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Staff Meeting Bulletin
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University of Minnesota

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Skull Defect Regeneration

Volume XV Friday, February 25, 1944 Number 17

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INDEX

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William A. O'Brien, M.D.

UNIVERSITY OF MINNESOTA MEDICAL SCHOOL
CALENDAR OF EVENTS
February 28 - March 4

Visitors Welcome

Monday, February 28

9:00 - 10:00 Roentgenology Medicine Conference; L. G. Rigler, C. J. Watson and Staff, Todd Amphitheater, U. H.

9:00 - 11:00 Obstetrics and Gynecology Conference; J. L. McKelvey and Staff, Interns Quarters, U.H.

12:30 - 1:30 Pediatrics Seminar; Speech Disorders in Children; Mrs. Brown, W-205 U.H.

12:30 - 1:30 Pathology Seminar; The Nervous Control of Renal Function; F. J. Kottke, 104 I.A.

4:00 - Preventive Medicine and Public Health Seminar; The Control of Anophles Gambiae in Brazil; Dr. Weaver, 116 M.H.

Tuesday, February 29

8:00 - 9:00 Surgery Journal Club; O.H. Wangensteen and Staff, Main 515, U.H.

9:00 - 10:00 Roentgenology-Pediatrics Conference; L. G. Rigler, I. McQuarrie and Staff, Eustis Amphitheater, U.H.

11:00 - 12:00 Urology Conference; C. D. Creevy and Staff, Main 515, U.H.

12:30 - 1:30 Pathology Conference; Autopsies; Pathology Staff, 104 I.A.

12:30 - 1:30 Physiology-Pharmacology Seminar; Metabolism of Nicotinic Acid; Olaf Michelsen, 214 M.H.

4:30 - 5:30 Obstetrics and Gynecology Conference; J. L. McKelvey and Staff, Station 54, U.H.

4:00 - 5:00 Pediatrics; Grand Rounds; I. McQuarrie and Staff, W-205 U.H.

5:00 - 6:00 Roentgen Diagnosis Conference; K.W. Stenstrom, M-515 U.H.

Wednesday, March 1

9:00 - 11:00 Neuropsychiatry Seminar; Please arrange with dept. for attendance at these exercises; J. C. McKinley and Staff, Station 60, Lounge, U.H.

10:30 - 12:00 Otolaryngology Case Studies; Out Patient Ear, Nose and Throat Department; L. R. Boies and Staff.

11:00 - 12:00 Pathology-Medicine-Surgery Conference; Carcinoma of Pancreas; E. T. Bell, C. J. Watson, O. H. Wangensteen and Staff, Todd Amphitheater, U.H.

12:30 - 1:30 Pharmacology Seminar; Cholera; A. Neva; 105 M.H.

4:00 - 5:00 Obstetrics and Gynecology Journal Club; J. L. McKelvey and Staff, Station 54, U.H.

4:30 - 5:30 Neurophysiology Seminar; Acetylcholine and Cerebral Activity; Dr. Chelgren; 129 M.H.

Thursday, March 2

9:00 - 10:00 Medicine Case Presentation; C. J. Watson and Staff, Todd Amphitheater, U.H.

10:00 - 12:00 Medicine Rounds; C. J. Watson and Staff, East 214 U.H.

12:30 - 1:30 Poliomyelitic Seminar; Chemistry of Viruses,; Erving Rusoff, 113 M.S.

12:30 - 1:30 Physiological Chemistry Seminar; Oral and Dental Biochemistry; W. D. Armstrong, 116 M.H.

5:00 - 6:00 Roentgenology Seminar; Reviews of Recent Radiological Literature; Staff, M-515 U.H.

Friday, March 3

9:00 - 10:00 Medicine Grand Rounds; C. J. Watson and Staff; Todd Amphitheater, U.H

8:30 - 10:00 Pediatrics Grand Rounds; I. McQuarrie and Staff

10:00 - 12:00 Medicine Ward Rounds; C. J. Watson and Staff; East 214 U.H.

11:45 - 1:15 University of Minnesota Hospitals General Staff Meeting; Malignant Tumors of the Kidney; L. Bixler; Powell Hall Recreation Room

1:30 - 2:30 Medicine Case Presentation; C. J. Watson and Staff; Eustis Amphitheater

1:00 - 2:30 Dermatology and Syphilology; Presentation of selected cases of the week; Henry E. Michelson and Staff; W-306 U.H.

1:30 - 3:00 Roentgenology-Neurosurgery Conference; H.O. Peterson, W. T. Peyton, and Staff, Todd Amphitheater, U.H.

Saturday, March 4

9:00 - 10:00 Medicine Case Presentation, C. J. Watson and Staff, Main 515 U.H.

9:15 - 11:30 Surgery-Roentgenology Conference; O. H. Wangensteen, L. G. Rigler and Staff, Todd Amphitheater, U.H.

10:00 - 12:00 Medicine Ward Rounds; C. J. Watson and Staff, E-214 U.H.

11:30 - 12:30 Anatomy Seminar; Comparison of Red Blood Cells of Lower Animals; Ruby Engstrom; The Relation of the Number of Ventral Horn Cells to the Number of Fibers in the Ventral Root and Pyramidal Tract; Leon H. Schreiner, 226 I.A.

II. BONE REGENERATION IN FRACTURES AND DEFECTS OF THE CRANIAL VAULT*

Jules D. Levin
Wm. T. Peyton

Introduction

In fractures of the skull it is true that one, as a rule, is little concerned with the healing of the fracture but is more concerned with the patient's recovery from the associated brain trauma. Probably for this reason relatively little has been published concerning the healing of skull fractures and the regeneration of bone in the skull. However, an understanding of regeneration of bone in the vault of the cranium has practical application: 1. for medicolegal purposes, to determine whether a fracture of the skull is new or old, or has already healed without residual evidence; 2. to decide whether a skull defect following fractures, osteomyelitis, or surgery will regenerate bone spontaneously to fill the defect or whether it must be repaired by a plastic procedure; 3. to know if osteoplastic bone repair is done for a skull defect, whether the transplanted bone heal into the defect by bone regeneration or remain as a loose fragment; 4. to determine, if one wishes to make permanent defects in the skull (as in synostosis cranii) how should they be made so that they will remain ununited and finally 5. regeneration of bone or changes in bony defects which take place if a person survives a head injury have long been utilized by anthropologists in gaining information from excavated skulls.

This discussion is concerned primarily with a study of the healing of fractures of the cranial vault especially of the changes occuring in relation to the interval that has elapsed since the injury. In addition, some slides will be shown to demonstrate regeneration of bone after portions of the cranial vault have been removed for osteomyelitis, to show the healing of osteoplastic flaps, to show bone regeneration after occipital craniectomy and after removal of osteoplastic flaps. Over a number of years some interesting observations have been made in treating all of the above types of skull defects in addition to linear, fragmented and depressed skull fractures at the University of Minnesota Hospitals and this material is supplemented by a study of 41 cases of skull fracture observed at the Ancker Hospital, St. Paul, in which roentgenograms were repeated after a number of months or years.

This paper, then, is a survey of observations made on regeneration of defects of the cranial vault rather than a solution of the various problems noted in bone regeneration. This discussion is not primarily concerned with the problem of osteogenesis, but a brief review of the histogenesis, growth, and regeneration of bone is included that the problem may be better appreciated.

Histogenesis and Growth of Bone

Bone develops either as cartilagenous or enchondral bone or as membranous bone. All of the skeleton, except parts of the clavicle and mandible and the greater part of the skull, is pre-formed in cartilage. The cranial vault is entirely developed in membrane. Small islets of spongy bone are formed and the lamellae develop radially from this point of ossification in one plane, resulting in a central solid mass of bone with peripheral rays or spicules of bone. The surface connective tissue then soon differentiates into periosteum and continues to lay down bone, thus increasing the thickness of the tables. In the course of time, by the process of internal reconstruction (a simultaneous but harmonious balance between new bone formation and bone destruction) the flat bone assumes its adult structure. In the end result, the bone cells and matrix are identical in both cartilagenous and membraneous formed bone, and each gives rise

* For the follow-up on 41 cases of skull fracture treated at the Ancker Hospital, St. Paul, and for permission to use this material we wish to thank Doctors R. Aurelius and A. Colvin.

to both dense or compact and cancellous or spongy bone, the latter being made up of many trabeculations.

Both types of bone consist of osteogenic cells (the osteoblasts and osteocytes), lacunae (spaces in which bone cells, the osteocystes, are lodged), matrix (the dense interstitial substance), canaliculi (containing cells processes between the lacunae, Haversian canals containing blood vessels, Canals of Volkmann (vascular channels connecting the marrow and Haversian systems with the periosteum). The Haversian systems are groups of Haversian canals and their lamellae of bone. The flat skull bones of the adult consist of thick layers of compact bone on each surface, the inner and outer tables of the skull, with a layer of cancellous bone, the diploe, sandwiched between the tables. The perisoteum, which is the covering or limiting membrane of bone, consists of a superficial layer of dense connective tissue and blood vessels, and a deep stratum of osteogenic cells derived from fibroblasts. In the skull the periosteum on the external surface is known as the epicranium, and on the inner side it is the outer layer of the dura.

The periosteum of young animals differ from that of the adult animal in that it has an abundance of osteogenic cells in the deep stratum, whereas in the adult animal the osteogenic cells are few or absent. However there is, in the periosteum of the adult, a latent osteogenic property which becomes manifest after fractures.

Bone Repair

Fracture results in haemorrhage about the fragments and into the surrounding tissue; organization of the clot soon takes place with the formation of granulations, giving rise to the pro-callus. Dense connective tissue, fibrocartilage, and catilage develop in the pro-callus, giving rise to the fibrocartilaginous callus between the fragments of fractured bone; osteogenic cells of the deep strata of the periesteum and endosteum invade the callus from the periphery and lay down bone, and ossify the callus by replacement. Contact of this newly formed spongy bone between the two fragments constitutes bony union. Reorganization and resorption of excess bone is followed by internal reconstruction and bridging of the gap with the final stage of the development of compact bony union.

Flat bones of the skull have a slightly modified method of bone repair. The process is apparently less elaborate, but takes a longer time. The haemorrhage accompanying fracture undergoes organization, with the production of a fibrous connective tissue, thus binding the fragments together. There is little if any callus formation. The fibrous union is gradually transformed into true bone by the deposition of calcium salts. When ossification is complete, the fracture line is no longer visible on X-ray. Sometimes, especially in widely separated fragmentation of flat bones, complete ossification never occurs, the healing being arrested at the stage of fibrous union. Under such circumstances there may no longer be any clinical evidence of fracture in that there is no palpable defect, but the X-ray evidence of fracture persists because there is no calcification or deposition of lime salts. This occurs especially in widely separated fissure fractures or in bony defects following the removal of fragments in depressed skull fractures.

Osteogenesis

The osteogenic function of the periosteum was discovered by Duhamel (1739), a member of the Paris Academy of Science, but not trained in medicine. He fed madder, a dye, to normal young animals and animals with fractures, and found that the dye was then deposited only in bone developed during the period of dye feeding. He further noted that it was deposited immediately beneath the periosteum and in association with the periosteum and endosteum at the site of the fracture. Haller opposed Duhamel's theory of the regeneration of bone, and after repeating Duhamel's madder-feeding experiments concluded that the periosteum took no essential part in the growth or repair of bone. Thus there came to be two schools of thought concerning the function of the periosteum, the one contending that the power of bony regeneration and repair lay with the periosteum, the other maintaining that the periosteum serves only as a limiting membrane of bone and a source of nutrition, and that bone itself had the power of regeneration and growth. These two theories have persisted to the present.

Supporting Duhamel's contention that periosteum was the maternal tissue of bone and that it contains all power of osteogenesis were Syme (1835), Flourens (1842), Ollier (1868), and Axenhausen (1893). Contesting this theory, and believing that bone devoid of periosteum has the inherent and sole power of production, growth, and regeneration were Haller (1740), Hunter (1760), Goodsir (1845), and Macewen (1912). The metaplastic theory of bone regeneration, as supported by Bancroft (1922), and Leriche and Policard (1928), states that groups of mesenchymal cells other then the pre-existing osteogenic cells have the power of bone formation and regeneration, and that this is accomplished by the mesenchymal cells by differentiation into osteogenic cells under suitable environment and stimulus.

The confusion in the interpretation of the experimental results arises from the great variability and difficulty in separating the periosteum from the bone. Those upholding the theory of the periosteum as the bone former explain away the regeneration from isolated pieces of bone by saying that in the separation of this bone from the periosteum some of the osteogenic cells of the deep stratum of the periosteum clung to the bone, and that the new bone growth and regeneration began from these islets. Conversely, those who believe that regeneration is from the bone itself and not the periosteum use the same argument to prove their point, saying that when regeneration of bone occurred from periosteum, it was because, and only because, some of the osteogenic cells of the bone clung to the deep layers of the periosteum, and that new bone arose from these islets.

The confusion then reduces itself to the interpretation of the type of cell responsible for the regeneration of bone. The problem is whether the power of regeneration rests with the adult bone cell, the osteocyte, which inhabits the lacunae and which developed from the osteoblast after it had exhausted or outlived its power and necessity of bone production, or whether it is the differentiated fibroblast which inhabits the deep stratum of the periosteum, the lining of the Haversian canals, and the endosteum, and known as the osteoblast, which possesses regenerative ability. The divergent opinions and conclusions arise because both the periosteum and the bone are composed of more than one type of cell; the bone minus its periosteum is made up not only of osteocytes or adult bone cells in the lacunae, but it also contains osteoblasts, lining the canals and in the endosteum; similarly, the periosteum is composed not only of the osteogenic cells, the osteoblasts, but also of an outer layer of dense fibrous connective tissue, blood vessels, and lymphatics.

Mayer and Wehner state the issue well when they say: "All results and evidence combine to emphasize the osteogenic function of the specific osteoblastic cell present in the periosteum, endosteum, or lining of the Haversian canal, and the inability of the adult bone cell, the osteocyte, to form new osseous tissue." No one has ever shown conclusively that the adult bone cell, the osteocyte, has any power of bone production.

<u>Healing of Skull Fractures</u>

Despite the wealth of literature on the subject of osteogenesis in general, there is surprisingly little to be found regarding the time factor in the healing of bony defects of the skull, due either to fractures or surgical interference. The changing character of skull fractures or their complete disappearance in roentgenograms is the best method to follow the healing of fractures and to differentiate between those fractures that will eventually heal and those that will probably never heal.

Schwartz (1910) first made observations on the roentgenological follow-up of skull fractures. Since that time, several other excellent analyses of such a group of skull fractures have appeared. All are in general agreement concerning some of the fundamental conclusions in the healing of skull fractures and bony skull deficits. These will be discussed below both in relation to literature and to our own experiences and observations.

One might expect that the fracture lines in the skull should heal and disappear rather quickly, because of the relative rigidity of the cranial vault and therefore the relative immobilization of the bony fragments. However, observation has demonstrated that skull fractures heal slowly, at first by a connective tissue bridge, subsequently by calcification of this connective tissue. There is no callus formation in the healing of skull fractures, and membranous bone in the cranial vault heals much less readily than does the long skeletal bone developed in cartilage.

The fate of fractures and bony defects in the skull varies from complete healing in a few months, to the permanent persistence of defects, and even the absorption of the bony margins of the fracture line with actual enlargement of the defect.

In the healing of skull fractures, as in the repair of bone in general, healing depends on the age of the individual. In the very young children, not only does the process of repair commence earlier, but it is carried to completion in a much shorter period of time than is necessary in the adult. It is noted above in the discussion of the histogenesis of bone that the osteogenic power is much greater in the young animal; that the normal histological structure in young animals includes an infinitely greater number of osteogenic fibroblasts and osteoblasts than does that of the adult animal; only in the presence of trauma or infection does the adult bone begin to manifest its latent osteogenic ability.

The character of the fracture is a major factor in the healing process. Fractures may be of the simple fissure or linear type, in which there is a single line of interruption in the continuity of the bone; multiple fissure or stellate fracture type, in which there are several or many of such simple fissures; diastatic fractures, or those with marked separation of fragments; impacted fractures (or the opposite of the diastatis type) in which the fragments are jammed together; bevel fractures, in which the bony tables are fractured at different points; depressed or penetrating fractures, in which there is displacement of fragments usually in a plane other than that of the skull; combinations of any or all of the above types of fractures, such as the sliding depressed and the fragmented and comminuted fissure fractures.

Simple fractures of the vault, without much separation of the fragments, heal most rapidly. Multiple fissure fractures and comminuted and impacted fractures with fragments in good apposition may eventually heal, but they heal more slowly. Depressed fractures and comminuted fractures with poor alignment of fragments or with loss of bony substance may never heal, or heal only after a very long interval. Occasionally, absorption of bony margins may occur, resulting in large defects that may require plastic repair. The amount of separation of fragments and their apposition is apparently as important in the healing of fractures of flat bones as it is in the long skeletal bones. The factors responsible for delayed union and non-union in fractures of the extremeitis do not all apply to lesions of the flat bones, but some of them are operative in the non-union of fractures of the cranial vault.

The shadows created by vessel markings and grooves and the overlapping of superimposed structures of the normal skull are most confusing in the interpretation of roentgenograms, and often render distinction between fracture lines and normal shadow variations almost impossible. Hence it is frequently difficult or impossible to distinguish between new and old fracture lines. However, as the healing progresses the usually sharply outlined shadow of the new fracture tends to fade, making the line less distinct. Such a fracture line, then, with indistinct margins, is evidence of healing or old fractures.

Stewart, and also Glaser and Blaine emphasize that it is important that the same technique that was originally used be employed to demonstrate the fracture when films are taken to follow its healing. The more uniform the technique is in both position and exposure, the better the roentgenologist can estimate the degree of healing that has taken place. One can readily appreciate why the roentgenologist is non-committal and cautious in making statements concerning the age of a fracture of the cranial vault.

Disappearance of Fracture Lines

There is diversity of opinion as to the time necessary for the complete disappearance of fracture lines on X-ray. Glaser and Blaine found in 8 fractures in children less than 6 years of age that 7 had completely disappeared within 6 months. Illig found complete healing in 4½ months in a boy 7 years old. Stewart found complete healing in 6 months in a child 3 years old. Vance reported a case of complete healing of a simple fissure fracture in a 4 year old child in 4 months and 20 days. Complete healing of fissure fractures in children has been reported by various authors to occur within 6 to 12 months. (Stewart, 6-8 months; Vance, 12 months; Glaser and Blaine, 6-12 months; Illig, 8 months.).

The earliest evidence of healing, or the time at which the fracture line could first be recognized as being that of an old injury, was reported to be at about 2 months (Glaser and Blaine).

The usual time necessary for healing of fissure fractures in the adult varies from 2 to 4 years. (Illig, and also Vance, 2 years; Stewart, 3 years; Glaser and Blaine, 3-4 years). The earliest evidence of healing in the adult occurred in about 7-8 months (Vance and also Glaser and Blaine). Many times the X-ray evidence of fractures remains permanently.

Stewart, and also Glaser and Blaine have noted that fractures of the occipital bone require longer healing time than do those of other bones of the vault which they believed was due to the greater thickness of the occipital bone.

Analysis

The skull fractures included in this review consist of a group of 65 cases from the records of the University of Minnesota Hospitals, Minneapolis, and the Ancker Hospital, St. Paul. The range of age of the patients is from 1 month to 73 years. The longest period of follow-up is 13 years 9 months, the shortest interval 2 months. Of the 65 cases, 50 were simple or multiple linear or fissure fractures, and 15 were depressed fractures.

The fissured fractures were subdivided into several groups, according to the amount of healing present. The fracture was considered entirely healed if there was no evidence of fracture to be found on the film when compared with the original film so that the exact site of the fracture could be scrutinized. If there was the slightest evidence of a shadow present, and healing was advanced but not complete, the fracture was classified as almost healed. If evidence of the fracture was still obvious in any segment of the original shadow, regardless of how much healing had occurred in other portions of the fracture they were grouped as fractures showing evidence of healing. Two cases of fracture, one in the fissure group and one in the depressed fracture group, showed resorption of the bony margins in some areas with complete healing and bridging in other parts.

of the original shadow. These two cases constitute a group designated as fractures with resorption of margins.

Of the 50 cases of fissure or linear fractures, 28 were completely healed, 14 were almost healed, 7 showed definite evidence of healing, but the fracture was visible in part or all of the original segment, and one showed marked resorption of the adjacent bony margins.

If these cases of fissure fracture are divided according to age, there were 9 cases less than 7 years of age, and 41 cases whose ages ranged from 7 to 73 years. 5 of the 9 cases in children under 7 years of age showed healing in from 1 3/4 years to 7 years 2 months.

Completely Healed Fissure Fractures in Children Less Than 7 Years of Age

Age at Injury	Bone Involved	Time Interval To follow-up	
½ year	Occipital	3 yrs.	5 mos.
1 "	Parietal	2	8
1 ½	Parietal	7	2
2	Parietal	5	10
4	Parietal	1	9
4	Fronto-parietal	3	4

Fissure Fractures Almost Healed in Children Less than 7 Years of Age

Age at Injury	Bone Involved	Time Interval to Follow-up	
1 month	Parietal	9 yrs.	8 mos.
4 years	Fronto-parietal	2	7

The remaining case was a child one year old who had a fissure fracture of the temporo-parietal bone, and who demonstrated very well the occasional extensive resorption of the adjacent bony margins. There were areas of complete healing and bridging of some of the fracture line, but there were other parts where resorption had occurred. The defect increased in size from 2 mm. to 2 cm. in diameter, and had rounded edges.

In this group of children the shortest interval for complete healing was 1 year and 9 months, somewhat longer than the 6-12 months given in the literature; this is probably due to the fact that we had no children in this group with follow-up examinations at shorter intervals.

On the other hand, in a child 1 month old there was a faint shadow of the original fracture line in the parietal bone after 9 years 8 months. After this interval it would appear that this skull fracture will probably never heal.

Analysis of Completely Healed Fissure Fractures in 22 Patients Over 7 Years of Age

Age at injury	Bone Involved	Time Interval to Follow-up	
8 years	Frontal	1 year	
9	Temporo-parieteal	10	10 mos.
11	Frontal	7	8
11	Occipital	1	6
12	Temporal	6	1
13	Occipital	4	2
14	Temporal	8	1
18	Parietal	1	3
18	Parietal	2	8
19	Frontal	3	6
19	Temporo-parietal	11	6
19	Temporal	4	5
23	Parietal	8	9
32	Occipital	4	10
44	Temporo-parietal	9	6
47	Parietal	6	6
49	Parieto-occipital	2	8
50	Temporal	8	4
50	Fronto-parietal	10	10
52	Temporo-parietal	7	6
71	Occipital	6	2
72	Temporal	3	10

Complete healing occurred in an 8 year old boy with a fissure fracture of the frontal bone in one year. The earliest evidence of healing occurred in 2 months in a 12 year old boy with a fracture of the temporal bone, and in $2\frac{1}{2}$ months in a 11 year old boy with a fracture of the occipital bone. There was no evidence for delay in healing of the fractures of the occipital bone as compared to other bones, in our series.

Analysis of Fissure Fractures Almost Healed in 12 Patients over 7 Years of Age

Age at Injury	Bone Involved	Time Interval to Follow-up	
9 Years	Occipital	8 yrs.	10 mos.
14	Frontal	7	7
21	Frontal	5	6
24	Temporal	5	2
26	Fronto-parietal	6	10
35	Frontal	13	9
38	Temporo-parietal	13	8
43	Fronto-parietal	7	
45	Occipital	6	3
45	Fronto-parietal	9	8
53	Parietal	4 (and 6 yrs.)	
73	Occipital	4	4

The shortest interval between injury and follow-up examination having elapsed in this group of almost healed fractures is 4 years. It is possible that some of these fractures may go on to complete healing with no residual evidence of fracture. In one patient 53 years old with a fracture of the parietal bone and in whose case there were follow-up films made at 4 and 6 years after injury there was no change in the status of the healing process between the 4th and 6th year. The same evidence of a faint fissure line persisted without evidence of change, hence it is likely that this slight bony defect will remain permanently.

Included in the above group are some fissure fractures whose peripheral segments have healed completely, but whose mid-segments or the segments of widest separation are still slightly visible. In all of them there was some healing in one or more portions of the fracture. In all probability, the two fractures above that have gone for more than 13 years with persistent slight fracture shadow will retain this shadow permanently.

Fissure Fractures With Definite Evidence of Healing in 7 Patients Over 7 Years Of Age

Age of Injury	Bone Involved	Time Interval to Follow-up	
17 years	Temporal	1 yr.	8 mos.
19	Frontal	4	11
23	Frontal	9	10
31	Frontal	4	0
37	Parietal	11	2
50	Occipital	3	6
58	Frontal	3	6

It will be noted above that in a 37 year old patient with a fracture of the parietal bone there was still definite evidence of the fissure fracture after 11 years and 2 months. The patient had an unusually wide separation of the fragments and 11 years 2 months later there was little narrowing of the fracture line. This will probably remain as a permanent defect. In 5 out of 7 of the above cases the original fractures were unusually wide fissures. In all of these 5 cases there was evidence of narrowing of the defect on follow-up films. There were 15 cases of depressed skull fracture, 4 of which occurred in patients less than 7 years of age, the remaining 11 cases were in patients over 7 years of age. They will be discussed together below.

This group is divided into those that were found to be completely healed, those that showed definite evidence of healing, those that showed no healing, and finally those that showed resorption of bony margins.

Depressed Fractures Showing Complete Healing

Age at Injury	Bone Involved	Time Interval to Follow-up	
5 years	Occipital	6 yrs.	8 mos.
13	Parietal	3	3
43	Frontal	5	8
48	Frontal	4	8
50	Frontal	4	10

The first group included 5 cases, varying in age from 5 years to 50 years. In all of these cases, the depression was slight and persisted as permanent deformity. There was no surgical interference, and complete healing occurred in all.

There were two cases in the group showing definite evidence of healing. One of these was a 19 year old patient with a multiple fissure and depressed fracture of the parietal bone. There was surgical elevation of the depression with preservation of most of the fragments in good position, and at the end of 8 years and 6 months all fissure fractures had completely healed, and there were areas of healing present where the fragments were in contact with the margins of the intact bone. The other case with evidence of healing was that of a 15 year old patient with a depressed fracture of the frontal bone. Healing was almost complete at the end of 8 months, at which time surgical elevation was done by removal of the depressed segment as an osteoplastic flap, and replacement of the flap after it had been rendered malleable by a spiral saw cut in the fragment from the center of the bone flap to the periphery. 1 year and 2 months later there was advanced healing of the fragments with some areas of complete healing, other areas of healing to a lesser degree. Six months later, further evidence of progress in healing was noted.

The third group included 7 cases, varying in age range from 1 year to 40 years, in which the depression was marked, and in which surgical elevation was done, with residual bony defect.

Depressed Fractures With Surgical Elevation and Residual Bony Defect

Age at Injury	Bone Involved	Time Interval to Follow-up	
1 year	Frontal	2 yrs.	6 mos.
3	Frontal	2	5
6	Parietal	7	11
9	Occipital	1	6
27	Frontal	3	11
37	Parietal	1	6
40	Parietal	4	2

There was no decrease in the size of the bony defect in any of these cases. The changes noted were those of rounding out of the margins of the defect; this was noted to occur in $1\frac{1}{2}$ years in two cases.

One other case in the depressed fracture group was that of a 30 year old patient who had a multiple fissured and depressed fracture of the temporal bone. After 10 years and 4 months all the fissure shadows had healed almost completely, but there was an area of resorption of the bony margins in the region of the originally depressed fragment with the resultant bony defect. This defect will probably be permanent.

Summary and Conclusions

A review of 65 cases of skull fractures on whom follow-up films were obtained, is presented. There were 50 fissure or linear fractures and 15 depressed fractures.

Fractures of the skull heal more slowly than do fractures of the skeletal bones.

Healing occurrs in a shorter time in the young than in the adults.

Healing depends on nature of fracture and apposition of fragments. Simple fissure fractures heal more quickly than other types. Depressed fractures with bony defects due to surgical elevation and removal of fragments apparently never fill in the defect.

Resorption of margins about fractures may occur with resultant larger bony defects than that of the original injury.

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III. GOSSIP

On Washington's Birthday the adolescent daughters in our neighborhood entertained their fathers and mothers at a dinner at one of the neighbors. An attractive menu featuring spaghetti and cherry pie was served. The atmosphere was that of a dive and we had to knock and give the proper sign before we were admitted. In keeping with our daughters' opinion of our ancient state the parents came dressed in costums of another day. Menus were on every table but the waitresses were out of everything except the Victory Special. During the evening the place was raided by noisy gentlemen of the same age as the daughters who cut the power line and snatched jewelry from the ladies. The floor show was most entertaining, and later on we played musical chairs. Upstairs two young men from the families were busy doing their high school mathematics assignment. As they failed to obtain the proper answer, they called upon the head of the Department of Mathematics and the head of the Department of Physics of the University of Minnesota for help. These learned gentlemen discovered that the answer in the back of the book was wrong and I felt sorry for their teacher the next morning. After the dishes were washed by the adolescents, the various families separated with high praise for their daughters' ability as cooks and entertainers as they vary in age from 13 to 15.....In Chicago last week at the meetings there was much talk of federal control of medicine. Gold braid, stars, and eagles dominated the gathering. The average doctor is bewildered by the great importance his humble efforts have assumed in the national scene. It appears that everybody wants more of what he has to offer but after all, no one else can give this service but the practicing physician himself. It would appear logical that his ideas on the way in which his services might be effectively rendered would be of interest to the planners as under their system funds collected from the good states would find their way into the poor states and services now established in an effective way would be superseded by others which might not be as effective. Those who believe state or local governments could do a better job than the federal should look about them and see what these agencies have accomplished. Suggestions have been made that a trial program in a definite area might be attempted. It would use public opinion, good leadership, and financial aid in developing present facilities. Most observers believe that teaching hospitals have developed acceptable standards for immitation by all of our hospitals. These involves standards of staff practice, trained personel and a continuous educational program. In the suggested plan there would be consultants in all of various hospital fields, who would visit the institutions at frequent intervals and in turn, those employed locally would go to centers, for a continuation study at regular intervals. The same plan would be followed by physicians.... It is interesting to note the meekness with which travelers accept their lot. Most of us have always done it, so it is nothing new. In Chicago bright spots still draw crowds, and an evening's entertainment runs into a considerable sum. At the old Heidelberg they still have student chorus and the plump maiden who sings the operatic airs. The boys still march through the audience as the people beat time. The orchestra plays much Victor Herbert and some of the other modern composers. Although the group is suppose to be German, one Larson sings Irish songs with all the tenderness of old. Families still come in groups and the place has preserved much of its old attractiveness....A few years ago we had an exchange Professor who spent some time here in exile from his native country. What he missed most was a place to sit down and flirt. Another thing he told us we needed was colder rooms so that we could wear heavy underwear and go from building to building without putting on an overcoat. In our post-war planning we should keep these pearls in mind.... One of the effective discussions in post-war planning was made by Dr. Davison, Dean of Duke University Medical School who said that most post-war plans reminded him of hoop skirts in that they covered everything but touched nothing.