THE IMMEDIATE TREATMENT
OF
FRACTURES OF THE LEG
BY
PLASTER-OF-PARIS SPLINTS.

BY
JOHN CROFT, F.R.C.S.,
SURGEON TO ST. THOMAS'S HOSPITAL.

Received June 6th—Read June 14th, 1881.

I BEG to state that my main object in bringing this subject before this Society is to endeavour to popularise the practice of applying plaster-of-Paris splints immediately for fractures of the leg. Plaster of Paris has been employed to form an immovable apparatus or case for the treatment of fractures since its introduction in 1828 by Klüge. Mathieson, in 1854, first described the plaster-of-Paris bandage. A plaster-of-Paris splint or envelope made of flannel was used extensively by the Bavarian surgeons during the Franco-Prussian war. Mr. Bryant at Guy's Hospital has employed an apparatus made of flannel, stiffened with gum and chalk, for fractures of the leg after swelling has subsided. I mention these well-known facts as they contributed to my "make up" of these splints.

The history of the introduction and adoption of plaster

of Paris in surgical practice is too well known to require further recapitulation.

I wish it to be understood distinctly that I do not employ plaster-of-Paris *bandage*, and that I do not employ a single splint which completely embraces the limb, such as the Bavarian apparatus that was used in the Franco-Prussian war.

I use *side splints*, one for the inner side and another for the outer side of the limb. The bandage for applying these splints is made of soft, dry muslin, and does not contain any plaster of Paris, and just enough bandage is put on to keep the splints steadily in place. The splints themselves, shaped like the well-known short outside splints, are made of two layers of common house flannel. The layer which is to go next the skin is not soaked in plaster, but the outer layer is well saturated with it.

It will be perceived that in the event of swelling or other reason arising for taking off the splints they can be very quickly and easily removed. The muslin bandage which spans the interval between the splints in front can be cut down with scissors or penknife. First one then the other splint can be turned aside. It is not necessary to wholly remove them. Another bandage can be put on outside the first with suitable tension. In this way the fracture is not injuriously disturbed. That is a most important advantage of the apparatus, and bears closely on the question which comes uppermost in the consideration of this paper, viz. the *immediate* application of the splints.

The great objection to an immovable apparatus made of plaster-of-Paris bandage is that, should swelling of the limb come on, so much difficulty is experienced in removing the "case." Another objection is that uneven application of the bandage and plaster may lead to uneven pressure or constriction, and consequent swelling of foot and ankle. A third objection is the prospect of having to apply a second "case" when the first has been taken off. These objections have, I believe, operated chiefly in

detering surgeons from immediately applying plaster of Paris for fractures of the leg. They have shrunk from the risks referred to.

Carefully pursued my plan is as safe as any other, and very advantageous.

During the six years that these splints have been in use I have had twenty-six house-surgeons and about forty dressers, implying twelve changes of house-surgeons and dressers. Notwithstanding this, no accidents of any significance have occurred from the use of these splints.

I believe that some surgeons still think that under no circumstances is it justifiable to cover in the injured part by splint or bandage. They think, on the other hand, that time must be given for the swelling to subside before the bandage may be carried over that part of the limb. Theory and experience have been against them for many years. My experience at St. Thomas's for a period of six years is decidedly in favour of quickly covering the part injured by an apparatus which ensures equal pressure and support.

The old opinions may be thus expressed:—1. That compression prevents the formation of provisional callus. 2. That compression delays union. 3. That the pressure or resistance of the splint &c. may lead to excoriation, slough, or gangrene of limb. 4. That the surgeon and patient are prevented from watching the progress of the case.

These opinions have been refuted over and over again, theoretically and practically, by experienced surgeons since the time of Larrey. We know that provisional callus is *not* necessary for the union of fractured bones, and we know that inflammation is not a necessary part of the repair of fractured bones.

I would advance in favour of immediate uniform pressure that (as regards the part about to swell) the physical phenomena are checked by it, the dilatation of the vessels is counteracted, and the exudation is prevented, provided the swelling is not due to rapid extravasation of

blood from a wounded artery. In another way uniform support prevents swelling. Spasmodic movements, which occur when the fractured bones are not properly supported and fixed, drive the rough ends of the bones into muscle and other tissues. This injury in its turn causes swelling. The perfect manner in which these side splints of plaster of Paris control the bones and abolish spasmodic movements prevents such secondary swelling.

May this apparatus be put on the limb when the latter is already red, swollen, and blistered? Yes; if pulsation in the tibial arteries is natural, the splints may be applied. If blisters have formed, they should be pricked, or drained by carbolised silk, and covered with carbolised oil. I have on several occasions applied the splints when the limb has been in the state referred to and the result has been eminently satisfactory.

I may particularly refer to two cases of Pott's fracture which were under my care in 1878. An attempt had been made by my house-surgeon in each case to treat it on a Liston's back splint. The displacement had recurred and swelling was on the increase. In one the integuments were blistered, red, and much swollen. Each patient was placed under the influence of chloroform, and I reduced the displacements thoroughly and applied the splints and muslin bandages. The comfort and relief and confidence which the patients derived from the proceeding made a great impression upon me. The splints were not taken off for six weeks, as no necessity arose for disturbing them.

In continuance of an examination of the advantages to be attributed to these splints I will take them in the following order:

Perfect adaptation to the limb and maintenance of extension.—The plastic material admits of the splints being accurately fitted to the inequalities of the limb. Whilst the plaster is hardening the fracture is kept by the surgeon in proper position. When the plaster has "set" the fracture cannot be unset by muscular action

the foot cannot approximate the knee, nor can the straight position become crooked; once "set" it is always set.

Diminution of risk of delayed union, and unrest.—Since I adopted this plan my patients have enjoyed uninterrupted rest, and delayed union has become of extreme rarity. During six years one case of delayed union of fractured tibia and fibula has occurred in an anæmic Jew, who took no butcher's meat but only fish.

Comfort to the patient.—These splints are so comfortable that sedatives are only rarely required. This quality is one of the great boons which these splints have conferred upon patients and attendants. Little aches and pains which used to be tolerated are now not felt at all.

Freedom of movement allowed the patient.—The freedom which this plan allows the patient is obvious. He is at liberty to turn on either side, to bend his knee a little, to get up in a few days.

Simplicity and cheapness.—Its simplicity and cheapness are too evident to need comment.

Economy of time and trouble.—Saving of time and trouble; these, too, are very evident.

The apparatus.

This consists of, first, inside and outside splints made of common house flannel and plaster of Paris, and, secondly, of muslin bandages.

The splints are shaped somewhat like the old short outside splint; the foot-piece is, however, wider. The inside splint is in every respect like the one for the outside. These splints should be long enough to extend from above the knee to the middle of the metatarsus, and together they should be in width about one inch less than the circumference of the limb at the corresponding part. A rough guide to the shape of the splint may be found in the injured person's stocking when it is laid flat on a table. Each splint is to be made of two layers of flannel.

The outer layer carries the gypsum, the inner forms a warm pliant lining, which protects the skin.

The splints are applied by means of muslin bandages. The bandage is put on like any other from the toes to the knee. One thickness is sufficient. Two bandages of five or six yards in length are more convenient than one of ten or twelve yards.

To make the splints.—A piece of house flannel which has been shrunk or which is warranted not to shrink or any suitable substitute is to be selected. The splints may be made by measurement. The measurements required are:—the circumference of the limb (1) below the knee, (2) at the biggest part of the calf, (3) just above the ankle-joint, (4) from the front of the ankle-joint round the heel to the front again, and (5) at the middle of the tarsus. Or the splints may be cut out from the pattern of the person's stocking. The flannel of the splint is to be in width half an inch less than half the circumference of the limb at any corresponding point. It should be long enough to extend from above the knee to the middle of the metatarsus. Four pieces of flannel are required, two for each splint. Two bandages of common muslin are prepared, each five or six yards long and two inches and a half in width. About a handful of good dry plaster-of-Paris is mixed with water to the consistence of thick cream. The inside pieces of flannel may be laid on the table or bed, the outer surface being upwards. The outside pieces are to be thoroughly soaked in the plaster separately and laid out on their respective inside pieces.

Application.—Whilst traction is kept up and the ends of the broken bones are maintained in apposition the splints are to be applied and smoothed out and the bandage is to be put on. Traction must be kept up whilst the plaster is hardening; the latter takes place in about three minutes. In applying the bandage, great caution should be observed that it is not drawn tightly anywhere, and that no one turn of the bandage is tighter than another. The support is to be equal everywhere.

After-treatment.—If it become necessary from any cause to inspect the limb at any spot or to ease the limb of a sense of tension, the muslin bandage can be cut down the front of the limb opposite the interval between the splints. In that situation and the corresponding one behind, the interval is spanned only by the muslin bandage. This having been slit up in front allows the surgeon to ease off one or both of the splints.

It is undesirable to wholly remove the splints. They are hinged together at the back by the muslin bandage. To readjust the splints it is only necessary to put on another bandage outside those already in place. It is better to leave the first bandage still adherent to the splints, as the material strengthens the flannel and plaster.

As swelling subsides and the splints become loose in any degree, an additional bandage should be put on to take up the "slack." The trimming of the apparatus may be done as soon as the plaster shall have hardened.

At the end of ten days or thereabouts the bandage may be gummed, or a fresh calico roller applied and gummed. Such an apparatus will last until splints are no longer needed.

At the end of a fortnight or three weeks, as the case may be, the patient may leave the hospital for his own home.

I do not employ these splints alone for fractures of the *femur*. The muscles of the thigh, arranged more or less loosely around a single cylindrical bone, change their shape and the shape of the thigh so much by their contraction and relaxation that the splints which fitted well at first do not lie closely later on. Cotton-wool lining does not prove a thoroughly efficient corrective. Therefore, for fractures of the *femur*, I prefer a long anterior splint of plaster of Paris, in combination with a long outside wooden splint. The anterior splint should extend from the crease of the groin to beyond the knee, about half way down the front of the leg. This has been found

to answer admirably. No perineal band is needed. Commonly the reduction of the deformity and the dressing are performed whilst the patient is under the influence of chloroform. Fractures at the junction of the upper with the middle third of the bone may be treated most successfully in this way.

Fractures of the patella.—The lateral splints have been found much superior in comfort and efficiency to any other wooden or metal splint. Pads, straps of adhesive plaster, and elastic traction have been ingeniously added to the splints, and excellent results have been obtained.

Fractures of the bones of the upper extremity.—I cannot specially recommend any form of plaster-of-Paris apparatus for these injuries.

Use in delirious cases.—This apparatus is extremely useful in delirious cases.

Excision of knee- and ankle-joints.—Splints made of plaster of Paris and flannel are of great service, either alone or in combination with metal splints.

Fractures of the spine and pelvis.—Splints made of plaster of Paris and flannel have proved of great service for these fractures.

Postscript.—This may prove the most interesting part of the paper, for it bears especially on the experience of this plaster-of-Paris apparatus, at St. Thomas's Hospital during the last six years, and the practice at other hospitals at the present time, with regard to fractures of the leg.

I am indebted to Mr. Battle, the present Registrar at St. Thomas's, for a few statistics which show the change that has gradually crept into use in our own hospital.

In 1875, at St. Thomas's, 97 simple fractures of one or both bones were treated.

63 by splints only.

19 by plaster of Paris only.

9 by splints first and plaster of Paris after.

4 by splints first and gummed band after.

2 by silica and whiting or gummed band.

- In 1876, 105 cases were treated.
 18 by splints only.
 51 by plaster of Paris only.
 34 by splints first and plaster of Paris later.
 2 by silica and whiting or gummed band.
- In 1877, 130 cases were treated.
 13 by splints only.
 84 by plaster of Paris only.
 30 by splints first and plaster of Paris after.
 3 by gummed bandage.
- In 1878, 124 fractures were treated.
 15 by splints only.
 96 by plaster of Paris only.
 13 by splints first and plaster of Paris after.
- In 1879, 130 cases were treated.
 2 by splints only.
 125 by plaster of Paris only.
 3 by splints first and plaster of Paris after.
- In 1880, 131 cases were treated.
 7 by splints only.
 123 by plaster of Paris only.
 1 by gummed bandage.

By this analysis we can trace the favour into which the immediate treatment by plaster of Paris gradually grew. In 1875, 19 out of 97 cases were treated by it, and in five years it had grown into such repute that in 1880, 123 cases out of a total of 131 were treated by it.

Treatment by splints alone declined in favour *pari passu*. In 1875, 63 cases were treated by splints only, but in 1879 and 1880 only 7 and 2 respectively.

From the foregoing analysis it appears that at least 498 cases of fractures of the leg have been treated immediately by plaster-of-Paris splints without any disasters.

In addition to the 498 cases immediately treated there are 89 in which the plaster apparatus was put on after a few days' use of splints. This makes a total of 587 cases treated without any ill results.

Average stay in hospital.—I cannot speak of the average

period of *cures*. I do not contend that this treatment has influenced the period of cure. The number of days or weeks during which the patient remains in the hospital depends partly on the surgeon, partly upon the demand on his beds, partly on the social condition of the patient, and on many other things. I can, however, say that the average stay in the hospital is shortened. With this apparatus on, protected by a gummed bandage, a patient is much more quickly in a travelling condition than under the old system of treatment by splints.

Practice at other hospitals.—I have added a table to show the practice at eleven of the metropolitan hospitals with reference to fractures of the leg, one or both bones. It is drawn from the replies made by the registrars of ten of the hospitals to Mr. Battle, the Registrar at St. Thomas's.¹ I beg to thank those registrars for their letters. (See table, p. 306.)

By this table it may be seen that the University College Hospital and St. Thomas's are the only two agreed in *systematically* treating fractures of the leg immediately by plaster-of-Paris apparatus. I believe I am right in stating that at University College Hospital the plaster-of-Paris *bandage* is used.

This is a most interesting table short as it is. How strongly conservative are some of the hospitals, and how tenaciously they cling to the old ways. I do not doubt they were *good* old ways, and I do not doubt that the *present* ways are good.

In conclusion, I would express a hope that the way of treating fractures of the leg which I have been advocating, and which, to some extent, is endorsed by the surgeons at University College Hospital, may grow in favour with the surgeons of other hospitals as it has grown in favour with the surgeons at my own hospital, and for the following reasons :

That it is the cheapest to the hospital.

¹ The letter from the Registrar of Westminster Hospital arrived too late for the meeting.

That it is the most comfortable to the patient.

That it makes the least demand on the time and attention of the surgeon and his assistants.

That it is quickly and perfectly efficient.

And that it is equally efficient for all simple fractures of the leg.

Hospital.	Immediate treatment by plaster of Paris.	By splints only.	Splints first and plaster of Paris afterwards.	With bandage on leaving hospital.
St. Bartholomew's	—	Sidesplints, with Lawrence's back splint and swing, for four weeks	—	Gum and chalk, or plaster of Paris.
Guy's	—	Side splints and back splint, a single outside splint, for four weeks	—	Stocking, gum and chalk and flannel, or plaster of Paris.
University College	Fixed apparatus applied at once, plaster of Paris over wool, and flannel roller, starch bandage if soft parts much bruised	—	For complicated cases	—
Middlesex	—	Cline's side splints, Bell's iron back splint, for three weeks	—	Plaster-of-Paris bandage.
King's College	—	Cline's splint, or Mac Intyre's, or Dupuytren's, for five weeks	—	Stiff bandage.
London	—	Side splints and back splint, swing and cradle, short outside	—	Stiff bandage of silicate or tripolith or gum and chalk.
St. George's	Mr. Holmes employs starch bandage and pasteboard splints	Side splints with foot piece, Assalini's fracture box, Pott's splints, Dupuytren's or Salter's swing, for three weeks	—	Plaster of Paris, silicate bandage, pasteboard
Charing Cross	Plaster-of-Paris bandage for fracture of fibula	Side splints with foot piece, and swung in Salter's cradle, for four weeks	—	Plaster of Paris.
Royal Free	—	Side splints and back splint of wood, short outside	—	Plaster of Paris.
Westminster	Fractures of leg, in which little or no displacement, are put up in plaster-of-Paris bandages	Posterior splints, Mac Intyre's splint, inside and outside	Rarely	Plaster of Paris, and gum and chalk.
St. Thomas's	Immediate of plaster-of-Paris side splints	—	—	—