb with considerable force by means of a simple appliance. It is a commonplace of

surgery that any part of a finger or thumb is worth saving. If one active finger or a thumb is left it is easy to fit a stump to which it can be opposed and thus to give the picking-up action and the power of holding a pen.

The Lower Extremity.

I do not hesitate to affirm emphatically that in the lower extremity exarticulation or amputation between the trochanters is better than amputation in the upper third of the thigh. I refer to the upper third anatomically speaking, which in the average limb includes a little more than six inches of femur, which gives only three or four inches of stump below the pubes. Such a short stump is unable to move the lever formed by the thigh bucket with sufficient force, no matter how light the limb may be.

Such improvements have been made in fitting what is rather inaptly called a "tilting table," that patients who have tried both the ordinary thigh bucket and this appliance usually declare that the latter is much the best. Certainly they walk better in it. This form of prosthesis (shown and described to you by Major Elmslie) forms to my mind one of the greatest improvements in artificial limb-making during the war. Although known and used for some years before, it has been developed and perfected in details during the last two or three years.

In the middle and lower thirds of the thigh the general considerations apply, which I have already outlined. The middle third is the site of nearly half the amputations of the lower extremity treated recently at Roehampton. The exact figure is 42.8 per cent. No other region approaches this in frequency, the next being the lower third of the thigh and the middle third of the leg, each with 11.6 per cent. only.

In this region the objects aimed at should be a non-adherent scar behind the bone, and a good disposition of the muscular masses on the inner side. If the great adductor muscles are allowed to retract too much a too conical stump results, and the bunch of soft parts at the top of the thigh just below the pubes forms a serious obstacle to the fitting of a socket. The tendons and fasciae should therefore be sutured if possible over, but at least near to the end of the bone.

In this connexion it may be worth while to recall that the femur on a thigh stump is eccentrically placed. It is almost subcutaneous along the outer side of the thigh and most of the lateral pressure of the artificial limb is borne on this outer surface. This position is very obvious on x-ray plates. Therefore in making incisions preliminary to or during amputation this surface should be spared if possible.

Although in injuries about the hip in civil life adduction is the common resulting deformity, after amputations of the thigh abduction is a frequent result, and adduction is hardly ever seen.

One of the greatest troubles of the orthopaedic surgeon and the limb-maker is the prevalence of flexion contraction of the hip in cases of thigh amputation. In treating such serious injuries it is natural that the primary consideration should be the early and complete healing of the wound. To secure this and for the comfort of the patient the stump is often propped up upon a pillow, thus favouring shortening of the flexors of the hip. This contraction, unless very severe, is masked by a compensatory lordosis and often unsuspected by those concerned, but when the patient is examined with the sound thigh well flexed upon the abdomen, the true state of affairs is revealed.

Practically every case of amputation of the thigh which is admitted to Queen Mary's Hospitals at Roehampton is found to have some flexion contraction, or diminution of the normal range of hyper-extension, and has to undergo a course of massage and passive motion, or the operation of tenotomy and fasciotomy, before a leg can be satisfactorily fitted. The structures most concerned are the tensor fasciae femoris, the long adductors, the ilio-psoas, and sometimes even the capsule of the hip-joint.

It is much to be wished that, in every case in which the general conditions are favourable, the stump should be fully extended while the opposite thigh is fully flexed upon the abdomen at least once daily during treatment of amputations in this region.

The lower third of the thigh, just above the condyles, offers the best thigh stump for fitting with an artificial limb. If a long anterior flap is made, even though there

may be an adherent scar behind the bone, a good end-bearing stump often results. If the patella can be securely fixed to the end of the bone so much the better.

The general objections to exarticulations apply to the knee-joint. Not many such stumps are satisfactory.

In the leg below the knee the most favourable site is the lower part of the middle third. The old seat of election about four inches below the joint was intended for kneeling legs. Nowadays kneeling legs are avoided and only used when a stump below the knee is too short to work a socket. With skilled fitting, however, even very short stumps are useful. A good gait has been obtained with as little as two and a half inches of tibia, but this was an exceptional case. Rarely is a good result obtained with less than three inches, and then generally the stump should be capable of end-bearing. Much depends on the bulk of the soft parts. When these are voluminous, the difficulty is increased.

These short leg stumps give a better gait than is got with a kneeling leg, and the artificial limb is less unsightly. Amputation in the lower third of the leg seldom gives a satisfactory stump. The bone surface at the end is too small for good weight-bearing, and the skin is often badly nourished, cold and cyanotic.

No one can deal with many below-knee stumps without being struck by the frequency with which the fibula is cut longer than the tibia. This constitutes an obstacle to successful fitting. The fibula bears pressure on its end very ill, and often it wobbles about and is insecure.

Although many patients with Syme's amputation ask to have one performed higher up, it is deserving of its great reputation. If properly done it gives a painless weight-bearing stump. The bones should be sawn through well above the internal malleolus so as to avoid too bulbous a stump, and care should be taken to make the section at right angles to the long axis of the whole leg and not at right angles to the often incurved lower fourth. Otherwise a varus stump is likely to result. Too low a section leaves no room for a strong transverse ankle-joint, and a too voluminous heel-flap means an unsightly artificial foot and boot.

Of Pirogoff's amputation our experience at Roehampton is small and unfavourable. If the os calcis is not united to the tibia by bone it will sooner or later tilt over, and cause pain, and in any case the stump is too long for the fitting of the best type of foot.

Chopart's amputation gives a good bearing surface, but generally the calf muscles pull up the heel and tilt the lower end downwards, and painful pressure on the scar results. The stump is too short to give a spring to the gait, and it is wellnigh impossible to fix any prolongation on to it. It has no advantage over a Syme, and I would submit that if the metatarsus cannot be saved nothing below a Syme is worth doing.

In conclusion, let me disclaim all intention of laying down the law on this subject. I offer the foregoing opinions for what they are worth as the result of the impressions made upon my mind by what I have observed at Queen Mary's Convalescent Auxiliary Hospitals.

During the past two years, and particularly during the past eight months, I have had exceptional opportunities of studying the results of other men's labours, and I have the greatest admiration for the excellent results achieved, often in most unfavourable circumstances.

DEMONSTRATION.

BY

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When the hospital for fitting limbs at Roehampton was started in the summer of 1915, not only was the supply of artificial limbs from limb-makers in this country totally inadequate for the requirements brought about by the war, but the types of limbs available were by no means perfect, so that a very great deal of experimental work had to be done, more particularly upon artificial arms. The limbs demonstrated were all provided at Roehampton, and, without attempting to illustrate every type of limb in use, represented a series of typical examples of the work there.

As far as the arms were concerned, they showed an immense mechanical advance upon the very elementary types alone available in London at the beginning of the war.

The function of an artificial leg is to give good stability in standing and walking and a natural gait. Hence the important points are: The way in which weight is borne upon the leg; the way in which the leg is built to secure stability; and the way in which the knee and ankle are controlled. A stump may take its bearing either upon its termination (end-bearing) or upon the bony prominences around the proximal joint. End-bearing is a quantity varying not only between stumps at different levels but also in individual stumps at the same level. In general, end-bearing, either complete or partial, may be expected when the bone section is through cancellous bone, when the bone is covered with thick skin and muscle or fascia, and when the skin over the stump is itself naturally adapted to weight-bearing. The type of end-bearing stump is that given by Syme's amputation. The other bearings used should be those upon the tuberosity of the ischium and upon the head of the tibia. Although a certain amount of bearing may be taken by fitting the stump tightly and so getting circumferential pressure upon it, yet this must not be trusted to any great extent, as by this method the skin is apt to be stretched tightly over the end of the stump, and if the scar is terminal or the skin thin this may result in ulceration.

POINTS IN THE FITTING OF A LIMB FOR AMPUTATION: LOWER LIMB.

Thigh.

For amputation through the thigh the limb is generally suspended by a sling over the shoulders, the lower end of which is attached to the leg below the knee either directly or by passing over a pulley. In this way it acts as a knee-extending mechanism. In short stumps, however, this is insufficient to enable the stump to remain securely in the bucket and to control the limb; therefore a pelvic band is added. The mechanism used to extend the knee is of two sorts. The older one is by the use of a spring, either of rubber or of steel; it should act in such a way that the knee is only extended by it from the right angled position; if it acts from a position of greater flexion than this it will prevent the man from sitting comfortably with a flexed knee. The second method is by the use of the sling from the shoulders, which pulls upon the front of the leg piece when the shoulders are raised or when the weight of the swinging limb comes upon it, thus extending the knee. The stops which limit the movement of the knee in both directions must be so strong as to be unbreakable even when the whole weight of the body exerts its maximum leverage upon them. The ankle mechanism is a point in which the present limbs almost all show a difference from the Anglesey leg, which used to be practically the standard pattern of artificial leg in England. In the Anglesey leg a considerable amount of movement was allowed at the ankle, this movement being co-ordinated with that of the knee by an artificial tendo Achillis. In the present types of legs the movement allowed at the ankle-joint is small in range (only about 20 to 30 degrees), and this movement is stopped by the compression of springs, usually of rubber, but sometimes of steel. The smallness of the range of movement is not found to interfere with walking—in fact, the walk is quite good if there is no movement at all.

Correct building of the limb is important if stability is to be secured. Two points are essential: first, the axis of the knee-joint must be behind the line which represents the centre of gravity of the body when it is erect, and, secondly, the foot must be mounted in slight equinus (20 degrees), and must be prevented from reaching the right-angled position.

The routine material for the construction of artificial leg is still willow, and as a rule the thigh and leg pieces are constructed of single pieces of wood, appropriately hollowed out, the joints being made of steel. It is not an advantage to have very lax joints in an artificial leg; as a rule the joints are lined with a bushing of leather, by adjusting which they can be made stiffer.

Hip-joint.

Hip-joint amputations are fitted with a leather cup, which entirely encloses the stump, fitting it very accurately. It is attached to the trunk by a steel pelvic band,