obtained in most instances from the post-mortem room, exist in all pathological museums. Surgeons are now supplying teaching collections with specimens obtained in the operating theatre. The value of such specimens is enhanced by complete clinical records and reports of microscopic examinations, without which many museum preparations are mere curiosities.

This lecture, in the main concerned with rarities, may be concluded with an example of a condition known as melanosis of the colon. Occasionally the mucous membrane of the large intestine from the ileo-cæcal valve to the anus is as black as ink. The specimen selected to illustrate this condition (Fig. 6) is an inverted

FIG. 6.—Cæcum and appendix turned inside out. The mucous membrane is charged with black pigment. From a woman aged 63. (Museum, Middlesex Hospital.)

cæcum with the vermiform appendix. The pigmentation begins sharply at the margin of the valve. In this instance the mucous membrane of the vermiform appendix is partially pigmented. Fortunately, the coloration is a curiosity and without sinister significance.

An instructive exhibition of fibroids, lipomas, and papillomas of the stomach and intestines was organised by Mr. Cyril Nitch and Mr. Herbert Paterson for the Surgical Section of the Royal Society of Medicine in May, 1920. The catalogue will be published in the Proceedings of the Society and should be useful to surgeons interested in the oncology of the gastrointestinal tract.

References.

- Bland-Sutton, J.: Migration of the Cæcum Producing Obstruction of the Ascending Colon, *THE LANCET*, 1908, i., 1837; and *Arch. of the Middlesex Hosp.*, July, 1912, p. 1.
 Breschet, G.: *Bull. de la Fac. de Méd. de Paris*, 1817, No. 5, 375.
 Clutton, H. H.: *Trans. Path. Soc.*, 1886, xxxvii., 252.
 Collier, W.: *Trans. Path. Soc.*, 1896, xlvii., 46.
 Danzel: *Langenbeck's Archiv*, 1874, Bd. xvii.
 Dujarier and Khan: *Bull. et Mém. de la Soc. Anat. de Paris*, January, 1920.
 Gossage, A. M., and Hicks, J. B.: *Proc. R. Soc. of Medicine*, 1913, Surgical Section, vii., 33.
 Outland, J. H., and Clendinning, L.: *Annals of Surgery*, 1913, lviii., 812.
 Port, H.: *Trans. Path. Soc.*, 1880, xxi., 307.
 Stewart, M. J.: *Journal of Pathology*, 1913, xviii., 127.
 Thompson, P.: *Journal of Anat. and Phys.*, 1897, xxxi., 392.

BONE-GRAFTING OF THE FRACTURED MANDIBLE.

WITH AN ACCOUNT OF SIXTY CASES.

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THE recent rapid progress in our knowledge of the bone-graft as a means of repair for the fractured mandible has been mainly due to the large number of such cases produced by the war. The transitory nature of this supply, and hence also of our opportunity for observing the results of surgical treatment, makes it desirable that accurate records should be kept of the results obtained by the methods so far attempted. I have, therefore, given as complete an account as space permits of the methods adopted and results obtained in all the cases with which I have so far dealt. In the pre- and post-operative dental treatment of these cases I have had the active coöperation of Mr. B. Mendleson, and the results obtained owe much to his judgment and skill.

Analysis of Results.

The cases now described are 60 in number. All but three are gunshot fractures and all were operated upon at the Queen's Hospital for Facial Injuries, Sidcup. They are consecutive and unselected cases, and represent all the bone-grafts I had done up to the end of 1919. In two cases the graft was lost owing to sepsis. Erysipelas accounted for one of these and a discharging ear, not noticed prior to operation, apparently accounted for the other. In one case sinus formation resulted in non-union, and the eventual absorption of the graft. This case has since been regrafted. In another case the graft, which extended from molar to molar region, is healthy and the wound soundly healed, but union has not yet occurred at either end. In the remaining 56 cases, 93 per cent. of the series, firm bony union has been obtained. 51 of the cases had edentulous posterior fragments, and in 40 of these the loss of bone involved the region of the angle. In 16 of the latter the loss involved the ascending ramus also.

General Principles of Technique and Treatment.

The graft was obtained from the crest of the ilium in all but the first two cases. This source has several advantages. The size of the graft is practically unlimited. All sclerosed and doubtful bone can, therefore, be freely removed from the jaw fragments. The soft and vascular nature of the iliac crest greatly facilitates the manipulation of the graft and its subsequent union and consolidation. Furthermore, it is possible by varying the position on the crest to obtain a graft of a general curvature suitable to each particular case. There is a complete absence of post-operative disability, even when the anterior superior spine has been removed with the graft. The cases were, as a rule, up and about 14 days after the operation, and in no instance has there been any complaint of the hip.

The aim, in every case, has been to obtain a sound carpentering junction between the graft and the jaw fragments, the bones being so trimmed that they fit end to end with accurate apposition of the largest obtainable areas of exposed vascular bone tissue. In this position they are firmly wired together. This technique was originally adopted in order to control the edentulous fragment and to facilitate early union by accurate and continuous apposition of opposed bone tissue. The technique has the additional advantage that it allows of the early exposure of the graft to the stresses incidental to muscular movement without risk of disturbing the close contact of bone tissue obtained at the time of operation. That this early stress is a factor in determining rapid union was only gradually recognised as a result of the impracticability, in the great majority of the cases dealt with, of obtaining rigid post-operative immobilisation by means of splinting. Where no teeth are present on the posterior fragment the rigid splinting of the larger tooth-bearing fragment to the upper jaw does not relieve the grafted area from all

muscular stress. Yet it was found that in over 60 per cent. of the successful cases union was of ivory hardness at the end of three to four months. In several of the cases, in which no effective control existed for either fragment from the time of the operation onwards, rapid bony union nevertheless resulted. (Case 50, Fig. 12, Cases 51 and 52.) Union was already fairly firm at the sixth or eighth week.

Experience has, therefore, led me to regard the chief rôle of the dental splint as being the maintenance of correct occlusion during the operation. The tendency to lingual deviation of the large fragment can be subsequently prevented by the interlocking of the splint when in closed bite or by means of a flange. The preponderance of edentulous fragments, far from being a stumbling block, was a factor in the success obtained, in that they prevented me from obtaining the rigid immobilisation I had proposed adopting as a routine measure. In order, however, that this early exposure of the grafted mandible to stress may be a factor in determining rapid union, it is important that it shall not involve any disturbance of the apposed bone tissue—that is, the “carpentering” at the time of the operation must be sound. A poor mechanical junction which allows of the subsequent movement of the bones upon one another will result in non-, or long-delayed, union unless rigid immobilisation by splinting can be obtained.

Pre-operative Treatment.

The interval between the original injury and the bone plastic has averaged 15 months. In some cases the period was considerably longer, while in a few a successful bone-graft operation was performed as early as five months after the injury. Pre-operative treatment has consisted in the elimination of sepsis, the extraction of teeth involved in the fracture or tending to cause malposition, the correction of the latter, and, finally, the immobilisation of the jaw fragments. At least three months has been allowed to elapse between the last visible indication of sepsis and the operation, and the same rule has applied to the extraction of teeth involved in the fracture.

The main factors producing malposition are defective dental occlusion, unopposed muscular action, and scar contraction. When both fragments bear teeth the usual deformity is a combined lingual roll and deviation, the free ends of the bones being drawn together, partly by muscular action, partly by scar contraction; while faulty occlusion of molar teeth has caused the fragments to rotate till the lower teeth may come to lie horizontally in the oral cavity. In the case of the toothless fragment the presence of teeth in the upper jaw impinging upon the gum causes the fragment to shift outwards into the cheek, in which position unopposed muscular action elevates it to the outside of the maxilla. As far as the tooth-bearing fragments are concerned, early splinting in correct occlusion will prevent these deformities. In the case of the edentulous fragment, however, this prolonged splinting of the opposite side has the effect of causing a progressive contracture of the unopposed muscles. Deformity can be equally well prevented by making the necessary dental extractions and then providing the toothed fragment with a flange to prevent lingual deviation. In cases treated in this way the toothless fragment shows little or no deviation and elevation. If these deformities are present it is to a relatively slight extent and readily overcome. (Mendleson.)

The inward roll, if markedly developed, cannot be corrected. The teeth may be used for splinting, and are then removed to prevent further deformity. The mesial approximation in the slighter cases can be corrected by continuous elastic traction. In severer cases, however, division of the intervening fibrous tissue and forcible separation are needed, a procedure which has so far invariably resulted in the mouth cavity being opened submentally.

In a few cases an effort was made to depress the edentulous fragment by means of a saddle carried as a detachable extension of the splint. Pressure ulceration was avoided by affixing the saddle very shortly before the operation, and removing it soon afterwards. This is

liable to throw a heavy strain upon the graft. Moreover, the presence of a saddle at the time of operating prevents the complete exposure of the jaw stumps. (Fig. 13, Case 57.) The practice has been, therefore, to take the posterior fragment in its position of rest, however elevated, and to rely upon firm fixation to the graft for its post-operative control. One effective of this elevation, as Sir Frank Colyer has pointed out, is greatly to reduce the size of the gap to be filled by the bone-graft.

After previously acquired malposition has been, as far as possible, corrected, interlocking double “Gunning” splints are cemented on and bolted together in closed bite the day before the operation, and, in the majority of the cases, only removed from three to four months later.

Operative Technique.

The incision varies according to the position and extent of the fracture. For a loss of moderate extent in the region of the body of the mandible, it is placed well below the lower border of the jaw with a gentle convexity directed downwards. When the angle and ascending ramus are also involved, this incision is carried farther backwards below the ear, the convexity now being upwards. In this way an excellent approach is obtained to all parts of the ascending ramus, without risk of injury to the facial nerve. When the loss of bone extends farther forwards the incision is extended anteriorly with the same gentle sweep below the mandible and then, in the symphysis region, is carried sharply upwards, across the lower border of the jaw close to the middle line. In this way none of the depressor anguli oris branches of the facial nerve are caught, and a slight but nevertheless disfiguring palsy is thereby avoided. Fig. 1 shows this incision and its relation to the facial nerve and underlying mandible. In cases with a short symphysis loss, an adequate exposure is obtained by utilising the anterior portion of the above incision on either side; an inverted “Y” being produced, the stem of which lies in the middle line directly over the symphysis. For larger mesial losses a simple transverse incision is used, which passes horizontally across the neck, well below the lower border of the mandible on either side.

The jaw fragments are first exposed along their lower border and the soft parts separated from both surfaces with a raspator, the length of bone exposed being determined by the extent of the obvious sclerosis. If teeth are present in the neighbourhood of the fracture, or if a saddle is in position on the posterior fragment, the exposure of the alveolar border is impossible, and extreme caution has then to be used in approaching this region. The oral cavity tends to pouch out between the fragments, often to a considerable extent, and as the tissue in this region is almost invariably scarred, it is wiser to leave a considerable mass projecting into the wound and shape the graft accordingly than to attempt too close an approach to the mouth cavity.

By means of gouge forceps¹ all sclerosed and doubtful bone is removed and the stumps suitably trimmed for fixation to the graft. They are then drilled as near as practicable to their upper border, care being taken to protect the deeper tissues lest the drill should enter the mouth, an accident which will render advisable the postponement of the operation. Pieces of tempered silver wire about 6 inches long are passed through each drill hole and their ends separately secured and held out of the way by forceps.

The fixation of the fragments in the case of the fractured mandible, due to the need for maintaining correct dental occlusion, accounts for much of the difficulty of bone-grafting in this region. Even in the case of the toothless posterior fragment the movement possible is a very limited one in an arc about the condyle. The graft has therefore to be cut accurately to fit the gap left between the jaw fragments on the completion of trimming. To facilitate this a piece of lead sheeting about 4 in. by 1 in., and stout enough to stand ordinary handling without distortion, is so cut and twisted that its ends lie evenly along the long diameter of the jaw “facets” and the sheet itself approaches these in a plane perpendicular to that of the facet. (Fig. 4.) This latter point is one of considerable importance, for it gives the plane of the short diameter of the facet, and thus enables the graft to be so cut that it is in accurate apposition throughout its thickness, and not merely along its outer edge, with the jaw fragments.

In the simpler type of case, when the jaw fragments lie more or less in the same plane, and their trimmed ends approximately face one another, the graft can be cut from the crest, shaped and drilled ready for wiring into the gap, with no other assistance than the lead template described above. When, however, the relation of the jaw fragments to one another is more complicated, it is impossible to cut the graft accurately by means of this template alone. In such cases a second or “check template” is used. (Fig. 5.) This is prepared from the first while the necessary transfer of the scene of operation to the hip is being arranged. In all essentials this second template constitutes a replica of the gap to be filled, the distance apart of the jaw fragments, the relative planes in which they lie, and the exact inclination of their trimmed ends to one another. The graft, cut with the aid of the first template, is placed against the check template. (Fig. 7.) If the fit is then found to be imperfect, the necessary alterations can be at once determined with an accuracy which would be wholly impossible were this test made in the wound itself.

In cutting the graft the template is so placed alongside the exposed crest that the future lower border of the graft corresponds to the free border of the crest, a portion of the latter being

¹ In the earlier cases I experimented with Albee's electrical saw, and with various types of hand saw, but none of these gave the precision of action, ease of manipulation, and freedom from injury to surrounding tissues which can be obtained by the use of gouge forceps. Chisels are contra-indicated on account of the risk of displacing the splints and of the strain they throw upon the teeth.

selected which possesses a curvature suitable to the particular case. A cut with the hand saw is then made across the crest, with an inclination in all directions corresponding to one end of the template. A steel strip is then slipped into the saw cut in order to facilitate holding the template, while a second cut is made in a position and at an angle corresponding to the other end of the template. (Fig. 6.) When, as is frequently the case, the two facets incline at an angle to one another, care has to be taken that the actual length of the graft is also correct. Fig. 6 shows the manner in which the template and steel strip are used in determining the plane for the second saw cut. The necessary measurement for the total length of the graft is indicated on both crest and template by a dotted line. The graft is now drilled at either end, the holes being placed close to the free border of the crest—that is to say, the future lower border of the graft. When it is not possible to use the whole thickness of the crest the latter is split with a chisel, the inner or outer portion alone being used. The graft is now removed with chisel and mallet. As this division determines the shape of its upper border regard must be paid to the amount of tissue to be accommodated between the jaw fragments. Throughout the cutting and drilling of the graft the latter remains attached to the ilium. Only when it is ready to be wired into position is it severed from the latter. The manipulation of the graft and the time occupied in the transfer to its final position are thus reduced to a minimum.

When the fracture involves the angle the posterior fragment, although thin, is often of considerable vertical extent, a narrow and elongated facet for apposition to the graft being the result. The latter is cut accurately to fit this elongated facet and the soft medullary tissue lightly gouged out so as to form a long and shallow groove (Fig. 8), into which the thin posterior fragment fits, embraced on either side by the slightly projecting compact bone of the graft. In this position the wiring holds the fragments beyond all possibility of subsequent displacement.

When the fracture involves the ascending ramus the atrophy seen in the region of the angle becomes more marked. The higher the loss extends, and the longer the period which has elapsed since the original injury, the thinner and more brittle the bone that is left. Fig. 9 (Case 30) shows an adaptation of the foregoing technique for dealing with such a condition.

When the loss extends anteriorly into or beyond the canine region it is impossible, owing to the curvature of the jaw, so to trim the fragment that the facet for apposition with the graft looks even

approximately towards the posterior fragment. The more anteriorly the loss extends, the more does the trimmed end of the jaw tend to face outwards. The sclerosis, which is always a marked feature of the anterior fragment, owing to the obliteration of its nutrient artery in the infra-dental canal, invariably extends further along the lower border of the bone than elsewhere. The effort to remove all trace of this condition usually results in the trimmed surface of the jaw stump facing obliquely downwards as well as outwards. (Fig. 10.) Fig. 2 shows the mode of cutting the graft in order to obtain a facet of sufficient breadth in this position. The anterior superior spine is exposed and an oblique saw cut through this, in a plane determined by the template, gives the facet for apposition with the anterior fragment.

In cases of extensive mesial loss involving not only the symphysis region but also part of each horizontal ramus, it is difficult to obtain a sufficient "bow" on the graft to accommodate the considerable mass of tissue intervening between the two jaw stumps, and to carry the chin and dentures out to anything like their normal position. A further difficulty is due to the inward rotation of the fragments. The first difficulty is surmounted by taking the whole of the anterior superior spine with the graft, the spine being retained or removed according to individual cosmetic requirements. (Fig. 3.) The second difficulty is got over by making the ends of the grafts correspond, the one with the thickening found at the junction of the middle and anterior thirds of the crest, and the other with the thickened bone lying directly above the anterior inferior spine. In this way broad areas are obtained at either end of the graft, and although the long axis of these facets cross those of the jaw facets often almost at a right angle, a very considerable area of vascular bone tissue remains in apposition.

The trimmed and drilled graft, on removal from the crest, is tested against the cheek template and at once transferred to the jaw wound. The wires, issuing from the deep aspects of the jaw fragments, are threaded through the corresponding holes in the graft and the latter slid down into position between the jaw fragments. If the technique has been successfully carried out the fit should be good, and no further alteration or adjustment needed. The graft is held firmly in position while the wires are given two or three turns upon one another and the ends cut short. No care has been taken to preserve the periosteum of the graft or of the jaw fragments, nor is any attempt now made to bring periosteum over the junction. Great care must, however, be taken that neither periosteum nor other soft tissue is allowed to intervene between

TABULAR ANALYSIS OF THE SERIES OF GRAFTED MANDIBLES.

Cases.	Months between ini. & op.	Nature of union obtained.	Weeks after op.	Loss of bone.	Teeth in post. frag.	Remarks.	Cases.	Months between ini. & op.	Nature of union obtained.	Weeks after op.	Loss of bone.	Teeth in post. frag.	Remarks.
1	24	Bony.	40	M1 to Pm 1.	0	Pedicle slide graft.	36	14	Bony	42	A to Pm.	0	Mouth entered during op.; sinus formation and delayed union.
2	10	"	24	M 2 to C.	0	Osteo-periosteal from tibia.	37	8	"	12	A to Pm.	0	On removal of splints.
3	8	"	25	A to Pm 1.	0	This and all remaining cases were free grafts from ilium.	38	22	"	17	M to M.	2 r. 1 l.	" "
4	16	"	31	A to Pm 1.	0	Very faint spring at 17 wks., patient "eating anything."	39	12	"	15	M to I.	1	" "
5	10	"	24	A to M 1.	0	Union probably earlier.	40	14	"	15	M to C.	0	Ivory union on removal of splints. Aged 38, looked older.
6	16	"	24	As R to C.	0	Faint spring only at 12 wks.	41	16	"	19	A to Pm.	0	Pedicle slide regrafted from ilium.
7	16	"	27	A to Pm 1.	0	"	42	15	"	—	Pm to C.	1	Fragments separated 3 mths. prior to op.; submental drainage to oral cavity resulted; sinus formation; delayed union.
8	18	"	23	M to Pm.	0	No earlier observation.	43	53	"	17	A to Pm.	0	On removal of splints.
9	6	"	21	Pm 1 to I 1.	2	On removal of splints.	44	16	"	—	A to Pm.	0	Firm union post. in 8 wks., ant. fragments sclerosed. Resulting non-union has been regrafted (Fig. 11).
10	9	"	24	As R to Pm.	0	"	45	10	"	14	As R to M 1.	0	On removal of splints.
11	5	"	21	As R to C.	0	"	46	12	Slight spring.	14	As R to C.	0	Eating ordinary food; cracks nuts without discomfort.
12	12	"	16	A to Pm 2.	0	"	47	15	Bony.	12	C to C.	—	On removal of splints. Teeth present.
13	12	"	18	A to Pm 2.	0	"	48	17	"	21	M to Op C.	0	Faint spring on removing splints.
14	4½	"	20	A to C.	0	"	49	12	"	11	A to Pm.	0	On removal of splints.
15	14	"	15	Pm 2 to I.	0	"	50	16	"	17	Pm 3 to Pm 3.	1 r. 1 l.	Splints loose from op. onwards; removed at 8th wk. Very faint spring then present.
16	12	"	25	As R to M 1.	0	Greater part graft removed as sequestrum 4 wks. after op. Firm union; all sepsis disappeared.	51	12	"	11	A to Pm.	0	On removal of splints. Splints opened; eating soft food from 6th wk.
17	7	None.	—	As R to M.	0	Sinus formation and graft absorbing. Since regrafted.	52	22	"	14	M to M.	0	No teeth on lower jaw.
18	17	Bony.	15	A to C.	0	On removal of splints.	53	25	"	—	A to I 2.	0	Copious discharge 2 days after op. Suppurating ear not noticed previous to op.
19	6	"	14	M to I.	1	"	54	18	Bony.	20	Pm to Op I.	1 M.	Attempt to approx. and plate fragments (at Millbank) had failed owing to sepsis.
20	14	"	18	As R to Pm.	0	Double rib-graft at Millbank, November, 1918.†	55	32	"	16	A to C.	0	On removal of splints.
21	8	—*	—	M to Pm.	0	Erysipelas shortly after op. Graft infected and removed.	56	11	"	12	Pm to Pm.	—	On removal of splints. Teeth present.
22	25	Bony.	21	Pm.	1	Due to blow from rifle.	57	14	"	14	M to C.	0	On removal of splints.
23	8	"	17	A to Pm.	0	Due to fall. Union on removal of splints.	58	28	"	15	As R to C.	0	Loss of skin over fracture made good by pedicle flap from neck prior to op.‡
24	7	"	15	As R to C.	0	On removal of splints.	59	16	"	12	Pm to Op C.	0	Slight spring only at 10 wks. Splints then left open.
25	7	"	9	A to Pm.	0	Sinus over graft ceased discharging some time after union.	60	40	"	16	As R to C.	0	On removal of splints.
26	15	"	12	A to Pm.	0	On removal of splints.							
27	24	"	10	M to I.	1	"							
28	13	"	27	As R to C.	0	Slight "spring on" removal of splints.							
29	35	None.	—	1. M 1 to r. M 3.	1	Soundly healed, spring still present both ends.							
30	21	Bony.	24	As R to C.	0	Union at ant. end in 11 wks.†							
31	10	"	14	A to C.	0	On removal of splints.							
32	14	"	13	M 2 to Op I.	1	"							
33	10	"	20	As R to Pm.	0	"							
34	19	"	14	As R to Pm.	0	"							
35	10	"	42	As R to Pm.	0	Loss of asc. ramus almost to sig. notch. Splinted in open gap owing to edent. upper jaw. Much loss of skin, wound gaped, sepsis followed, loss of greater part of graft as sequestrum.							

—* Graft lost. † Right graft lost owing to sepsis. ‡ Rib B.G. attempted at Millbank and removed 24.5.18. ¶ Two previous attempts (both at King George's), first from tibia, second from iliac crest, failed owing to sepsis.

A, angle. As R, ascending ramus. I, incisor. C, canine. Pm, premolar. M, molar. r, right. l, left.

FIG. 1.

FIG. 5.

FIG. 2.

FIG. 6.

FIG. 3.

FIG. 7.

FIG. 4.

FIG. 8.

FIG. 9.

For descriptions of Figures see opposite page.

FIG. 10 (Case 25).

FIG. 11 (Case 44).

FIG. 12 (Case 50).

FIG. 1.—Diagram showing the relation of the incision to the branches of the facial nerve and the underlying mandible.

FIG. 2.—Portion of ilium utilised when the facet on the anterior fragment is in the canine region, and unavoidably trimmed to face downwards and outwards. The corresponding facet on the graft is obtained by the oblique saw-cut through the anterior superior spine seen on the left of the diagram.

FIG. 3.—Portion of ilium utilised for extensive mesial loss. Considerable "bowing" can thus be obtained, while the thickened region at either end allows a considerable area of opened bone tissue to be in apposition with the trimmed end of either ramus.

FIG. 4.—The lead "template," showing the manner in which it records the relationship of the trimmed jaw stumps to one another.

FIG. 5.—The same template as in Fig. 4 and the "check template" made from it.

FIG. 6.—Mode of using the template. The graft to be cut is outlined as a transparency. A sheet of thin steel has been slipped into the saw-cut on the right, and against this one end of the template is being held. The saw is shown in position in the second cut, its direction being determined by the other end of the template.

FIG. 7.—Mode of testing graft against the check template.

FIG. 8.—Mode of trimming the thicker graft to embrace the thin posterior fragment.

FIG. 9.—A modification of this technique for very small posterior fragments—e.g., Case 30.

FIG. 11A.

Microphotograph of the area X.....X in Fig. 11 ($\times 15$). The section shows the line of junction between graft (left) and post fragment of jaw (right) six months after operation. A continuous layer of compact bone passes from the surface of the thinner jaw fragment to that of the thicker graft. There is a sudden transition from the compact structure of the jaw to the cancellous structure of the graft, no intermediate zone being present. There is no sign of absorption and redeposition in the graft. The arrow placed above the section marks the line of junction.

FIG. 13 (Case 57).

FIG. 14 (Case 28).

FIG. 15 (Case 24).

FIGS. 10, 11, 12, 13, 14, and 15 are semi-diagrammatic reconstructions of some of the grafted mandibles. They have been made for me by Mr. Hornswick from information supplied by radiograms, some of them stereoscopic, and by the lead templates. The size and position of the graft and jaw fragments are correct and follow as closely as possible the radiograms; the Mercator-like projection of the more outlying parts of the photograph has, however, been eliminated. The diagrams show the character of the "carpentering" employed, but do not show the nature of the union obtained.

the apposed bone surfaces. In no case has it been possible to attribute sepsis to the presence of the wire, and successive radiographs entirely fail to suggest that the wire in any way inhibits bone formation.

The wound is closed, when practicable, in two layers, deeper tissues, muscle, fascia, or maxillary gland being all drawn together over the graft with deep catgut sutures, not merely to serve as an additional covering between this and the skin flap, but also, and mainly indeed, in order to obliterate all spaces round the graft. The closed incision is finally painted over with tinct. benzoin. No dressing or drainage-tube is used. A careful watch is, however, kept for the first few days, and any serum or blood collecting is drawn off through a small opening by means of a Bier's suction glass; this process being repeated, if necessary, on successive days.

Permanence and Functional Value of the Grafted Mandible.

The permanent character of the repair effected by the bone-graft can only be determined by the lapse of time. In some of the cases in the present series more than a year has elapsed since the operation, and the only change shown in successive radiographs is one of progressive consolidation. In Case 44 a fibrous union had resulted owing to failure to remove all the sclerosed tissue from the anterior fragment. At the operation for resecting and regrafting this non-union, six months after the original operation, the posterior union, which had been firm clinically since the splints were removed, was represented by a faint rounded ridge where the thicker graft passed into the thinner posterior fragment. Both the graft and the ridge marking the line of union showed a hard smooth surface exactly resembling that of the adjacent jaw fragment. A small piece, indicated by dotted lines in Fig. 11, was resected for examination. During its removal the vascularity of the graft was found to be in every way as good as that of the adjacent jaw fragment. A microphotograph of a section of this fragment in the direction of the line X.....X is seen in Fig. 11 A. This section is in complete agreement with the X ray appearance presented by the union in other cases. It is often possible to recognise the uninterrupted passage of the bone architecture of the graft into that of the mandible. This is particularly striking when viewed stereoscopically and stands in sharp contrast to the fibrous union, however firm this may be clinically. In Case 26 this contrast is seen side by side on the same horizontal ramus. The radiograph shows the spontaneous union as a white line of fibrous tissue which has undergone no change in appearance. The graft, on the other hand, has merged so completely with the mandible that it is difficult to see exactly where the original junction was situated.

In determining the subsequent functional value of the grafted mandible there are several factors to be taken into account, besides the permanent character of the graft and its bony union. The prolonged disuse results in a weakness of the muscles of mastication and the same cause greatly increases the normal periodontal sensitiveness. That these, however, are not permanent conditions is shown by the nature of the diet of some of the patients within a few months of the operation. By the method adopted for obtaining the graft, the upper or alveolar border is constituted by open cancellous tissue. Successive radiographs show that under the influence of the stress and strain to which the graft is subjected in the normal use of the jaw the architectural structure becomes modified in accordance with Wolff's law, and a compact layer of bone is formed completely encircling the central tissues of the graft. In several cases I have found the graft able to bear directly the pressure of a denture within a few months of the operation.

The Fate of the Free Graft.

General opinion is, on the whole, tending towards the view that the free graft remains alive and takes an active osteo-genetic share in the union. The graft, with its thin tables of compact bone, is relatively more transparent in the earlier post-operative radiographs than is the far denser mandible. There is, however, no constant post-operative increase in this relative transparency. On the contrary, successive radiographs show a uniform increase in the opacity of the graft. The small area of vascular tissue exposed in the case of many of the posterior fragments, and the dense and relatively avascular nature of the anterior fragment,

taken in conjunction with the large size of many of the grafts, make it very difficult to imagine that the latter owes its rapid consolidation, wholly, or even mainly, to invasion and replacement by osteogenetic tissue from the mandible. The behaviour of the graft in the presence of sepsis is even more suggestive. In Case 16, in which the graft was of considerable size, there was extensive suppuration after the operation. A month later a large sequestrum came away. Union nevertheless occurred at both ends, and a subsequent radiograph shows the upper or alveolar border of the graft, together with the whole of its anterior portion, still in position and firmly united at either end. All sepsis has since disappeared, and the final result is excellent. That we are not dealing with an involucrum is, I think, shown by the appearance of the anterior end of the graft, with its close fit to the jaw fragment and the wiring still in position. The view that the sequestrum was thrown off by the living graft is supported by three other cases in which small sinuses over the graft closed after the separation of one or more small sequestra from the latter, without leading to its infection, or in any way interfering with the progress of union. In one case sepsis has resulted in the infection of the graft. The appearance of this case, with the entire absence of any attempt at union and the irregular rarefaction of the graft, stands in striking contrast to that of the other cases.

I have only seen one case in which dead bone, a boiled autogenous graft, was used. The graft remained sterile and the wound healed by first intention. Months afterwards, however, there was still no trace of union, or of any invasion of the graft by bone tissue from the jaw fragments, and successive radiographs unmistakably show the graft undergoing progressive absorption.

Summary.

The series consists of 60 consecutive cases of bone-grafted mandibles. Of these all but two were free autogenous grafts from the ilium. 51 possessed edentulous posterior fragments and in 40 of these the loss involved the region of the angle. In 16 of the latter the loss involved the ascending ramus also. Firm bony union was obtained in 56 of the cases, 93 per cent. of the series.

The graft and jaw fragments were so trimmed as to fit accurately end to end, with the largest obtainable areas of exposed vascular bone tissue held in close contact by firm wiring. The close apposition results in early bony union, while the firm fixation allows of the bones being subjected at once to some degree of muscular strain without fear of displacement, thus leading to the early consolidation of the primary union. In over 60 per cent. of the successful cases the union was of ivory hardness on the final removal of the splints, three to four months after operation.

Note.—The favourable influence of early exposure to stress is strikingly shown by seven cases grafted while the above paper was in the press. The splints in each case were removed in the second or third week, and in one case within three days of the operation, a flange being fitted to prevent lateral strain upon the graft. Four of these cases were firmly united within the month, and the remaining three were firm before the end of the third month. In two cases in which union was secured within the first month a previous bone graft (not by the author) had been attempted and failed. In one of these the loss involved the greater part of the ascending ramus. In only one case did the posterior fragment bear teeth, one molar tooth being present on each fragment. The splints in this case were, however, loose from the time of the operation onwards. In one case no teeth were present on either fragment, and there were only two teeth in the upper jaw.

PORTSMOUTH AND SOUTHERN COUNTIES EYE AND EAR HOSPITAL.—At the annual meeting of this hospital held in the Town Hall, Portsmouth, on June 24th, it was reported that the new wing erected in 1914 had been paid for. The general financial position was one for anxiety. There was a decrease in the current revenue, a deficit on the year's work of £398, and a bank overdraft of £751.