

## Original Articles.

THE CLOSURE OF THE CRANIAL SUTURES AS A SIGN OF AGE.<sup>1</sup>

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It is, I believe, pretty generally admitted among anatomists that the time and order of the closing of the cranial sutures are very uncertain, far too much so for them to be trustworthy guides to determine the age of the skull. Humphry's remark is well-known: "In some skulls edentulous from age, I have found them still well-marked; whereas in others, which bore evidence of having only just reached maturity, they could scarcely be traced." Nevertheless, it is still rather vaguely taught that they begin to close about middle life, or, according to some, from thirty to forty. Testut, in his new work on anatomy states that "la synostose physiologique debute vers l'age de quarante-cinq ans." It seems to me that medico-legal writers are, on the whole, rather more confident than the anatomists. Tidy writes: "In old age . . . the sutures become firmly ossified and generally less distinct. If the sutures of the skull are indistinct we may thus fix the age as at least between fifty and sixty." Some others say pretty much the same thing. There is, I think, little doubt that the statements of one writer on this point are simply repeated by the next with little attempt at verification. Topinard makes the following very precise statements in his "Anthropologie": "In fine, if no suture is affected, the person is about thirty-five years old or less. If the hind part of the sagittal is beginning to close he is about forty. If the coronal suture is ossified near the bregma he is fifty or more. The temporal suture being closed he is seventy or over." He admits, however, that the time of the closure of the sutures varies within large limits. I could mention a circular from a high official source in this country in which the following directions were given for estimating the age of bodies in which it could not otherwise be obtained. "This [the condition of the sutures] it is claimed by anthropologists, affords the most reliable guide to the determination of the age in such cases. If the sagittal or coronal suture shows bony union, the individual is said to be at or beyond middle life, or somewhere in the vicinity of forty-five years; if sagittal and coronal are joined, it indicates forty-five to fifty years; if sagittal, coronal and lambdoidal are synostosed, the age indicated is said to be from fifty-five to sixty-five; and if all the sutures are obliterated, the age is from sixty-five to eighty years."

With regard to the order of the closure of the sutures, Humphry teaches that "the fusion of the bones commonly takes place first at the fore part of the sagittal suture, next in the lambdoidal suture near the sagittal, then in the coronal suture near the inferior angle of the parietal bones." Sappey holds that it begins in the sagittal suture near the parietal foramina and travels both forward and backward, that the coronal begins to close at its lower ends, and the lambdoidal above. According to Merkel, the process usually begins in the sagittal, between the parietal

foramina, and the coronal is usually the last to close. Rambaud et Renault gives the same order. The most thorough study of this subject is probably that by Sauvage "Sur l'état Sénile du Crâne,"<sup>2</sup> founded on tables of observations made by Broca at Bicêtre and at la Salpêtrière on 126 subjects of known ages. The most important conclusions concerning the three chief sutures are the following: the first to ossify is the sagittal, the union beginning behind in the part between the parietal foramina. Later, the process is more active in the middle than in the front part. The lambdoidal closes next. The process begins on the right, then is continued in the middle, and finally on the left. The closure is most complete in the middle. The coronal comes a little later; the middle part is the first to close, and is more completely obliterated than the lateral ones. The right side closes before the left. The obliteration always begins on the inside of the skull. It is very uncommon for the sutures to be obliterated on the outside of the skull. In general the obliteration begins towards forty-five years. So far Sauvage. Topinard gives the following somewhat different statements, but ends his remarks by referring to Sauvage in a foot-note. This first point of closure is usually in the posterior part (but not at the end) of the sagittal, but sometimes it is at the lower ends of the coronal. The second or third place is in the lambdoidal, either by extension from the sagittal, or in a new spot in one of the branches of the suture. The fourth point is in the coronal near the bregma, and the fifth in the squamous suture of the temporal.

I have studied this question on 100 heads, the ages of which were given, but as they were all from paupers, it is not to be expected that the reports of the ages should in all cases be correct. They are, however, sufficiently so for the very general conclusions I shall draw from them. I regret very much that at first I in many cases did not examine the inside of the skull.

I am not able to say how often this occurred, because at first I often noted the condition of a suture as open, closed, etc., as the case might be, from a study of both sides without, however, stating that fact. It is possible that rather more than one-third of the cases were examined on the outside only. The effect of this will be that as the process begins on the inside, in some cases the records will show less than has occurred. It happily will not lead to any wrong conclusions for, as will appear later, one of the most striking results of these observations is that closure begins much earlier than is generally supposed.

The cases are recorded in order of age. Only the chief sutures of the vault were considered. It was found impossible to tabulate the results satisfactorily, and it seemed best to give a short account of what was found in each case. This method makes it easy to compare the observations with the statements in books.

A word is needed on the terms used. By "open," as applied to a suture, is meant that there is no union between the bones which it separates, so that after maceration they could be taken asunder. By "closed," and "partly closed" is meant that there is more or less bony union between the bones, though the general course of the suture may be perfectly distinct. By "obliterated" is meant that the union is so complete that the suture has disappeared. For this the shorter word "gone" has sometimes been substituted. I fear that in some of my earlier notes I did not always ob-

<sup>1</sup> This is part of a paper entitled "Medico-Legal Studies on the Human Skeleton," read December 27, 1889, at the meeting of the Association of American Anatomists at Philadelphia. The number of heads examined was then 69. The observations have since been carried to 100, and the paper has been practically rewritten.

<sup>2</sup> *Bulletins de la Société d'Anthropologie, Paris, 1870.*

serve this distinction, and may sometimes have put "closed" for "obliterated"; therefore the progress of coösfication is, if anything, understated.

TABLE OF ONE HUNDRED OBSERVATIONS.

1. Age 17, female, white. Three chief sutures open.
2. Age 21, male, white (Armenian). Very distinct outside and inside; probably open.
3. Age 25, male, white. Ditto.
4. Age 26, female, white. Sutures distinct; lambdoidal shows signs of closing.
5. Age 26, female, white. *Outside*: Obliteration of sagittal and coronal for a short distance at bregma; elsewhere sutures very distinct, with small points of closure in sagittal. *Inside*: Lambdoidal quite open; advanced obliteration of other two.
6. Age 26, male, black. Lambdoidal open; sagittal probably open; coronal obliterated nearly to the top on the *inside*; only at the lower ends on the *outside*.
7. Age 27, male, black. *Outside*: Coronal distinct, sagittal and lambdoidal closing. *Inside*: All three gone.
8. Age 28, male, white. Sutures distinct.
9. Age 28, male, white. Sutures distinct; probably quite separable.
10. Age 29, male, white. *Outside*: Most of coronal and front part of sagittal present, back part of latter and top of lambdoidal obliterated.
11. Age 30, female, white. *Outside*: Coronal distinct except below; sagittal closed; lambdoidal obliterated at apex, visible below. *Inside*: Coronal, obliterated; sagittal closed and in back part obliterated; lambdoidal obliterated below, visible at apex.
12. Age 31, male, white. Sutures partly closed, but distinct on both surfaces; the least distinct is the coronal on the *inside*.
13. Age 31, male, white. Sutures very distinct; coronal closing in spots.
14. Age 31, male, white. Coronal obliterated, so is sagittal except for about one inch near bregma; lambdoidal closed, but visible.
15. Age 31, female, white. *Outside*: Sutures distinct, but obliteration has begun in back part of sagittal. *Inside*: Chief suture obliterated.
16. Age 32, female, white. Coronal closed at both lower ends and at bregma; sagittal closing in front; lambdoidal open.
17. Age 33, female, white. *Outside*: Sutures distinct; sagittal partly closed. *Inside*: Sagittal partly obliterated.
18. Age 34, male, white. *Outside*: Sagittal obliterated in posterior half, nearly so in front; coronal obliterated below, closed above; lambdoidal distinct. *Inside*: All gone except lambdoidal, of which a trace remains.
19. Age 34, male, white. *Outside*: Sutures closing, but distinct, except lower ends of coronal. *Inside*: All are practically obliterated.
20. Age 35, male, white. *Outside*: Coronal distinct, lambdoidal less so; sagittal nearly obliterated. *Inside*: All nearly gone.
21. Age 35, male, white. Sagittal open; coronal obliterated on *inside*, except at top; on *outside*, at lower ends, very distinct elsewhere; lambdoidal very clear *outside*, obliterated *inside* except at top.
22. Age 35, male, white. Coronal distinct; sagittal obliterated except in front; lambdoidal becoming obliterated.
23. Age 35, male, white. Sagittal obliterated except for an inch or so in front; other two pretty distinct, but closed or closing; lambdoidal especially shows signs of obliteration.
24. Age 35, male, white (Italian). All three open; one point of closure at left lower end of coronal; a frontal suture is also open.
25. Age 36, male, white. Sagittal completely obliterated; other two apparently closing.
26. Age 36, male, white. Coronal probably open throughout, except at lower ends; sagittal obliterated *outside*; distinct *inside*, except at lower ends; lambdoidal on *outside* distinct, beginning to close, contains large Wormian bones. *Inside*: Suture distinct; Wormian bones small or wanting.
27. Age 37, male, white. Sagittal becoming obliterated, especially in front; other two distinct.
28. Age 37, male, white. There was an ulcer near the vertex. All nearly obliterated.
29. Age 37, male, white. *Outside*: Some obliteration of sagittal, others distinct. *Inside*: All gone except part of lambdoidal.
30. Age 37, male, white. All sutures closing; coronal obliterated on lower end on right; sagittal obliterated except in front; lambdoidal distinct.
31. Age 38, female, black. Sagittal open except at hind end; coronal closed at lower end on both sides; lambdoidal open.
32. Age 38, male, white. Sutures closed and beginning to disappear; hind portion of sagittal in part obliterated.
33. Age 38, male, white. Coronal distinct but closed; sagittal obliterated except near bregma; lambdoidal becoming obliterated.
34. Age 38, male, white. A persistent frontal suture is distinct; coronal closed below on both sides, other two distinct.
35. Age 39, female, white. Sagittal obliterated; coronal obliterated at bregma, closing below; lambdoidal becoming obliterated.
36. Age 39, male, white. *Outside*: Sutures very distinct, apparently open, except lower ends of coronals. *Inside*: Lambdoidal distinct, probably open; sagittal distinct behind, obliterated in front; coronal is the most obliterated, quite gone on top.
37. Age 40, female, white. Sutures almost completely obliterated, but visible on *inside*; very thick skull.
38. Age 40, male, white. Lambdoidal closed; other two distinct.
39. Age 41, male, white. Sutures closed; and, in parts, obliterated.
40. Age 41, male, white. *Outside*: Sagittal partly obliterated; coronal distinct, but closing; lambdoidal apparently open. *Inside*: Sagittal and coronal visible, but closed.
41. Age 41, male, black. Closure of sutures well advanced.
42. Age 41, female, white. *Outside*: Coronal distinct, except at lower ends; sagittal distinct; lambdoidal visible in places. *Inside*: Coronal obliterated; other two nearly so.
43. Age 41, female, white. *Outside*: Sagittal obliterated; coronal also, except on top; traces of lambdoidal. *Inside*: All gone, except traces of lambdoidal at apex.
44. Age 42, male, white. *Outside*: Sutures closed, but in most places distinct; obliterated in spots, especially lower ends of coronals. *Inside*: Sutures in general obliterated, occasional traces left.
45. Age 42, male, white. Coronal distinct; sagittal closed in most parts, obliterated behind; lambdoidal closing.
46. Age 43, male, white. Sutures distinct, except lambdoidal, which is in places obliterated.
47. Age 43, male, white. Coronal distinct; other two almost completely obliterated.
48. Age 43, male, white. *Outside*: Sutures nearly obliterated. *Inside*: Perhaps a trifle less obliterated than *outside*, especially apex of lambdoidal.
49. Age 44, female, white. *Outside*: Sutures distinct, apparently open. *Inside*: Almost wholly obliterated.
50. Age 45, male, white. *Outside*: Coronal very distinct; sagittal distinct, but closed; lambdoidal closing. *Inside*: Coronal almost obliterated; sagittal obliterated in places about the same as on *outside*; lambdoidal closing in the lower parts.
51. Age 45, male, black. Coronal nearly obliterated; sagittal so in parts; lambdoidal distinct, but closed.

52. Age 45, female, white. Obliteration beginning in the three chief sutures; lambdoidal contains Wormian bones, probably for the most part free.
53. Age 46, male, white. *Outside*: Sutures distinct, but closing, especially sagittal. *Inside*: All nearly obliterated, except apex of lambdoidal.
54. Age 47, male, white. *Outside*: Sagittal obliterated; others visible, but obliteration beginning. *Inside*: All closed.
55. Age 47, male, white. Distinct, but beginning to be obliterated.
56. Age 49, male, dark (cross between Indian and Mexican). Obliteration beginning in upper half of coronal on each side; sagittal obliterated, except in front; coronal gone.
57. Age 50, female, white. *Outside*: Coronals distinct; others nearly obliterated. *Inside*: All obliterated.
58. Age 50, female, white. *Outside*: All pretty distinct; hind part of sagittal apparently closing. *Inside*: All closed, or closing.
59. Age 51, male, white. Sutures distinct; but obliteration beginning, especially in posterior half of sagittal; it is more advanced in right side of lambdoidal than in left.
60. Age 51, female, white. Coronal visible on left, obliterated on right; sagittal obliterated; lambdoidal closed, but not obliterated.
61. Age 51, male, white. *Outside*: Sutures tolerably distinct, except lambdoidal. *Inside*: All obliterated.
62. Age 51, female, white. Sutures distinct, but closing.
63. Age 54, male, white. Back part of sagittal and top of lambdoidal beginning to be obliterated; the rest distinct, including a frontal suture.
64. Age 55, male, white. Coronal closed at both lower ends; sagittal closing; lambdoidal closing, complicated with Wormian bones.
65. Age 55, male, white. *Outside*: Lambdoidal obliterated on right, nearly so on left; sagittal nearly obliterated in back part; coronal distinct. *Inside*: All obliterated.
66. Age 56, female, white. *Outside*: Coronal pretty distinct, though closed; others obliterated. *Inside*: All obliterated.
67. Age 60, female, white. Sutures closing in many places; front of sagittal obliterated; top of coronal and lower part of lambdoidal nearly so.
68. Age 60(?), female, white. *Outside*: Sutures visible, but becoming obliterated. *Inside*: Obliterated.
69. Age 62, male, white. Coronal distinct, but closed; others nearly obliterated.
70. Age 63, male, white. Sutures nearly obliterated; right side of coronal least so; some remains of frontal.
71. Age 64, female, white. Chief sutures distinct; little, if any, coössification.
72. Age 64, female, white. *Outside*: Sutures apparently open. *Inside*: All gone, except apex of lambdoidal.
73. Age 65, male, white. *Outside*: Coronal distinct, except at lower ends; sagittal obliterated; lambdoidal nearly gone. *Inside*: Coronal and sagittal obliterated; lambdoidal nearly so.
74. Age 65, male, white. *Outside*: Traces of coronal, the rest gone. *Inside*: All gone, except a trace of apex of lambdoidal.
75. Age 65, male, white. Coronal distinct; lambdoidal obliterated; sagittal visible in front, and gone behind.
76. Age 65, male, white. *Outside*: As in preceding case. *Inside*: Precisely the converse, except that lambdoidal is not clear.
77. Age 65, male, white. Sagittal nearly obliterated; other two closing.
78. Age 66, male, white. Obliteration in various places. Lower ends of coronal and front of sagittal gone.
79. Age 67, female, white. Coronal partly closed; sagittal distinct, slight union behind; lambdoidal apparently open.
80. Age 68, male, white. *Outside*: Closed but visible, including a frontal suture. *Inside*: Barely visible.
81. Age 68, male, white. Coronal distinct, but closing; other two obliterated.
82. Age 68, female, white. *Outside*: Distinct, though obliteration is beginning in sagittal and lambdoidal. *Inside*: Obliteration all but complete.
83. Age 70, female, white. Sutures distinct; apparently not closed.
84. Age 70, male, white. *Outside*: Visible, but obliterating, especially the sagittal. *Inside*: All practically gone; a trace of apex of lambdoidal.
85. Age 70, male, white. *Outside*: Slight traces of sutures, especially of coronal. *Inside*: All practically obliterated.
86. Age 71, male, white. *Outside*: All very distinct, except lower ends of coronals, which are gone. *Inside*: All obliterated, except apex and left side of lambdoidal.
87. Age 71, male, white. *Outside*: Sutures irregularly closed. *Inside*: Obliterated.
88. Age 72, male, white. Sutures perfectly distinct; little, if any, obliteration.
89. Age 75, male, white. Lambdoidal and back of sagittal nearly obliterated; the rest distinct.
90. Age 75, male, white. Lambdoidal gone; sagittal also, except for an inch or so in front; coronal distinct on right, nearly obliterated on left, especially below.
91. Age 75, male, white. *Outside*: Traces of sutures, including upper part of frontal. *Inside*: All gone.
92. Age 75, male, white. *Outside*: Coronal visible, but obliterating; sagittal visible in front, gone behind; lambdoidal visible in places. *Inside*: all obliterated, except apex of lambdoidal.
93. Age 75, male, white. *Outside*: Coronal distinct, except at lower ends; all else gone. *Inside*: All gone.
94. Age 79, male, white. Chief sutures nearly obliterated; lambdoidal perhaps the least.
95. Age 80, female, white. Chief sutures perfectly distinct; no sign of obliteration, though there may be some union; thin skull.
96. Age 80, female, white. Sutures closed, but lines distinct.
97. Age 81, female, white. *Outside*: Coronal distinct, but closed; sagittal obliterated; lambdoidal visible in spots. *Inside*: All gone, except apex of lambdoidal.
98. Age 82, female, white. Sutures can be made out, though in parts obliterated; a frontal suture is by far the most distinct.
99. Age 82(?), male, white. A frontal suture is distinct in most places, though obliterated at lower end and in other parts; coronal obliterated at lower ends, elsewhere distinct; sagittal obliterated behind, distinct in front; lambdoidal contains Wormian bones; it is pretty distinct.
100. Age 91, female, white. *Outside*: Coronal very distinct; sagittal closed in hind portion, but visible, very distinct elsewhere; lambdoidal almost obliterated. *Inside*: Sagittal completely obliterated; the other two nearly so.

The most evident conclusions from this table seem to be:

(1) That the sutures begin to close much earlier than has ever been stated. The process is apparent in several cases of persons under thirty. Of those from thirty to forty there is but a single case (No. 24, an Italian of thirty-five) in which closure has not made progress, and in this one it is beginning. In another (No. 36) there is but little union to be seen on the outside.

(2) That the closing almost invariably begins on the inside, which was well-known before. It seems, however, that the process does not at all necessarily appear first on the outside opposite the points previously attacked on the inside. On the contrary, in several cases one part of a suture is obliterated on the outside,

and the other on the inside. In (No. 76) the inside of the skull of a woman of sixty-five, shows almost precisely the converse of the ossification of the outside. What is open on one surface is closed on the other except for the lambdoidal.

(3) That the time of closure of any particular part of a suture, and the order in which the process advances are very uncertain. In proof of this we need only compare the appearances of the individual cases of any group of five or six skulls of the same or nearly the same age in the first half of the table. As to the usual order I shall venture only to say what I *think* about some points.

I think that closure generally begins in the back part of the sagittal and often as soon or nearly as soon in the lower ends of the coronal. I think that when the sutures close early the coronal usually closes before the lambdoidal, but that in old skulls, on the outside, at least, the lambdoidal is more frequently obliterated than the coronal. On the inside of old skulls there is very often a minute line showing the position of the apex of the lambdoidal suture when all the others are quite gone. A persistent frontal suture is one of the last to disappear as has been previously taught.

As to the rules for determining the age of the skull from the condition of the sutures, it is necessary only to compare them with the observations recorded in this table to see what they are worth. It must not be forgotten that there are other guides to the age of the skull; and I am not prepared to assert that, taken together with them, the sutures are absolutely worthless in the hands of an experienced anatomist. I am sure that to any one else the rules in question are misleading and dangerous.

## ACCIDENTS FROM THE ELECTRIC CURRENT.<sup>1</sup>

### A CONTRIBUTION TO THE STUDY OF THE ACTION OF CURRENTS OF HIGH POTENTIAL UPON THE HUMAN ORGANISM.

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MOYER<sup>19</sup> reports the case of a man who received a shock from an arc light and fell grasping the side wires of the light with his hands, grounding the current with his knee against an iron rail. There was a punched-out opening over the knee, and an eschar on the posterior aspect of the thigh, leaving a deep fistulous track which was slow to heal. There was no other trouble.

Hummel<sup>20</sup> reports two cases. One was a man who got a shock from a 3,000-volt Brush-light wire, running fifty 2,000-candle lights. He got also an extra current from cutting the wire. He hung by his hands from the wire for three minutes, and then was able to come down a ladder without help. The hands were burned, but he had no other trouble sufficient to confine him to the house. There was some slight loss of motion and sensation in the forearms for a time. The second man received a shunt current, of unknown strength, from a Brush-light wire for five minutes. He was senseless for a time, but soon rallied. The thumb

and two fingers of one hand were so badly burned as to require amputation. The pulse never got above 86, nor the temperature above 101° F., nor the respiration above 24. There was a similar transitory diminution of motion and sensation in the arms.

Buchanan<sup>21</sup> reports a case where a man received a shock from a Brush-light wire. He was stunned, his sight was dimmed, his hands were burned, and his face and neck blistered, and there was slight shock. All the symptoms passed off in twenty-four hours, except that the burns sloughed and required six weeks for recovery.

Terry<sup>22</sup> reports the case of a man who received a shock from an electric light wire, and hung by the legs with his head down for an hour before he could be removed. He had no memory of the shock, and no surgical shock at any time. The hands were burned, and there was a burn over the inner aspect of the thighs and the end of the penis, taking off a congenital phimosis. The burns sloughed, but finally healed. The man made a satisfactory recovery.

Dana reports the case of a young man who was struck by a live arc-light wire. He grasped it with his left hand and instantly fell. The current passed through his arm and body for several moments. He remembered only feeling a sudden blow on the head which knocked him down and made him partially unconscious. He heard voices about him, saw a glimmering light, felt intense pain, expected death, and at last lost consciousness. The left hand was so badly burned as to require amputation, but the arm was not in the least paralyzed or anæsthetic, and the effect on the general bodily functions was *nil*.

The subsequent history of these cases, however, is not always obtainable. It is possible that some of them, later, exhibited nervous symptoms of the types of which I shall now speak.

### II. Cases followed by more or less protracted symptoms, chiefly of a nervous character.

The cases already reported show the remarkable tolerance of the human organism to currents of high potential. I have already spoken of the influence which the wonders of electricity exert on the diseased imagination of the paranoiac. It would be strange if, when the newspaper reports of electrical accidents have produced a feeling of panic in many minds, the actual victims of such accidents should not develop many nervous symptoms which often have a distinctly psychical origin. Such symptoms might naturally be expected to be most common in nervous persons, unfamiliar with the action of electricity. It would be going too far, however, to assume that the nervous symptoms which follow an electrical shock were purely psychical, or were to be found only in persons of the class mentioned, as the following cases will show.

CASE VI. Probably imaginary shock. Marked tremor, nervousness and general shattering of the nervous system. Recovery.

I was asked by Dr. D. W. Cheever, to see George L., forty-two, married, a coachman, who was said to be suffering from an electric shock. I saw him on April 14, 1889, and obtained the following history of his accident. He had always been well and strong, although slightly hypochondriacal, had used alcohol pretty regularly, although never to excess. He had been in one or two

<sup>1</sup> Read before the Boston Society for Medical Improvement, February 24, 1890. Concluded from page 371.

<sup>19</sup> Moyer: Chicago Medical Journal and Examiner, November, 1886.

<sup>20</sup> Hummel; Philadelphia Medical Journal Bulletin, April, 1885,

<sup>21</sup> Buchanan: Lancet, February 12, 1886.

<sup>22</sup> Terry: North American Journal of Homœopathy, December, 1888.