ON AMPUTATION.

By Henry Marshall
Amputation in General.

In considering the subject of Amputation in General, the following points require to be noticed.

I. The means of providing against an undue amount of hemorrhage during the operation.

II. The manner of dividing the different textures, so as to form a stalk, in which the bone will be well covered with soft parts.

III. The means of arresting the hemorrhage immediately after the removal of the part amputated.

IV. The mode in which the stump is to be dressed.

V. The restraining of secondary hemorrhage.
The means of providing against an undue amount of Hemorrhage during the Operation.

This object is usually attained by stopping the flow of blood in the principal arterial trunks which supply the part, either by the application of a tourniquet, or by the pressure of the fingers of an assistant.

In minor operations the latter method is preferable for most convenient and surest, but in major operations it is more doubtful. Much depends upon the amount of confidence that can be placed in the assistant, if he is not already possessed of a considerable amount of endurance. This mode of providing against hemorrhage possesses several advantages over the tourniquet. The compression of the artery is not made till the very instant that the operation is going to commence; at the same time the return of blood to the heart is not interfered with. If the assistant can be more easily attracted. This last point I have seen strikingly illustrated a few weeks since in an amputation of the thigh in a very muscular man, when a tourniquet caused very considerable difficulty in extracting the soft parts although the amputation (a modification of the cerceral) was performed immediately above the knee. In amputating any near the trunk of the body, this method is adopted from necessity, as the application of a tourniquet...
This statement is made on the authority of Staff Surgeon Dr. Gordon, late of the 95th Regiment, who has continually adopted the practice himself.
is impossible. The tourniquet is chiefly to be prepared in those cases in which a large number of blood vessels upon the finger is expected to require ligation, or any very large vessel. Early prolongation of the incision, as long continued pressure within the fingers becomes very uncomfortable to the assistant. If it is used, it should not be applied till just before the operation, in order to avoid as much as possible engorgement of the limb with blood. Some surgeons have recommended that the principal artery should be tied previously to amputating, if the limb be removed near the trunk of the body, but such a practice is quite unnecessary, as it only adds to the danger and complication of the operation. Some Army surgeons are in the habit of amputating without taking any measures to stop the arterial supply to the limb at first, the hemorrhage being arrested by an assistant firmly grasping the limb as soon as they are cut; such a mode of procedure, however, could scarcely be considered warrantable in civil practice. Other surgeons have taken upon themselves the double duty of compressing the artery with one hand while they amputate with the other. However, much this may be calculated to display the dexterity of the operator, I conceive there are few who would feel themselves warranted in following this practice.
* Celsus de Medicine. Lib VII Cap. 33.
II. The manner of Dividing the different joints so as to form a stump, in which the bone will be well covered with soft parts.

The great object is to obtain a stump in which the bone is well covered, without at the same time, any redundancy. For long it was the custom to make a circular incision down to the bone, which was then sawn off on a level with the soft parts. After this simple mode of amputating, the muscles contracting, left the bone prominent, and the groove suppuration from the exterior wound thus formed, which had to heal by the slow process of granulation, added much to the danger of the operation. Also, the stump, unless healed, was, of a conical shape, with the bone covered only by a thin cicatrix, subject in the great majority of cases, to much pain, from changes in the weather, pressure, &c.

Various plans were introduced to overcome these difficulties. Celsus recommended the soft parts to be retracted from the bone, sit again divided, and all the tissue of the whole limb cut, with "incidit in scaphello corne vasaque ad ostium,""ubi ad ostium est, ad quae albo luna coro, "at circa ostium subsecundum est, ut sae quaque parte "alignam corne adexit." This direction Zenoius was neglected at a later period. Comparatively rarely, "extractores"
* * McBurney, Practical Thrombosis Amputation, p. 19

'exteators' muscle ritter of pretext. Split cloth, or beaten were introduced, with the object of more completely fulfilling this indication.

In 1780 Cheseled introduced the method of amputating by 'double incision' as it was termed, which consisted in dividing the skin down to the muscle by a circular incision, then drawing it back and dividing the muscles down to the bone as high as they were exposed. Then retracting them and laying the bone, on a band with them. By this means a considerable amount of skin was removed to clear the surface of the wound. On this general principle of amputating by double incision, very many modifications of this must have been introduced.

*Major of Birmingham (1783) carried the retraction of the skin to a very great extent, dissecting it from the muscles and turning it back like the sleeve of a coat, and then dividing the mass of muscle down to the bone. However, the result of this method of amputating, as far as I could observe, was very uncertain, and it was impossible to determine the soundness of the muscles, as many of them were torn and bruised by the operation itself. This method was particularly adapted to those cases where there was a great extent of skin to be removed, and where the muscles were not broken by the fracture. However, it was not always successful, and in many cases the skin was torn and bruised, and the muscles were not freed from the bone. The result of this method was very uncertain, and it was impossible to determine the soundness of the muscles, as many of them were torn and bruised by the operation itself.

*Sherf (1757) following Cheseled's mode of amputating, but still finding the bonecept to Instruct, recommended the 'cross-stitch' which consisted in drawing the edges of skin together with two thick threads.
* Alanon. Practical observations on Amputation. 2nd Edit. (1782) - p. 57 et seq.

Lucis (1750) endeavored to make a concavum wound with the bone at the bottom, by dividing the muscles by two circular incisions, the first penetrating through the superficial layers which he retracted before dividing the deeper ones.

Alison of St. Andrews (1782) insisted strongly on the propriety of sacrificing a sufficient quantity of skin "as well after the operation is finished, fully covering the wound with the most perfect care." He also recommended a peculiar mode of dividing the muscles, by cutting the knip on a level with the skin. Thus, the muscle was detached by cutting upward and inward to the bone, keeping the edge in this oblique line. He carried the knip around the limb, thus dividing the muscles obliquely, the joint of the knip being in contact with the levelling around the bone during the whole of the division. This plan was even much used, on account of the difficulty or impossibility of properly performing it.

*Benjamin Bell (1788) made a circular incision through the integuments & having retracted them for some distance, divided the muscles as high as they were crossed, then separated them from the joint with the point of the knife, retracting them about an inch before breaking it through.
Desault (1812) cut the muscles through in several layers, allowing the divided layer to contract before cutting through the artery.

The circular operation was now generally performed consists of the following steps. An assistant firmly grasps the limb above where it is to be amputated, draws the skin upwards. The operator then divides the skin and superficial fascia, with a circular stroke of the knife. The incisions are then probably drawn upwards, facilitated if necessary by any fibrous attachments of the fascia being divided by the point of the knife. The knife is then again carried around the limb close to the edge of the retracted skin, to cut to divide the superficial muscles, these again are retracted together with the incisions, in order to divide the 2 planes by another circular sweep of the knife, all the tissues are divided down to the bone; a tendon retractor is then put on the Volar part and drawn back, when the bone is drawn through close to the retractor.

A curved or sickle shaped knife was used by the older surgeons for performing this operation, but one recommended by Mr. Liston was slightly curved but a straight one continues perfectly well. Till a comparatively late period it was the

custom.
custom of surgeons previously to performing their operation to bind a piece of tape tightly round the limb, in the situation where the incision was to be made, partly to keep the muscles compact and close to the bone, but principally to guard the knifin making the first circular incision. It was a much controverted point, whether the tape should be applied immediately above or below where the incision was to be made. Alarcon was one of the first to point out the uselessness and inconvenience attendant upon this procedure.

The flap operation is one which has only come into general use only of late years. The first surgeon who recommended a flap amputation appears to have been Loudham, an English surgeon, whose exposition was published in 1679 in Young’s "Cursus Triumphalis de Zedrulturina." At this time it was practiced by other with process, but appears soon to have fallen into disuse. It was subsequently advocated on the Continent by Perthes (1696) and Sabourin (1702) who claim to have laid claim to the discovery. Loudham only proposed his operation in the leg and made one flap, but Narvalot (1742) and Vermeil (1757) extended the operation to the thigh and arm. He introduced amputation with two flaps. Narvalot performed his operation by making a circular incision through the integument.

White (Charles). Papers in Medical Observations & Inquiries.


From two to four finger breadths below where the bone was to be divided, the skin was first retracted, and a circular incision was made through the muscle down to the bone, even with the retracted skin. Flaps were then formed by making two incisions, one opposite the other, reaching down to the bone, and terminating in the circular incision. The two flaps were then raised to have been at a right angle of union. Verneuil practised the more convenient method of forming the flaps by transfixed, cutting them around the side of the bone for about half an inch, and then obliquely outwards.

Several British surgeons advocated flap amputation during the latter part of the last century. In 1765 an Irish surgeon, Dr. M'Adonnell, wrote a book advising the flap amputation of the leg. Subsequently White of Manchester (1768), Bonsfield (1771), and Allan wrote in support of the operation, but confined it chiefly to amputation at the lower part of the leg.

Of late years it has come into very general use in this country through the advocacy of Dr. E. Liston, Syme, and other surgeons. Dr. Liston amputated by flaps first in 1822, and subsequently practised it.

The flaps may be formed in different ways, most commonly by transfixed or cutting outwards, but...
The particular circumstances of the case may make it more convenient to cut obliquely inwardly to the bone, thus from one flap to the other, or without inwardly. When the flaps are joined by transfixion, in making the second, the point of the knife should be partly in the incision made by the first, but from half an inch to an inch from its end, which makes it easier to bring it out, without any cross-cutting of the integument, in the first incision, on the outer side of the limb. The size of the flaps must be modified according to the individual case. In an enlarge muscular limb, the flaps require to be very long, in order to compensate for the muscular contraction. On the other hand in a thinner associated subject, that ones would be indicated. The part of the limb to be amputated also regulates the length of the flaps; the greater the distance from their origin the muscles are cut, the greater the length of the flaps required. But in all cases it is necessary to make the flaps longer than what would be sufficient to make a good stump in the dead body. The bone should be loosen through, where the angle of union of the flaps, having first been well cleared fromh

muscle & periosteum, at that part where the saw is to be applied.
The comparative advantages of these two modes of
amputation have been the subject of much controversy,
with the result that the flap has very muchsuperseded
the circular. The flap operation has the advantage of
being more rapid, quickly and easily performed, while the
two surfaces brought together, being cut smoothly,
crease in a better state for union than the ragged edges
of the circular method; moreover, they are more
accurately adapted to one another, as in the circular
considerable thickening of the edges must necessarily
take place when contraction is effected. By the
flap method the surgeon also possesses a greater power
of selection of the best parts to be preserved. By it also
a more convenient and substantial covering for the leg
can usually be obtained, being muscular instead
of composed of integuments alone. On the other hand
the muscular constituent of the flap being contractile
 tends to increase the size of distraction of the bone, and
under certain circumstances this operates so unfavorably
as to render the circular operation, or a modification
of it, preferable. There is greater difficulty in securing
the vessels after the flap operation, in consequence of their
being cut obliquely, but if they are well pulled out
before the ligature is applied, this objection is overcome.

III. The means of Arresting Hemorrhage immediately after the Removal of the Part Amputated.

The great difficulty that was formerly experienced in restraining the hemorrhage after amputation, made it an operation much dreaded, but seldom performed. The practice of ligaturing arteries is said of very old date being referred to by Galen, Celsus, Helius, and other ancient authors, but curiously enough fell into entire disuse, and a great variety of most barbarous means were introduced. The most common of these was the actual cautery, which however was found to be very unsatisfactory in its effects, hemorrhage repeatedly taking place when the bones were separated, requiring repetitions of the cautery. Some recommended amputating with a red hot knife, or with one blade of iron or wood, night in aqua fortis. Others applied something hot in boiling turpentine, or were plunged the stump into a mixture of boiling oil and spirits. Lea, wrote in favour of a 'philitum' or 'Alum' applied to the arterial orifices. More dangerous applications as Arsenic or corrosive Sublimate were used by others.

When Ambrose Paré in 1582 proposed ligaturing arteries he was met with violent opposition, but the method was but slowly adopted, and confined to the arrest of hemorrhage from the larger vessels.
The idea that a ligature applied to the vessel alone, would almost surely cut it through, led to the practice of including a very considerable quantity of the surrounding tissues within it, and when a vessel of any considerable size was thus included, it gave rise to great pain and other unpleasant symptoms. Brownefield and Ellman were, in this country, among the first to point out that the ligature of the vessel alone was the proper practice. They recommended that they should be well drawn out from the surrounding tissues before the ligature was applied. In Great Britain, the seraculum was the instrument generally employed in taking up arteries, and is still very commonly used. Forceps are likewise more convenient, especially those provided with a catch, introduced by Dr. Lister, which take a secure and permanent hold of the part included in them, and have the advantage of rendering the operator independent of any assistant. The vessel should be pulled out without quite independently of any surrounding tissue. One end of the ligature may be cut off close to the knot. The other ought to be left quite out. Some have recommended both ends to be cut off close to the knots, but such a practice often occasioned many distressing effects, the knot acting as a foreign body, giving rise to much irritation and swelling.
Delivered January 10th 1853.
Following case shows. During one of Dr. Syden’s clinical lectures, a man presented himself suffering intense pain in the stump of an arm which had been amputated seven months previously. The stump was well formed & quite healed, but much inflamed & very tender. Dr. Syden detected fluctuation at one point, which he considered was the cause of these unpleasant symptoms, & might possibly proceed from an old ligature remaining in it, in consequence of which ends having been cut off during the operation. He made an incision to allow the pus & foreign body to escape. The wound healed quickly & the patient left the hospital a few days after quite well.
III. The mode in which the Stump is to be Dressed.

Past improvements have taken place in the manner of dressing stumps after amputation, as now the endeavour is to obtain union by first intention, which before the introduction of amputation by double incision was quite impossible. From the nature of the wound, which necessarily healed by granulation. But soon after amputation by double incision was introduced, the complicated mode of dressing which prevailed rendered union by first intention equally impossible.

The cavity of the stump was stuffed full of layers of dry lint or horse fluff, & lastly a compress of two flours being held in place by strong strips of adhesive plaster. "Planks of digestive sediment" were applied to the edges of the stump to prevent the dressing sticking.

Alanson would seem to have been the first to discard this most objectionable practice, & to introduce a simpler mode of dressing stumps. He first apparently had some idea of obtaining primary union after amputation but did not carry it into practice. Alanson pointed out the great disadvantages of introducing any dressings between the raw surfaces which are to be united, & directed instead to
"Place the skin and muscles over the bone in such a direction as that they would appear only on a line across the face of the stump, with the angles at each side." He also directed that the edges to be kept in contact if necessary by strips of plaster passing across the face of the stump - great credit is due to Alfonso for this simplification in surgery, & helping it become the aim of multiple surgeons generally. Attaining ignition by just intention, but the plan of treatment they adopted for the accomplishment of his object was such as almost surely to prevent it & the Marvel is that they did not always fail. Success was however comparatively so rare as to make continentat surgeons slow to endeavour to bring about a result they for long thought impracticable, & to till a very late period. The practice of dressing the stump continued & is even yet practiced in some places, as for instance I knew to be the case in the great Hospital of Florence. The ordinary mode of dressing stumps as practiced by British surgeons was pretty much as follows. Immediately after the operation, long gauzes were employed tightly round the limb to keep the end of the stump, to prevent retraction of the muscles. The edges of the wound were then brought into contact & held retained by strips of adhesive plaster as applied. That no portion.
The face of the stump was uncovered by them, a hole being cut in those straths that would press over the ends of the ligatures to allow them to pass through. Then this was glazed, and a pledge of healing ointment. Then, compress clothes, and bandage over all. These dressings it was not considered orthodox to touch before the morning of the fourth day, though the patient might complain of great heat and pain in the stump. Some were removed from before the fifth or sixth day. It is not surprising that when, they were taken off, instead of union by first intention, one was found both lying between the wound and plaster, and completing the life of the former. Straps of plaster were then applied with the same care as before, forming an inflammatory covering, and completely preventing the escape of any discharge. This most objectionable mode of dressing cannot yet be said to be completely exploded. It being still the fashion in some hospitals (even in London) carefully to cover the ends of the stump with a helmet of plaster.

The art of surgery was greatly advanced by Sir C. Sydenham, pointing out the serious risks of this mode of treating stumps, and incised wounds generally, which now the one followed at the time he wrote as follows: "Blood being exposed from the raw surfaces, a growing proclivity of creeping, causes separation and destruction."
"distinction. Adhesion is consequently frequent; & the
fracture is caused by a strong action; then the instant
complaints arise of pain & heat, with Stiffness & all the other
symptoms of fever. Thus it is formed, & the observer is
instructed. It is not necessary for its prevention of
adhesion that blood should be diffused into the
cavity, since the resisting action is always in the first
day, or at least of the second, attended with an
obvious discharge of venous serum fluid, which, if retained
acts quite as effectually in preventing the surfaces from
adhering. This effusion & continued discharge
of venous fluid during the adhesive process, is what
I am most anxious to impress upon the reader; &
if this main fact be kept in mind, there can be
little difficulty in seeing, preceding why the healing
up of wounds should be the most certain means of
keeping them open, or in determining as to the best
means of bringing about a different result."

Mr. Seque's practice at first time was to delay dressing
the stump for from six to twelve hours after the operation,
merely leaving the new surfaces approximated,
during this time all oozing ceased, & the surfaces
assume a glazed appearance from fibrinous
production. On two the opposed surfaces were brought
into the most exact possible contact — This mode


A treatment was warmly advocated and adopted by Lister and Dupuytren, and is recommended in the more recent works of Mr. Miller and Mr. Nicholls. It is that of inserted at the middle of the wound, for the first few hours. The method of dressing this wound is to keep the whole of the raw surfaces in close opposition instead of the edges only, while at the same time the discharge is free and continuous. By using the dressing, but primary union will as surely take place, when it is dressed immediately after the operation, with much greater comfort to both patient and surgeon than when it is delayed until the dressing. To attain these objects very simple means are required. Intermittent dressings are applied at quite close intervals (about half an inch) which keep the edges in perfect contact. The dressing is then left in its least pressure a few inches of fluid. Contours of the first —
Then laid on the cicatrice of the stump, or retained by a bandage so as to exercise pressure over the whole of the raw surfaces, to thus all accumulation of fluid without the cavity of the wound is prevented. A single fold of lint may be placed over the end of the stump for cleanliness & protection. Unless there is some contra indication the first dressings are not removed till the third or fourth day, according to circumstances. The subsequent dressings are conducted upon the same principles. Always leaving a free drain for any discharge. Then every time of applying pressure by compresses of lint & a handkerchief to the deeper portions & then clean to the edges of the wound.

Water dressings are in great favour at present & are most commonly used, but dry lint is preferable, and requiring to be changed so often, it is more convenient. But if any inflammatory symptoms develop themselves in the stump, wet lint should be substituted.

The stitches are removed when loosened by ulceration, if necessary, strips of adhesive plaster applied to keep the edges in contact.

These principles of treatment, first proposed by Dr. Syme, in the paper above referred to are "The treatment of amputated wounds" and have long been carried into effect in the Edinburgh Surgical Hospitals with the best results, wherein by

p. 395 - 1847
first intention of my force greater part of the wound after computation being thus generally attained. The treatment followed in various often hospitals is sometimes different. In London the general practice is to bring the edges of the wound together by a few contours or strips of adhesive plaster placed between them, a piece of wet lint or lint spread with oilpaint is laid along the length of the wound, a roller then applied. The first dressings are usually removed within 24 hours. By these means the spectral pressure is exerted over the whole of the exposed raw surfaces. Primary union is believed best common in being considerable extent of the wound. The application of dressings in the first instance are unnecessary if the contours are applied close enough, their tendency is to retract the raw parts, their spread points being from above, they do not allow of the same free exit to discharge, and effect no deep pressure, but have certain tendency to turn the edges inwards.

Chelius however strongly preserves insists upon the importance of covering the wound completely with the dressing, and alleges that serious evils have resulted from leaving any part exposed; an opinion however which I do not think is quite correct.
Dr. Dinnmurra is in the habit of dressing his stumps entirely without strapping; trusting after the sutures have been removed, altogether to thick compresses laid on the sides of the stump and retained by a bandage. The excellent stump he which Dr. Dinnmurra succeeds in obtaining under this treatment, shows the importance of well adapted compresses, at the same time that want of straps does away with a most important support, and their absence often leads to troublesome results from the long delayed union of the edges.
V. The Restraining of Secondary Hemorrhage.

Hemorrhage may occur at various times after the stump has been dressed. This secondary hemorrhage as it is called, may occur within a few hours of the operation or after an interval of several days. Vessels which do not bleed at the time of the operation in consequence of the collapsed state of the patient, may pour out blood when reaction occurs, and this may arise particularly in the case before the employment of chloroform which by leaving the patient free from all of the operation, prevents almost entirely the tendency to faintness. But vessels whose damage is more contracted at the operation from the stimulus of the knife of exposure to the air and cold water are very apt to bleed after their coats have become relaxed as the patient gets warm in bed. Hemorrhage from this cause may occur even so late as the night after an operation performed at noon. If the bleeding be but slight, elevating the position of the stump, applying cold externally will often prove sufficient; but if the cavity of the wound is at all distended with blood, the wound should be washed thoroughly cleaned out, the bleeding vessels secured. Cold wet cloths will then counteract any fainting tendency to bleeding that may show itself.

† Miller. Practice of Surgery. 2nd Edit. p. 676.


The hemorrhage sometimes occurs at a later period, three, four, or even as late as ten days after the operation, and is independent upon an ulceration of the arterial coat. If any slight cold, support, or motion causes it, but if at all time these means will not avail. The treatment recommended by different physical authorities in this case appears to this writer's right view in these circumstances "the circulation into the part must be weakened by ligation of the trunk which gives off the branches which are implicated." A similar kind of practice is recom-
manded by Cullen, Fergusson, Chevins, Dupuytren, and many others. Chiefly on the grounds that ligation applied to the arteries of the vessels will induce ineffectual an account of their diseased state. Dr. Rynne in his Principles of Surgery concurs in the opinion of the uselessness of attempting to ligature the vessels at the bleeding point, but states that the hemorrhage must be arrested by pressure, effected through means of a bandage applied externally. This he states is sufficient with very few exceptions, but if it fails the trunk of the artery must be tied. If it were practicable it would be far preferable to secure the bleeding point by ligature, since by doing so
The difficulty and additional danger of ligaturing the trunk of the artery would be avoided: for instance, by quickly ligaturing the secondary branches to occur from some of the large trunk branches of the femoral artery. The external iliac would be the trunk ligatured if any, & this operation is of course a serious one. At the same time the bleeding would be once effectively arrested as the consequent circulation will bring blood even to the main trunk below the point where the ligature has been applied. And even if the process of union be less advanced, the stump would be just in a more favorable condition, than if no local means were used, when it would have to remove the clot by absorption. This practice is also recommended by Mr. Galt, in opposition to the opinion of Chelius, a judging from a clinical lecture once heard delivered by Mr. Segure. I should suppose him to be now of the same judgment. My own opportunities of observation, as far as they have extended, support this treatment. The last two cases of any considerable hemorrhage in the Royal Infirmary were treated in this way. One of them was a case of amputation of the leg under the care of Mr. Segure in which bleeding came on to an alarming extent five days after the operation; for Lister (Mr. Segure's resident surgeon) separating the fibers found that
it proceeded from the posterior tibial artery which appeared to have ulcerated in consequence of the sharp edge of pressure of the sharp edge of the tibia upon it. The ligature first applied cut through the textures, crick within the brim of the lymph, and came away, but the second held. The wound healed without any further inconvenience. The other was a case of amputation of the forearm, under the care of Dr. Quesnay, in which nothing occurred on the surface of the wound, and the evening hemorrhage came on from one of the principal branches, which had already lost a good deal of blood before the attention of the surgeon was directed to him. Dr. Pitcairn (who was called to the case) applied a ligature without difficulty. No further bleeding occurred. The stump afterwards did well.

If no further bleeding should again recur to the ligature, at its bleeding point would be of little avail, as pressure was not sufficient to control it. Ligature of the arterial trunk must be had recourse to.
Special Amputations.

I. Of the Upper Extremity.

1. Amputation of the Phalanges and Fingers.
Amputation of the distal and middle joints of the fingers is easily and quickly performed by Lisfrance's method. The articulation being intact, the joint is opened from the dorsal aspect with a wedge of soft tissue, if not divided in this incision. The lateral ligaments involved with the joint of the knife, the head of the bone to be Amputated, is then turned out, the knife carried behind it & a flap formed from the soft parts on the front of the fingers. If the direction may be reversed, the flap on the palmar aspect being formed by transposition in front of the joint, cutting obliquely outwards, the articulation is then opened. The separation completed with one stroke of the knife.

Amputation may be performed through the phalanges either by circular incision of the soft parts, or by flaps, the bone being divided by the saw or cutting pliers.

These amputations are but very seldom called for. Few morbid conditions require the removal of the distal phalange & if more has to be taken
taken away, it is generally better to amputate the whole finger, as a useless and unnecessary stump would be left. In certain occupations a stump, especially of the free finger, may be useful. Therefore the operator ought to be consulted as to whether the whole or a part is to be removed.

Amputation of the finger at the metacarpal joint is an operation which may be performed after any definite rules. If it be the middle or ring finger which is to be taken away, while the assistant holds aside the neighbouring fingers, the point of the knife is inserted in the center of that knuckle, an incision made, first on one side, then on the other, to the angle of the web between the fingers, then round to the middle of the fold of the integument in the palmar aspect of the joint, where the incisions will again meet. With a little dexterity, disarticulation is easily effected.

One or two sutures may often advantageously be inserted to keep the edges in contact, but what is of more importance for this purpose the adjacent fingers are tied tightly together with a piece of bandage. All the dressing that is required is two pads of folded lint, placed one on the palmar side, and the other on the dorsal aspect of the wound, retained with a bandage. It is important to avoid placing any dressing between
between the fingers, as it check'd the free escape of discharge. The first dressings may generally be left till from from 3 to 7 days, when union with will most commonly be found to be pretty complete. When the index or little fingers require to be amputated, the same incisioncarrying the one on the free side to a point on level with the angle of the web between the attached side, to whence into the palm as before, or connected with the incisions already formed on the dorsal side of the palmar aspect, commencing at the angle of the web between the fingers, terminating opposite the articulation on the outer side.

Many recommend the head of the metacarpal bone to be ligatured after amputation of the finger; on the ground that it diminishes the gap between the fingers; but this is very doubtful. The practice has two strong objections that the transverse ligament is apt to be destroyed, the bone firmly secured mortally. Sometimes projecting in an unsightly manner, while the power of the hand is considerably reduced. In the case of amputation of the index or little fingers, the transverse angle of the metacarpal bone may be advantageously cut off obliquely with bone forceps.

When the rest of the metacarpal bone of the thumb is to be trimmed as well as the fingers, the point of the knife...
Should be cut into the dorsal aspect of the bone, where it is intended to be divided, & the incision carried downwards as far as the knuckle, when a divergent incision is made on each side, as in amputation of the finger only. The bone is divided with cutting forces.

In amputating the thumb, the same rules ought to be followed as nearly as possible as for the other fingers. If removal the whole of the metacarpal bone of the thumb is required, an incision should be made into the angle of the web between it & the forefinger & carried upwards till the triceps is incised by the articulation; its edge is then turned laterally, & the joint opened & loosened so as to allow the knuckles pass through it, when a flap is formed from the hall of the thumb by bringing the blade outward, keeping close along the line to its distal extremity.

Amputation of the little finger with its metacarpal bone, is performed in a very similar manner, except that the flap is formed first, the joint opened from without.
2. Amputation of the Hand at the Wrist Joint

This operation may be performed by a circular incision, but more satisfactorily by flaps. A semicircular incision is made over the back of the hand from one styloid process to the other. The flap turned back is first formed, the joint exposed and disarticulated; a flap is then formed on the palmar aspect by cutting outwards and downwards, avoiding the first dorsal nerve in doing so.

This cannot, however, be spoken of as a good operation, even in those cases which admit of its performance. As amputation at its lower part of the fore-arm affords a stump to which any artificial substitute for the hand can be more conveniently adapted. The prominent angles of the lower end of the bones, covered only by areolar tissue, are apt to cause inconvenience, and do not form so complete a stump as is obtained higher up in the limb.

In Amputation of the Fore-arm the flap has a very decided advantage over the circular incision, as from its concave shape especially at its lower front, the skin will not retract to the extent to be cleared, after the circular incision.

The humeral acting being compressed, the limb is placed in a middle State between formation & configuration so as to relax the muscles equally; these flaps are then formed one on the dorsal, the other on the palmar aspect.

These may both be formed by transfixion of the biceps so the point of the knife should be inserted at one side, cut on the palmar aspect, then applied over the palmar side of the bones, care being taken in closing so not to press between the bones, after which the point is depressed so as to bring it out at a corresponding place on the other side; this dorsal flap is trimmed, made by cutting downwards & outwards.

The palmar flap is burst formed by transfixion also.
The soft parts being retracted by an assistant, & some distance beyond the angle of the flaps, a stay is drawn through together. The fingers of the above recommend the dorsal flap to be formed by cutting from without inwards, in doing so care must be taken that the two ends of the palmar incision extend sufficiently far into the palmar aspect.
In this as in other amputations, the length of the flap must be regulated by the musculature & tonicity of the limb. Acton recommended the pre-arm part to be amputated below the middle, on the arm, but otherwise a good covering could not be found for the ends of the bone. The experience of other surgeons does not however tend to confirm this opinion. A longer stump is more convenient. Mr. Miller prefers the limb to the held in a state of relaxation for the operation, as he states the knife is not so apt to have between the bones in this position; but with ordinary care this accident will not occur. Mr. Payne has remarked that this is the only flap amputation in which he has observed union of the muscular part of the flap, but that in this case a soft cord like the extremity of the thumb may be generally obtained on account of this union occurring.
4. Amputation at the Elbow Joint.

This operation is one but very rarely performed, as amputation of the lower part of the arm is usually impracticable. The operation at the elbow was first performed by Farcé, and safety has been advocated by Dupuytren.

The operation is performed by transfixing the limb in front of the joint over the condyles, and by cutting downwards towards a flexure. Next, a circular incision is made over the integuments over the back of the joint, and the joint disarticulated by opening into it in front. The obliques may be drawn off as recommended by Dupuytren, or altogether removed.

5. Amputation of the Arm.

This amputation may be performed by a circular incision, but more satisfactorily and easily by first joining the transfixing incision, and then forming a circular incision above it. Dr. Lipson has stated that when so performed, this operation is "perhaps as simple and easy of accomplishment as any operation in the whole range of surgery."
II. Of the Lower Extremity.

6. Amputation of the Toes.

The toes are amputated at their meta-tarsal articulation on the same principles as the fingers, having in mind, however, that the meta-tarsal-gelenal articulations of the small toes lie deeper in the heel of the foot, from the corresponding joint in the hand. In the case of one foot the proximal phalanx should be preserved if possible.

When the whole or a portion of the meta-tarsal bone of the foot requires removal, it may be accomplished in a manner similar to that described for the removal of the little finger with its meta-tarsal bone. Making an incision on the dorsum of the foot commencing over the tarsal articulation, or over the joint where the bone is to be divided, is carried farther towards the lateral side of the bone, to the meta-tarsal joint where the knife is made to sweep round below to the inner side of the joint, into the inter-space and division extended to the joint opposite where it commenced. The flap is then turned back, the knife pressed between the first and second meta-tarsal bones near the bone, the cutting quickly outwards to the middle of the web between the toes the remaining joint heads are divided. The bone is then disarticulated on cut across with shears as the case may be.
Another mode of operating is to make an incision as before, on the dorsum of the foot to the metatarsal articulation, but cut in on the lateral side of the bone, two divergent incisions are then made, through to the web between the toes, one often to a point opposite this, whence it is continued to meet the former. The fat flakes are then dissected off so as to allow the metatarsal bone to be dissected and divided across.

The latter method has the advantage of leaving only one incision, but by far former this point is easier accessible.

7. Amputation through the Foot

Amputation may be performed at almost any point through the foot, but there are two recognized amputation in this situation, one, those known as Hays and Chestnuts respectively.

Hays operation consists in the removal of all the metatarsal bones at their terminal articulation. A first flap is made on the dorsum of the foot, by entailing the knife (in the right limb) over the common of the base of the metatarsal bone of the little toe, making a semilunar incision down to the bone, terminating at the base of the metatarsal bone of the great toe. In the left foot this incision is reversed. The flap...
is turned up, and while the extremitie of the foot is forcibly depressed, the tarsal-metatarsal line of articulations likened with the point of the knife, when disarticulation is completed, a flap is made from the sole of the foot by cutting outwards.

B. Chevassu's operation is performed higher up, all the fascia of the tarsus being removed except the astragalus and calcaneum. A vertical incision is made from a point midway between the external ankle and the base of the metatarsal bones of the little toe, which nearly corresponds with the articulation of the cuboid with the os calcis, across the sinus of the foot to a point directly opposite, which will nearly correspond to the articulation of the tarsal bone with the astragalus. The knife is then made to traverse the sole of the foot, at the extremity of the first incision, and a long flabby flap formed by cutting outwards. The disarticulation is readily accomplished. Some surgeons use in the habit of disarticulating before joining the plantar flap. Dr. Ferguson recommends the exposed articular process of the astragalus and calcaneum to be sawn off.

Chevassu's operation is applicable in a much greater number of cases than Grey's, as disease is not rarely sufficiently limited to allow of the performance of the latter. Its introduction brought about a great improvement in the practice previously adopted, of amputating.
The leg in all cases of cicatrice of the tarsus. The operation appears first to have been performed by Du Foveau in 1789, but first described by Clément. It was introduced into Britain by Mr. Syme in 1829. The operation was opposed in France and it was held that the attachments of the flexor muscles of the ankle being divided, the extensors would draw up the heel, and make the cicatrix joint to the ground. The flexor tendons remain from the attachments to the cicatrice, & this unfortunate result seldom occurs; when it does happen it appears to be probable that it is in consequence of the leverage of the foot being removed, which in the natural state of things tends to contract the extensors. On this account Supra Operation ought not to be preferred in those cases where the injury or disease is sufficiently limited, as the portion of the foot remaining will tend by its superior leverage to contract the tendons to permanent extension of the ankle joint. This gives progression is equally good in both Clément & Supra Operation, since the anterior stability of the arch of the foot being destroyed in each, an advantage is gained from the portion of the arch left in the latter Operation. When the heel is only slightly drawn up, division of the Tendo Achillis by a stabincious incision might do good.
8. Amputation at the Ankle Joint.

The operation has been performed on the continent of Europe by Brandt, Lispa, Brandtii, Veleman, &c., but as these surgeons, in their different modes of performing this operation, all proceeds from carrying off the end of the internal malleolus, from the skin above of its external or side of the foot, the result was far from satisfactory, especially as the malleoli were left projecting. This operation was consequently but rarely adopted, &c. Dr. Syme in 1842 invented a new mode of amputating at the ankle joint, by providing a strick from carrying off the bones from the integument of the heel & uncovering the projection of the malleolus.

The mode of operating as now recommended by Dr. Syme, is as follows: The foot being held at an right angle to the leg, the point of the knife is introduced immediately below the malleolar projection of the malleolus, carried nearer its posterior from anterior edge, & then carried straight across the bone to the inner side of the malleolus, where it terminates at a joint exactly opposite its commencement. The extremities of the incisions thus formed are then joined by another gassing in front of the joint. The operation must proceed to detach the flap from the base, & for this purpose, having placed the fingers of his left hand
*Syme. Supplement to Principles of Surgery. 1851. p. 22.*
"Over the prominence of the os calcis, insert the point of his thumb between the saphes of the plantar incision, and guide the knife between the bone and the skin of the thumb, taking great care to cut parallel with the bone, to avoid resewing or laceration of the integuments. He then opens the joint in front, carries his knife outwards and downwards on each side of the astragalus, so as to divide the lateral ligaments, thus completes the disarticulation. Lastly, the knife is carried round the extremities of the fibulas, so as to afford room for applying the saw, by means of which the articular cartilage are removed together with the thin connecting sheet of bone covered by cartilage. The nerves being then tied, the edges of the wound sutured together, a piece of wet lint is applied lightly over the wound, without any bandage, so as to avoid the risk of effusion under pressure in the event of the cavity becoming dilated with blood, which would be apt to occasion overflowing of the flap. The knife employed should be strong and about would not exceed four inches in length. An assistant should compress the tubal artery by grasping the ankle. In dissecting back the flap from the heel, special attention must be paid to the direction above given, to cut parallel with the surface of the bone, perpendicularly, avoiding tearing the flap by which vessels and veins in it parallel..."
†Syme Contributions to Surgery. 1848. p.146. Also were mallei in the
Monthly Journal of Medical Science. p. 1847. p. 82.
Handed to its surface, would be cut across, and more or less narrowing result from interference with the supply of blood. Dividing the posterior lateral artery before its division into its plantar branches for a similar reason.

This operation has proved one of the most valuable improvements in surgery in modern times. Even after its introduction of Chopart's operation, amputation of the leg and foot is to be employed in those numerous cases of cases in which the joint between the astragalus and calcis, or the ankle joint itself were dislocated, as well as in many causes injuries of the foot, in which amputation at the ankle joint is now substituted. There is little, if any, escape in its execution, the artist of joints removed being little more than in Chopart's operation, while the stump resulting, unlike any other will bear the whole weight of the greatest direct upon it, so that he can if he please, walk about on his gnawed stump, the double motion provided by motion the supporting the weight of the body, being still employed for the same purpose.

It has been objected to this operation that it is difficult, very difficult in its performance, and that in flesh in after it ought. Other serious objections arise from disregard of the directions given by Mr. Syme when some years since, as the result of his more extended experience of the operation. In his earlier cases he...


Sparrow made two curved incisions with the convexities forward, the inferior one extending to within the gale of the foot. By this means the difficulty of the operation was much increased. In dissecting the flap off the heel, bearing actions difficult. The flap also was unnecessarily large and flexible to rough. Dr. Ferguson in the last edition of his Practical Surgery (1852) in describing this operation, ostensibly according to his own practice, directs the incisions to be commenced from, to date from excising the skin from the projecting part of the os calcis. "It is hardly possible to avoid cutting the integument," but states on this point, "I have tried to do "no curiosity, as one opening here is rather an advantage, "than otherwise." By following these directions it is not to be wondered at, that bleeding of the flap (a result almost unknown in Edinburgh), should be an uncommon result. Some direct instead of dissecting the flap off the Achilles, to dissectulate first, cut away the first cut of the heel. This plan is however objectionable on account of the greater risk of tearing the flap.

Various modifications have been practiced by different surgeons. Dr. Handywood recommends semilunar incisions along the sides of the foot, forming anterior lateral flaps, but this does away with one of the chief advantages of the operation, viz., the preservation of the flap heel surface to form an cushion for the stump. At the same time the edges of the integument.

from disease or injury may be such as to render their modification advisable. In some exceptional cases a modification of Mr. Richard Mackenzie’s flap formation of a large internal flap, is likely to be found useful, and a very good stump can be obtained by this method.

Professor Felszöff of St. Petersburg, has lately recommended this and of the parcell to be drawn off, leaving it attached to the posterior flap, from turning it forwards so as to make it swim with the cut surface of the tibia. Mr. Syms Subjects it, to the following reasons: ‘first, that it is calcar in a hump prejudicial to carry, it is therefore unsuitable to leave any part of it; Secondly, the operation is not facilitated by the change of procedure; but on the contrary, considering the use of dorsal veins involved, it is greatly complicated. Thirdly, the union of the osseous surfaces is not likely to take place easily. The fourth principal objection is, that it involves an union of the heel, which should form a cushion for its patient to rest upon, are necessarily carried forwards to the end of the stump in covered by skin, which is not designed for sustaining the weight of the body.

The interosseous has been improved to the left, but is objectionable on account of its position to ears, an ordinary sized flap will be insufficient to cover it.
I. Amputation of the Leg.

It was for this amputation that the flap operation was first introduced. Dr. Lang apps. 65, O'Fallon 1765, Allanson 1788, Wolfe 1761, and other British surgeons of about the same date were strongly advocating it. The flap operation however gives less satisfactory results in amputation of the leg, than probably in any other situation. The weight of the posterior flap together with its muscular, tend to draw it away from the skin in front & cause obstruction of the bone, giving rise to an unendurable sore or imperfect cicatrix over the bone. This is by no means an uncommon result, in those cases where this accident does not occur, there is a view of redundant matter in the posterior part of the stump, which it has been asserted furnished a good cushion & took the weight of the body in using an artificial leg, but this is not the case, as it not only affects no covering for the end of the bone, but a boggy mass behind there. But besides in using a artificial leg, the weight of the body does not rest on the end of the stump, but is diffused generally over the surrounding part, as in case of an amputation leg, the situation is then removed out of upper part, the weight of the body is sustained chiefly by the ilia.

Care should be taken to provide a sufficient covering

of integuments, this object is most satisfactorily obtained by a modification of the circular excision, making skin flaps and then dividing the muscles by a circular incision. By this means a sufficient supply quantity of integments are easily procured, & the retraction of the edges which latter have after the ordinary circular excision, when completion is effected is avoided. This mode of operating was recommended by Mr. Liston when muscular plethoric objects exist with sudden severe accidents which require immediate amputation, [as] the large quantity of muscle which is necessarily left in the flap is liable to suppurate, fractured very much the patient's recovery, sometimes to produce dangerous consequences. Mr. Cope recommends a similar modification of the circular incision in all cases of amputation of the leg, & directs two semilunar incisions to be made, with their convexities downwards, from side to side of the limb, the angles of junction being from two to two and a half inches below the anterior crest of the head of fibula. The flaps of integument are then dissected back to an inch or an inch & a half below the anterior crest. The muscles behind are then divided about an inch lower down from the reflected integuments, those helping the interosseous ligament on a line with which the bone is to be divided, thus allowing made for their unequal attraction; the bones are drawn through.
as high as the skin has been directed up, a piece of
hangnail, pressed between the bones will act as a useful
retractor. In sawing the bones, it is safe to divide the
femoral first to prevent it splitting. It is also advisable
to saw off the sharp projecting edge of the tibia, which might
incline through the skin.

The advantage of amputating thus high up, instead
of about the middle of the leg, when it can be accomplished,
as is usually recommended, are that the cancellated tissue
of the bone exposed is not so liable to suppuration as the dense
substance of the shaft, while at the same time the stump
is long enough for an artificial leg of a very simple construction
to be applied, allowing of the instruments of the knee joint
as completely as in its longer stump; or, if the patient should
prefer it, he may walk with his knee bent, without the
inconvenience of a long stump projecting behind.

In amputating the leg by making the cutaneous one
is formed by making a curved incision from side to
side. The posterior one is usually by transfixion and
cutting outwards slightly.
+Syne Month Journal of Medical Science. May 1845. p. 357.
10. Amputation at the Knee Joint.

This amputation was recommended as early as 1612 by Guillemaud, and subsequently by Forin in 1764, since then it has been occasionally performed by different surgeons, especially by Lister of Deeside. It was introduced into this country by Mr. Fry in 1844 who improved it by removing off the articular surfaces of the femur. Thence lately this operation has been recommended by Mr. Ferguson.

It is best performed by making a longitudinal incision from one condyle of the femur to the other, in a line with the inner edge of the patella. The knife is then made to traverse behind the joint, and a long flap made from the calf of the leg. The articular extremity of the femur is then removed, by applying the saw or chisel to the condyles.

The term which results is longer than necessary, and is convenient as in this amputation is performed at the lower end of the thigh. At the same time the operation has the advantage of being less dangerous to life, as the amount of N. P. nerves divided is less; fewer vessels require ligature; suppuration of bone less likely to occur; the cancellated structure being exposed instead of the dense bone of the shaft, or the extensive mediullary canal & hemicellae, also cut opened into. Under these circumstances,
The operation may be advisable in cases of great prostration. If the operation is performed for disease of the knee joint, its unhealthy appearance of the soft parts near the joint should be regarded, as tending in evincing a stage of tissue necrosis, which will not prevent the healing of the wound though it will retard it.

II. Amputation of the Thigh.

Previously to 1822 the thigh need always in this county been removed by an incision incision, but about this time Dr. Lisfran, introduced from the continent, the plan of amputating in this situation by flaps, which it was thought by Lisfran and other surgeons, since this time it has been generally adopted. Among Dr. Packer, Dr. Larue, Dr. P. J. B. D. B. J. B. J. B.

Anterior and posterior flaps are usually preferred, though many adopt Prinsep's plan by lateral flaps, especially when amputating at the lower part of the thigh, considering that a better covering of the parts can be thus obtained. Prinsep's operation is objectionable on account of the bone being apt to appear at the upper angle of the wound, at the same time the state of the soft parts of the limb among necrosis this operation advisable.

In amputating by anterior-posterior flaps, the surgeon
Liston. Practical Surgery. 4th Edit. p.382
surgically girds the soft parts in front of the line, so as to draw them forward. A third transverse cut is made from side to side, cutting the knife closely over the free part of the line, from the anterior flap, by cutting outwards; which being held off by an assistant, the knife is again passed through the limb, through the second flap formed from the posterior surface. This flap should be longer than the first, to make allowance for the greater contraction of the muscles on the posterior aspect, to allow the stump being placed in a slightly flexed position. The flaps are then retracted strongly (if the limb be muscular a retractor is useful) the bone cleaned with some circular motions of the knife, then often considerably above the angle of union of the flaps. A bandage should be applied to the upper part of the stump, to keep down the soft parts, the stump dressed according to the principles I have before mentioned.

Mackenzie recommended "the more should not be drawn very much lower than its middle" as he considered that an artificial limb could be better applied than if the stump were longer. It is impossible, he said, to be the case, instrument makers generally preferring a longer stump; a greater leverage is gained by the additional length. Amputation at the lower third of the thigh is also a less dangerous operation, as for
size of the wound inflicted is smaller and the rent removed less. It is however more difficult to obtain a good stump in this situation by the limb amputation, especially in a muscular limb, as owing to the distance the muscles are cut from their origin, the amount of their contraction is greater, and the bone is apt to intrude within all the ends of the severed bone stump.

To prevent these inconveniences, Dr. Sappey has practiced in amputating at the lower third of the thigh, a modification of the circular amputation, very similar to that already mentioned in amputation of the leg. A semilunar incision with its concavity forward is made from side to side on the anterior aspects of the limb. The integuments are thus retracted from their subjacent connections, so as to expose the muscles at least two inches above the angle of union of the skin flaps. The muscles are then divided as high as they are exposed in front, as low behind, so as to compensate for the inequality of their contraction, and thus retracted from the bone. In about two inches higher from where it is first exposed in front, which is then divided on a level with the vastus muscles, as they are held back with a retractor.

When the thigh is small or if, whether from disease or otherwise, soft flaps inserted in the wound.
may, taking care to explore the bone for a considerable distance before applying the saw, will be sufficient.

The femur may be divided as high up as through the outer 

femurline, which is a less dangerous operation than amputation at the knee joint. If, however, the patient be prepared for amputation, it should be preferred. The flap should, as in the great limb amputation, be anterior to posterior, but here as in all amputation, the surgeon must be prepared to carry incision

when the circumstances of injury or disease require it, or as to

obtain a covering for the limb by a flap from every portion of the

limb. Great care may be found in the illustrations of this

amputation. In the case of a man, James Melville, aged 61, admitted into the St. Mary's Hospital, under Mr. Sykes, on the 21st of July, 1853, with a malignant one on the inner aspect of the thigh, measuring 7 inches by 6 inches, protruding about as high as the knee, it had resisted cautery and other treatment for seven years during which time it had been constantly

increasing, and caused much pain. The patient came from Lichfield in order to have the limb removed. On

the 27th inst. Mr. Sykes amputated through the small

femurline, forming a large flap from the outer aspect of the thigh. The case did well, and the patient left the Hospital with the wound healed.

In amputating at the hip joint a variety of methods have been proposed, and the surgeon must be guided in his selection by the nature of the case he has to deal with. If it is in his power, antero-posterior are always decidedly preferable.

The common formula being compressed by an assistant as it passes over the bone of the pelvis, a long narrow knife is entered about half way between the ilium and the trochanter major, if the left limb is to be operated upon, made to pass deeply behind the vessels immediately in front of the joint. The joint being depressed is brought out just above the tuberosity of the ischium, a large anterior flap is formed by first cutting downwards and forwards, while this is being done, the assistant who bears his thumbs over the artery follows the back of the knife with his fingers, and grasps the flap as it is cut so as to compress the artery between the fingers and thumb of the right hand, while which hand he is also able to hold up the flap, while the left is at liberty, if necessary, to move one of the assistants to arrest the hemorrhage from the posterior flap in the after part of the operation. The limb is then forcibly adducted and exerted, the joint opened by dividing the capsular ligament with a sharp stroke of the knife, and...
and the head of the femur made to project. The cornet ligament of posterior part of the capsule are then divided; the knife being passed behind the great trochanter, the assistant having previously brought the limb back from the state of abstraction, the posterior flap is made by cutting backwards & downwards, & downwards. The assistant now immediately makes pressure on the bleeding arteries of the posterior flap with his fingers, or what is on the whole better, a large sponge firmly against its middle. The arteries of the posterior flap are then tied ligatured, as they are little under control. The femoral & its branches in the anterior flap, having been tied the edges of the flap are brought together by sutures, after mourning dressed by large packs of lint on the flaps & a hemostage passing around the pelvis.

If the right thigh is to come to be amputated, the femoral is removed, the knife being cutted just above the inferiority of the line, a brought out between the trochanten major & inferior process of the ilium.

[Signature]

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