character of this alkaloid, however, apart from other reasons, makes it undesirable for general use in the mouth.

Iodine.

Even in such weak solutions as 1 in 3,000 iodine is a splendid antiseptic, but its destructive action on the tissues is well known, and it would obviously not make a satisfactory mouth-wash for general use. It is, however, useful to dental practitioners, not only owing to its antiseptic properties, but because it stains the leptothrix and so facilitates its removal.

Hypochlorite Solutions.

Even if hypochlorite solutions do not attack the teeth, as is claimed,¹ they are still not suitable for general use owing to their instability.

Chloramine-T (toluene sodium sulphochloramide), which has given such good results when used in solution as a spray for the nasopharynx of meningococcus carriers, was tested in 2 per cent. and 3 per cent. solutions. No growth occurred after submitting films of mouth bacteria to them for any time over fifteen seconds. However, the solutions have an unpleasant chlorinous taste, and this, in addition to possible action on the teeth and their stoppings, at present makes their general use undesirable.

Oxidizing Agents.

Hydrogen peroxide solutions are too readily reduced to be successful in the hands of an ordinary patient. *Potassium permanganate*, another oxidizing agent and deodorant, is sometimes used as a mouth-wash. It is by no means ideal, being only a weak antiseptic, and, in addition to staining the teeth, has an unpleasant taste.

Other Antiseptics.

Zinc sulphocarbolate (zinc phenol parasulphonate) has been recently recommended to be used in 4 per cent. solution as a "gum-wash" in cases of pyorrhoea. In my experiments I have used chiefly a 10 per cent. solution, and out of nine bacterial films submitted to this strong solution for half to two minutes, I have never once obtained complete sterility. In most there were many more colonies than the thirteen shown in Fig. II, 6.

Flavine and other dyes with antiseptic properties are obviously unsuitable for general use in the mouth owing to their tinctorial properties.

To sum up: in health as well as in cases of oral disease, antiseptic mouth-washes should be used as often as possible, and a really satisfactory mouth-wash, both cheap and effective, is a saturated aqueous solution of thymol.

REFERENCES.

- ¹J. M. Beattie, F. C. Lewis, and G. W. Gee: Hypochlorous Solution, *BRITISH MEDICAL JOURNAL*, February 24th, 1917 p. 258. ²J. A. Gunn: The Pharmacological Action of Harmine, *Trans. Roy. Soc. Edin.*, 1909, xlviii, p. 83. ³H. Pixell Goodrich and M. Moseley: Certain Parasites of the Mouth in Cases of Pyorrhoea, *Journ. Royal Micros. Soc.*, December, 1916, p. 513. ⁴C. Robin: *Végétaux parasites qui croissent sur l'homme*, 1853.

THE TREATMENT OF FRACTURES BY SPLINTS;

WITH SPECIAL REFERENCE TO THE TREATMENT OF FRACTURES OF THE FEMUR IN CIVIL AND MILITARY PRACTICE.

BY

CHARLES A. MORTON, F.R.C.S.,

PROFESSOR OF SURGERY, UNIVERSITY OF BRISTOL; SENIOR SURGEON TO THE GENERAL HOSPITAL, AND THE CHILDREN'S HOSPITAL, AND THE BEAUFORT WAR HOSPITAL, BRISTOL.

In order that we may determine the right method of treating a fracture by splints, it is necessary that we should first try and answer the question, Is it desirable that the fragments should be immobilized? and then, if this seems to be essential, we should further consider whether it is necessary to fix the joints on each side of the fracture to obtain this immobility. Lucas-Championnière taught¹ that not only did a slight amount of movement at the seat of fracture do no harm, but that it actually aided union. But we must consider not only the effects of movement on the reparative process, but the risk of disturbing the position of the fragments by such movement.

In a transverse fracture in which there has either been no displacement, or it has been reduced, and there is no tendency to its recurrence, the risk of slight movement at the seat of fracture might be ignored; but on the other hand, if we had only succeeded with much difficulty, under an anaesthetic, in correcting marked deformity at the seat of fracture, and we found that unless the parts were most carefully and thoroughly fixed the displacement tended to recur, obviously any movement at the seat of fracture would be most undesirable. Now with movement of a neighbouring joint there must be a risk of displacement of the fragments, and this is, of course, in proportion to the nearness of the joint to the seat of fracture. For instance, in that very troublesome fracture of the femur just below the trochanters, in which there is such marked riding upwards of the lower end of the upper fragment, as well as other forms of displacement, there must be considerable risk of displacing the fragments with movement at the hip-joint, after they have been placed in the best possible position we can obtain under an anaesthetic. Or take another example—fracture of the lower end of the femur just above the condyles. If after much difficulty in reducing the backward displacement of the lower fragment under an anaesthetic, and fixation of the limb on a double inclined plane, we move the knee-joint, we must run a risk of again displacing the fragments.

I have lately had a very striking instance of the way in which movement of the neighbouring joint may disturb a fracture. I treated a soldier with a very comminuted gunshot fracture of the middle of the femur in the Military Hospital with the splint I am about to describe, which fixed the hip-joint. After the splint had been applied for several weeks, and the fracture was slowly uniting, he asked to be allowed to sit up more. I thought this might be done without harm, at the stage of union then reached, and I altered the splint so as to allow of it. When I next saw him I expected him to express satisfaction at the greater freedom of movement, but I found he had not been able to take advantage of the possibility of raising his body into the sitting position, as it caused pain at the seat of fracture. Later on, after further union had taken place, he was able to do so.

There can, of course, be no doubt of the value of movement of the joints above and below the fracture, to prevent them becoming stiff, but it seems to me we ought not to perform such movements at the risk of disturbing the position of the fragments when there is considerable liability to recurrence of displacement of a serious character. I am fully aware that, when it can be carried out without risk of disturbing the fragments, passive movement of the joints above and below the seat of fracture is greatly to be recommended; but I fear there is a tendency to recommend it without laying due stress on the risk of disturbing the position of the ends of the fractured bone. It is sometimes said that if considerable extension is maintained, the risk of displacing the fragments by movement of the neighbouring joint need not be seriously considered. No doubt if extension is acting powerfully, it will to a large extent reduce the risk, but it seems to me very doubtful if it really removes it.

I do not believe that in every fracture a really perfect anatomical position of the fragments is essential to good function. Indeed, I feel sure it is not. But gross deformity must obviously be corrected, and the fragments so fixed in the corrected position that serious displacement does not recur. I do not think that in some cases we can expect to maintain this improved position, which we may have only obtained with much difficulty under an anaesthetic, if we move the neighbouring joint. Not only is movement conveyed to the seat of fracture by moving the articular end of the bone, but every movement of the joint moves the muscles which are attached to the bone, and may be attached just at the seat of fracture. No doubt movement of the joint remote from the fracture—the hip-joint, for instance, in fracture of the lower end of the femur—is not nearly so likely to disturb the position of the fragments by direct movement of them as would movement of a neighbouring joint, but there might be just as much muscular movement produced in the limb. Even if the joint movement is only performed by the surgeon, it is apt to excite some involuntary active movement on the part of the patient, even if he is cautioned against making them.

When a fracture is close to a joint the liability to stiffness of the joint is of course increased, and the surgeon in

such cases very often grasps the limb at the seat of fracture very securely and then moves the neighbouring joint. If the surgeon can really satisfy himself that he can by grasping the limb securely prevent any displacement of the fragments, then the movement of the joint is most desirable, but it seems to me it is better to take the risk of stiffness of the joint than of serious displacement of the fragments. Stiffness of a joint after union of a fracture, though often very troublesome, will yield to passive and active movement in time, whereas the displacement of the fragments can only be remedied by re-breaking the bone or performing an open operation.

It is sometimes stated that one advantage of fixing the bones by plates and screws is that you can then move the neighbouring joint freely without risk of disturbing the fracture, but all the screws get loose before long, and though it may be safe enough to move the joint freely just after the plating, a little later, when the screws have become loose and the union has not progressed far, displacement may occur. This would not, of course, happen if a double-bolted screw or a wire surrounding the fragments had been employed.

In some forms of fixation apparatus the joint near the fracture can be moved without disturbing the splint. For instance, the knee can be extended when, in fracture of the femur just above the condyles, the limb is on a double inclined plane, without any disturbance of the limb on the splint. But if in order to move the joint it is necessary to move an important part of the fixation apparatus, this causes an additional risk of displacement of the fragments.

If, then, it is desirable in certain cases to fix the joint above and below the seat of fracture, as used to be taught in the textbooks of surgery, how can such a method be best carried out in treating fractures of the femur? None of the splints now commonly used for fracture of this bone fix the hip-joint; neither Thomas's knee splint, Hodgen's splint, or Groves's cradle splint do so. The splint which I use does so, but, unlike the long Liston splint, it allows the patient to raise his shoulders from the bed, so that he can easily look about the room, read, and feed himself. I find that if a bar is fixed across the abdomen at the level of the umbilicus this will prevent the patient sitting up

FIG. 1.—The splint.

to such an extent that the pelvis is moved, and any movement of the body will not cause movement at the hip-joint, and therefore not at the seat of fracture. In my splint the transverse portion passes across the patient's abdomen, reaching up to the level of the umbilicus (Figs. 1 and 2). It is an advantage to screw this part of the splint on to the vertical part on which the fractured limb rests after the limb is placed on it. And it is also an advantage to pass a strong piece of cloth

FIG. 2.—Showing the relation of the transverse (pelvic) part of the splint to the patient.

beneath the patient's sacrum, and nail it to the lower border of the transverse part of the splint. This forms a kind of floor to the pelvic part of the splint, which will prevent the pelvis falling downwards, if by any chance the splint should be raised from the bed. It seems to me that it is very desirable to have a posterior splint as well as a lateral, in the treatment of

fracture of the femur. It must always be wise to allow a fractured limb to rest securely on a firm support, just as a fractured leg rest on a back splint. When wounds are present on the posterior aspect of the lower limb slings may have to be used as this support. I described a splint with such slings in the *BRITISH MEDICAL JOURNAL*, 1915, vol. ii, p. 321, for fractures of the leg with posterior wounds. But slings are not an ideal support. They must be used in these cases with posterior wounds because the only support possible has to be at intervals between the wounds, but obviously a firm splint is a much more satisfactory support. This is supplied in my splint, joined to a lateral splint. By means of this combination, antero-posterior and lateral displacement can be prevented. The posterior splint should reach as high as the junction of the thigh and the gluteal region, that is, just a little below the perineum. The upper edge must be round and carefully bevelled, or it will cause discomfort from pressure on the under aspect of the thigh. The lateral splint can have a bracket space wherever required to allow access to wounds.

If slings must be used in compound fractures, I think slips of bent metal are a better support than rubber or mackintosh cloth; a little flat pillow covered in mackintosh cloth, like a large flat heel-pad, should be placed between the limb and the metal sling.

I have treated cases of fracture of the femur on the splint which I have just described, in the extended position, but I quite see there is an advantage in a certain amount of flexion of the knee and hip, from relaxation of the muscles; but if extension is made by plaster in fracture of the femur, with a flexed knee, the only surface to which the strapping can be fixed is the sides of the knee and the thigh just above it. If the fracture is low down in the femur, or there is a wound low down on the thigh, there is very little room left for fixation of strapping here, and the extension pulls almost entirely on the condyles of the femur. But if in such a case the limb is extended at the knee, then the strapping can be fixed also to the sides of the leg, and thus a much larger area for fixation can be obtained. Of course, if weight extension is made by transfixion of the lower end of the femur, the knee can then quite well be flexed, but transfixion extension is not a method free from risk, and I should not be inclined to adopt it if I could get a satisfactory extension by strapping. Moreover, if the knee does become fixed in the flexed position, it is a more serious matter for the patient than if the limb is straight.

It would obviously be possible to make extension with strapping fixed to the leg and lower part of the thigh, in the flexed position of the hip-joint, by placing the limb on a plane inclining upwards from the hip to the foot, but it seems to me that it is flexion of the knee rather than of the hip that is most desirable, in order to relax the powerful hamstring muscles, and that muscular relaxation brought about by flexion of the hip is not as important. But my splint (as shown in the drawing) could easily be modified, so that if it was desirable to secure flexion of the knee and hip, this could be done. The straight back splint could be replaced by a double inclined plane, and such a form of splint would certainly have to be used in fractures of the femur just below the trochanters and just above the condyles.

Those surgeons who consider it is best to treat a fractured femur not by continuous weight extension, but by what they call "fixed extension," which means securing the limb to the bottom of a Thomas's splint, can easily employ this method, for to either the side or back splint a support can be attached to which such fixation can be made.

It is, of course, not enough to fix the hip-joint so that antero-posterior movement of the pelvis is prevented, but my splint also controls lateral movement. In order to do this it must prevent lateral tilting of the pelvis. When I first used the splint it was carried down by the side of the sound limb, as in a Bryant's splint, and the sound limb was fixed to it. This, of course, prevented lateral tilting of the pelvis, if the foot of the sound side was also fixed to a foot-piece; but the fixation of the sound limb worried the patient and prevented easy use of the urine bottle, and it did not seem really necessary, for if the fractured limb is pulled down by a powerful weight and the pelvis is also fixed by a sling around the perineum to the top of the bed, lateral tilting must, I think, be prevented. This perineal sling is essential for another reason: without it the

weight pulls patient and splint down towards the foot of the bed, even if fairly high blocks are placed under the lower legs of the bed. The sling should be made of a cylinder of cloth, stuffed with wool and covered with jaconet, and the groin should be kept well dusted with boracic acid powder. When we wish to obtain abduction of the limb we must put the sling around the perineum on the opposite side to the fracture, and thus produce a tilting up of the pelvis on that side. But when abduction seems desirable, as it does in fracture high up in the femur, the thigh (vertical) part of the splint can be fixed at any required degree of abduction of the pelvic (transverse) part of the splint.

In certain cases of gunshot fracture of the pelvis a support underneath some part of the pelvis can be added to the splint, and a vertical part could be made for each lower limb, so that it would act in the same way as Colonel Robert Jones's abduction frame. If a piece of well-padded wood were joined to the bottom of the pelvic part of the splint so as to make a floor to it on which the pelvis was supported, the splint would be quite suitable for transport of a gunshot fracture of the femur. The extra piece could then be removed when the soldier had been transferred to the base hospital, and the rest of the splint retained in use.

There may be an objection to a splint of wood in cases with wounds. It is, however, more quickly and easily made than an elaborate metal splint, and if the wood in the neighbourhood of the wound is varnished and covered with mackintosh material, there is no real objection to the wood.

With whatever care the surgeon may have placed the fragments in good position, and secured the limb in splints, unless special precautions are taken in the use of the bedpan, movement at the seat of fracture is apt to be produced. It has been pointed out that with the long Liston splint the fracture may be disturbed in this way, as both patient and splint have to be raised to get the bedpan under him, and it has been suggested that the movement at the seat of fracture might be avoided by using a splint which does not fix the hip-joint. But if the hip is not fixed by a splint, but the patient is sitting up in bed, the pelvis cannot be raised for placing the patient on the bedpan without movement occurring at the seat of fracture, for the upper fragment will certainly be raised together with the pelvis. The surgeon leaves the patient sitting up in bed with his fractured thigh secured in a splint, and fails to realize that every time the bedpan is placed under the patient the pelvis and with it the upper fragment of the fracture is raised from the bed. I do not know the amount of distress the use of the bedpan may cause to a patient with a fracture high up in the femur, but I can imagine that it may be very considerable. The best arrangement to allow of defaecation without movement of the fracture is to have a divided mattress, so that the piece corresponding to the coccyx and upper part of the thigh is removable or insertion of a receptacle used as a bedpan. But support must not be removed from under the sacrum, or the pelvis will sink down and movement at the fracture be produced. If a divided mattress cannot be obtained, I have found it possible to arrange firm pillows so as to leave a space for the bedpan, as shown in Fig. 3; but the pillows must be quite firm, and the edge of the pillow underlying the sacrum should be supported by a sandbag lying beneath it, for it is very important that the sacrum should be well supported. Much better than ordinary pillows, however firm, would be firmly stuffed pillows with sides made like a mattress.

To lift the pelvis of a patient with fractured femur, or to slightly roll the patient's body towards the fractured side, in order to get at the sacral region, for the purpose of washing it and applying spirit to it, is very likely to disturb any fracture situated in the upper part of the thigh; but the nurse might safely pass her fingers, covered with a piece of lint, between the skin over the sacrum, and the mattress or pillow it was resting on, and thus wash it

and apply spirit to it, but she ought to be cautioned not to attempt to raise the pelvis, or attempt to roll the patient on his side.

In gunshot fracture of the femur with posterior wounds, we must, as I have already pointed out, use some form of sling splint. I have generally used a Hodgen's splint, and found its extension very satisfactory; but I see no reason why to the transverse (pelvic) part of my splint two strong metal rods should not be attached, and supported at a considerably higher level at the foot end, thus making an inclined plane from the hip up to the foot. This would be practically a combination of the pelvic part of my splint with the side bars of a Thomas's knee splint, and as it is difficult to fix a Thomas's splint with a suitable sized ring, unless the ring is made for the patient by careful measurement, it would be a great advantage to dispense with the ring, which is so often too large, and lies not on the ischial tuberosity but in the perineum, or even on the opposite side of the perineum, in many of the cases which arrive at the military base hospitals in this country, and cause much distress to the patient, as they can neither urinate or defaecate without great discomfort.

I should prefer continuous weight extension to the mere fixation in extension of the Thomas's splint, but this could be quite easily carried out if lateral bars were fixed to the pelvic part of my splint so as to make a sling splint.

I desire to add some brief remarks on the treatment of fracture of the femur in the aged and in children.

In fracture of the neck of the femur in quite old people we

are told in the text-books on surgery that we must not keep them in bed, or they will get hypostatic pneumonia and die. It is said that because bony union in intracapsular fracture will not occur, it is no good fixing the fracture in any way, and that

we ought to get them out of bed very soon after the accident. I am sure this is an error. The mere getting the patient out of bed does no good, and causes great distress in a case of recent fracture. It is entirely the position of the patient, not of getting the patient out of bed, which is essential. If the old person is placed in the Fowler's position, with a bed-rest by day, how can he be in any better position in an armchair? We cannot, of course, fix the hip-joint in such cases, for we must keep the patient sitting up by day, and I find a Hodgen's the best splint to use in such cases. Even though we cannot expect bony union, it is desirable to restrict movement to prevent pain, and painful movement at the seat of fracture is much more likely to be controlled by a Hodgen's splint than by sandbags. As to the production of bedsores, there is certainly no greater risk if the patient is supported on an air cushion in the bed than if sitting in an armchair. I have treated in this way, quite satisfactorily, several cases of fractured femur in quite old people—that is, people about 80 years of age.

Then with regard to the treatment of fractured femur in children, it seems to me that if the child is quite young vertical suspension of the lower limb is the best method to employ. The excreta can be attended to without disturbing the fracture and continuous extension can be maintained. The absence of any reliable splinting makes the surgeon a little anxious about the occurrence of deformity, but the result is generally excellent. In older children I think my splint can be used with advantage both for fracture of the femur or for osteotomy in the lower limb; but it may be necessary to fix the whole body in a restless child. This can always be done by a towel and sandbags applied above the level of the splint, so long as the child is restless, or the pelvic part of the splint can be carried up to the axilla, as in Bryant's double splint, and a vertical part can also be added, as in Bryant's splint, for the sound limb; but it seems to me that my splint has the great advantage over a Bryant's splint, that it has a posterior support on which the fractured limb, or the limb on which osteotomy has been performed, rests.

REFERENCE.

BRITISH MEDICAL JOURNAL, 1909, vol. i, p. 1397.

FIG. 3.