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THE RELATION OF THE CRANIAL SUTURES TO AGE.

BY F. G. PARSONS, F.R.C.S., AND C. R. BOX, M.D.

IN former years many anatomists professed to be able to estimate the age of a skull pretty accurately by the amount of obliteration which had taken place in the cranial sutures, and it is probable that this was the criterion on which the late Dr. Barnard Davis chiefly relied in giving approximate ages to the skulls of the great collection which now stands in his name in the Museum of the Royal College of Surgeons. That the practice was not a very reliable one may be gathered by comparing the statements of writers like Testut, Tidy and Topinard, and then trying to fix the age of any individual skull by them. Each of these writers no doubt spoke from personal experience, but they were all generalising on too small a number of observations to make their statements of much practical value.

The first really scientific paper on the subject is by Dr. T. Dwight ("The closure of the Cranial Sutures a sign of Age:" *Boston Medical and Surgical Journal*, vol. cxxii, No. 17, p. 389), who reviews the literature of the subject up to 1890, and gives the details of 100 skulls of people of European and African descent, the ages of whom at death he knew. His conclusions contrast very curiously with the dogmatic statements of the older writers, and although his paper should be studied in its entirety by anyone interested in the subject, we may be allowed to quote some of his conclusions. He finds that the sutures often begin to close before 30; that between 30 and 40 ossification has almost always made good progress, that the closing almost invariably begins on the inside, and it seems that the process does not necessarily appear first on the outside opposite the points previously attacked inside. "I think," he says, "that closure begins in the back part of the sagittal, and often as soon or nearly as soon in the lower end of the coronal." "I think that when the sutures close early, the coronal usually closes before the lambdoid, but that in old skulls, on the outside at least, the lambdoid is more frequently obliterated than the coronal." In 1895 another important paper appeared by Dr. T. Picozzo (*Archiv. di Psichiatria, Scienze Penali e Antropologia Criminale*, xvi, 6, pp. 364-398), who lays a good deal of stress on the different order of closure in the two sexes. As far as we are able to gather from a review of his paper in *Archives Italiennes de Biologie*, 1896, tome 26, p. 333, he does not distinguish between the ecto and entocranial aspects of the sutures, and this to us seems unfortunate, for our own observations teach us that the latter are by far the most important.

The paper now presented contains the records of 82 skulls, by far the greater number of which have been observed in the Dissecting and Post-mortem Rooms of St. Thomas's Hospital, and are of lower and middle class English people. A few are skulls from the Museum of the Royal College of Surgeons, of which the age at death was accurately known, and of these one or two are foreign. We are indebted to the kindness of Professor C. Stewart, the Curator of the College of Surgeons' Museum, and of Dr. C. Powell White, our Pathologist, for allowing us the use of material and for assistance generally. It will be seen that our records are fairly evenly distributed over the different decades of life, and we hope that they will contribute towards the more exact knowledge of a subject which may be of considerable anthropological and medico-legal interest. In the following lists the ecto and entocranial appearances are treated separately, but as in a few cases we were unable to look at the inside of a skull, the numbers do not always correspond. To remedy this we have placed two numbers in front of the entocranial records, and the second of these (in brackets) refers to the number in front of the ectocranial record of the same skull.

ECTOCRANIAL SUTURES. Below 30.

1. ♂ *æ*t. 17. All patent.
2. ♂ „ 18. Obliteration commencing below L. stephanion.
3. ♂ „ 18. All patent.
4. ♀ „ 19. „ „
5. ♀ „ 25. „ „
6. ♀ „ 26. „ „
7. ♀ „ 27. „ „
8. ♀ „ 27. „ „
9. ♀ „ 30. „ „
10. ♂ „ 30. Obliteration commencing below stephanion and upper half of metopic.
11. ♀ „ 30. All obliterated except coronal above stephanion.

This points to the conclusion that under 30 the sutures are usually patent, but that ectocranial obliteration commences below the stephanion.

ECTOCRANIAL SUTURES. Between 30 and 40.

1. ♂ *æ*t. 31. (Thurtell's skull, R.C.S. Museum). Obliteration commencing below stephanion.
2. ♂ „ 31. All patent.
3. ♀ „ 32. „ „
4. ♂ „ 33. Obliteration below stephanion and at obelion.
5. ♂ „ 33. All obliterated except middle of coronal.
6. ♂ „ 33. „ „ „ „ „ „ „ and lower two-thirds of lambdoid.

7. ♂ *æ*t. 34. Obliteration below stephanion and at obelion.
8. ♀ „ 34. All patent.
9. ♂ „ 34. Obliteration below stephanion and at obelion.
10. ? „ 35. (Bengalee, R.C.S.) All obliterated.
11. ♀ „ 35. All patent.
12. ♂ „ 36. Obliteration below stephanion, obelion, and most of lambdoid.
13. ♂ „ 37. All patent.
14. ♀ „ 38. Obliteration below stephanion only.
15. ♂ „ 38. „ at obelion „
16. ♂ „ 39. „ below stephanion „
17. ♀ „ 39. „ at obelion „

These indicate that between 30 and 40 there is usually some obliteration below the stephanion or at the obelion or both. The evidence that the stephanion is the earliest point to close is more marked than in the last list.

Nos. 3, 8, 11, 14 and 17 (the only females), taken in conjunction, make us suspect that female skulls close later than males as far as their ectocranial surface is concerned. This agrees with Picozzo's experience.

ECTOCRANIAL SUTURES. Between 40 and 50.

1. ♂ *æ*t. 43. Obliteration at obelion only. (Metopic patent.)
2. ? „ 44. (R.C.S.) Obliteration below stephanion, all sagittal and upper part of lambdoid.
3. ♀ „ 44. Obliteration below stephanion and at obelion.
4. ♂ „ 44. All patent.
5. ♂ „ 45. Obliteration below stephanion and at obelion.
6. ♂ „ 45. „ „ „ only.
7. ♀ „ 45. „ „ „ „ (very thin skull).
8. ♂ „ 45. „ „ „ „
9. ♂ „ 45. „ „ „ „
10. ♂ „ 46. „ „ „ „
11. ♀ „ 47. All obliterated.
12. ♀ „ 48. Anterior two-thirds sagittal, lambdoid and upper one-third; metopic nearly obliterated.
13. ♀ „ 48. Evident but indistinct at stephanion and obelion.
14. ♂ „ 49. (Eugene Aram, R.C.S.) Obliterated at stephanion and obelion; lambdoid patent.
15. ♂ „ 49. Obliterated below stephanion and at obelion.
16. ♂ „ 50. „ „ „ only.

Among these 16 skulls there is only one which shows no obliteration at all, whereas in the last decade there were 5 out of 17 in which no closure was seen. It is remarkable how often the whole sagittal suture is patent ectocranially; this is in marked contrast to Picozzo's statement, that between 41 and 50 the sagittal is almost always closed in males except at the anterior part.

ECTOCRANIAL SUTURES. Between 50 and 60.

1. ♂ *æt.* 51. All patent (metopic ditto).
2. ♀ „ 51. Obliteration below stephanion and at obelion.
3. ♂ „ 51. „ „ „ „ „
4. ♀ „ 52. „ „ „ „ „
5. ♂ „ 52. „ „ „ only.
6. ♀ „ 52. „ „ „ and upper half lambdoid.
7. ♀ „ 53. „ „ „ and obelion and upper quarter of metopic.
8. ? „ 54. Obliteration below stephanion and at obelion.
9. ♀ „ 59. „ „ „ „ „
10. ♂ „ 59. All obliterated except coronal above stephanion.
11. ♀ „ 60. Obliteration at obelion only.
12. ♂ „ 60. „ below stephanion only.

In this decade it is still the usual thing to find the suture open except at the stephanion and obelion, but there is one example of their being completely unobliterated as far as the outside of the skull goes, and one of their being completely closed.

ECTOCRANIAL SUTURES. Between 60 and 70.

1. ♂ *æt.* 61. Obliteration complete in lambdoid and below stephanion ; coronal and sagittal feebly marked.
2. ♂ „ 61. Obliteration below stephanion, at obelion, and lambdoid in its upper quarter.
3. ♂ „ 61. Faint traces of all (including metopic) except stephanion and obelion.
4. ♂ „ 62. Obliteration complete except upper part of coronal (thick skull).
5. ♂ „ 62. Obliteration below stephanion and at obelion.
6. ♂ „ 63. „ „ „ posterior two-thirds of sagittal.
7. ♂ „ 63. „ „ „ and obelion.
8. ♀ „ 64. „ at lower two-thirds coronal, posterior half sagittal, and upper one-eighth lambdoid.
9. ♂ „ 65. Obliteration below stephanion and at obelion.
10. ♂ „ 67. „ „ „ and at upper part of coronal ; all sagittal and upper half of lambdoid.
11. ♂ „ 68. All obliterated, including parieto-mastoid.
12. ♂ „ 68. Obliteration below stephanion and upper part of coronal, obelion, and all lambdoid.
13. ♀ „ 69. Obliteration below stephanion and obelion.
14. ♀ „ 70. „ „ „ „ „ (lambdoid singularly patent).

15. ♂ *æ*t. 70. Obliteration at stephanion and upper part of coronal, all sagittal and upper half lambdoid.
16. ♂ „ 70. Sutures almost invisible, stephanion and obelion quite so.
17. ♂ „ 70. All obliterated except one-fifth coronal.
18. ♂ „ 70. Obliteration at obelion and upper and lower one-third of coronal.

In this decade a very marked increase in the obliteration of the sutures takes place, and it is exceptional to find only the stephanion and obelion obliterated. Where the sutures are visible they are usually very shallow, though this is difficult to indicate in a table.

ECTOCRANIAL SUTURES. OVER 70.

1. ♂ *æ*t. 71. Obliteration below stephanion and all sagittal.
2. ♀ „ 71. All patent.
3. ♀ „ 73. Upper half coronal, middle of sagittal, and lambdoid feebly marked, others obliterated.
4. ♀ „ 73. Faint trace of coronal just above stephanion, also of sagittal, others obliterated.
5. ♀ „ 73. Obliterated below stephanion, others patent.
6. ♀ „ 85. All obliterated except lambdoid just above asterion.

Nos. 2 and 5 are examples of how late the sutures sometimes are in becoming obliterated on the surface of the skull.

ENTOCRANIAL SUTURES. BELOW 30.

- 1 (1). ♂ *æ*t. 17. All patent.
- 2 (3). ♂ „ 18. „ „
- 3 (4). ♀ „ 19. „ „
- 4 (5). ♀ „ 25. „ „
- 5 (6). ♀ „ 26. „ „
- 6 (7). ♀ „ 27. „ „
- 7 (8). ♀ „ 27. „ „
- 8 (9). ♀ „ 30. „ „
- 9 (10). ♂ „ 30. Lower half coronal obliterated. Metopic obliterated.
- 10 (11). ♀ „ 30. All completely obliterated.

This record corresponds very closely with that of the ectocranial sutures below 30, but points to the fact that at this early age obliteration may be complete and, if it is present at all, is more advanced than on the outer surface.

ENTOCRANIAL SUTURES. Between 30 and 40.

- 1 (1). ♂ *æ*t. 31. Coronal obliterated in upper inch. Sagittal obliterated except close to lambdoid.

- 2 (2). ♂ *æ*t. 31. Coronal scarcely recognisable, slight obliteration at obelion.
 - 3 (3). ♀ „ 32. Coronal and sagittal obliterated.
 - 4 (4). ♂ „ 33. Coronal obliterated below stephanion and upper half, also posterior half sagittal.
 - 5 (5). ♂ „ 33. All obliterated.
 - 6 (6). ♂ „ 33. „ „
 - 7 (8). ♀ „ 34. Coronal obliterated in upper one-third, others patent.
 - 8 (9). ♂ „ 34. Coronal obliterated except at middle point; sagittal obliterated at middle.
 - 9 (11). ♀ „ 35. Obelion alone obliterated.
 - 10 (12). ♂ „ 36. Lower half coronal, posterior half sagittal, all lambdoid obliterated.
 - 11 (13). ♂ „ 37. Only obliterated below stephanion.
 - 12 (14). ♀ „ 38. Lower half coronal only obliterated.
 - 13 (15). ♂ „ 38. Only patent for 1 inch from lambdoid in all three directions.
 - 14 (16). ♂ „ 39. Only obliterated below stephanion.
 - 15 (17). ♀ „ 39. Coronal and sagittal quite obliterated. Lambdoid patent.
- In these fifteen skulls there is not one in which some obliteration has not occurred.

ENTOCRANIAL SUTURES. Between 40 and 50.

- 1 (1). ♂ *æ*t. 43. Posterior inch of sagittal and lambdoid patent (others, including metopic, obliterated).
- 2 (3). ♀ „ 44. All obliterated.
- 3 (4). ♂ „ 44. Lower two-thirds coronal and upper three-fourths lambdoid obliterated.
- 4 (5). ♂ „ 45. All obliterated except 1 inch from lambda in all three directions.
- 5 (6). ♂ „ 45. Lower three-fourths coronal obliterated.
- 6 (7). ♀ „ 45. Only lambdoid and middle of sagittal patent.
- 7 (8). ♂ „ 45. Stephanion and small part of middle of lambdoid obliterated.
- 8 (9). ♂ „ 45. Lower half coronal only obliterated.
- 9 (10). ♂ „ 46. Upper two-thirds coronal and upper quarter lambdoid alone patent.
- 10 (11). ♀ „ 47. All obliterated (stephanion and obelion faintly seen).
- 11 (12). ♀ „ 48. Sagittal, lower two-thirds coronal, and lower half metopic obliterated; lambdoid patent.
- 12 (13). ♀ „ 48. Only obliterated below stephanion.
- 13 (14). ♂ „ 49. Coronal, sagittal, and middle of lambdoid obliterated.
- 14 (15). ♂ „ 49. Obliterated for some distance near stephanion and obelion.

All these skulls show some obliteration internally, though there is only one in which it is complete.

ENTOCRANIAL SUTURES. Between 50 and 60.

- 1 (1). ♂ *æ*t. 51. Upper one and half inch coronal and metopic, anterior one and half inch sagittal patent (obliteration more complete on L. than on R).
- 2 (2). ♀ „ 51. All obliterated.
- 3 (4). ♀ „ 52. Sagittal alone patent except at obelion.
- 4 (5). ♀ „ 52. All obliterated.
- 5 (7). ♀ „ 53. „ „ except upper two-thirds lambdoid.
- 7 (9). ♀ „ 59. „ „
- 7 (10). ♂ „ 59. „ „
- 8 (11). ♀ „ 60. „ „ except posterior 2-inch sagittal and upper 1-inch lambdoid.

Complete obliteration is much more common in this decade, and complete patency is not found at all.

ENTOCRANIAL SUTURES. Between 60 and 70.

- 1 (1). ♂ *æ*t. 61. All obliterated.
- 2 (3). ♂ „ 61. „ „
- 3 (4). ♂ „ 62. „ „
- 4 (5). ♂ „ 62. „ „
- 5 (6). ♂ „ 63. „ „
- 6 (7). ♂ „ 63. „ „
- 7 (8). ♂ „ 64. „ „
- 8 (9). ♂ „ 65. „ „
- 9 (12). ♂ „ 68. „ „ (except posterior part sagittal).
- 10 (17). ♂ „ 70. „ „
- 11 (18). ♂ „ 70. „ „

In this decade the complete obliteration is very marked.

ENTOCRANIAL SUTURES. Over 70.

- 1 (1). ♂ *æ*t. 71. All obliterated.
- 2 (2). ♂ „ 71. „ „
- 3 (3). ♂ „ 73. „ „
- 4 (4). ♀ „ 73. „ „
- 5 (5). ♀ „ 73. „ „
- 6 (6). ♀ „ 85. „ „

This, with the last record, makes it evident that after 60 all the sutures inside the skull are obliterated.

CONCLUSIONS.

We quite agree with Dwight that closure of sutures may occur in a healthy skull before 30, though it is rare, and, for practical purposes, the absence of any internal obliteration would fix the probable age at less than 30.

Over 30 there is always a fair amount of obliteration of the coronal and sagittal sutures internally, while over 50 usually, and over 60 always, all the entocranial sutures are obliterated.

The ectocranial sutures are so variable that no estimate of age should be made from them when the inside of the skull can be looked at, and the fact that so few Museum skulls are opened detracts very much from the practical value of many of our great collections.

With regard to the place at which ossification usually begins, Dwight is doubtful whether it is below the stephanion or at the obelion, though he rather favours the latter place, and other authors seem divided in their opinions. Our own evidence makes us think that somewhere in the lower half of the entocranial aspect of the coronal suture obliteration usually commences, and that this is followed very rapidly by external obliteration of the same suture below the stephanion where the temporal ridge crosses it.

The sagittal suture seems to close internally about the region of the obelion, and soon afterwards at its anterior part, the posterior inch sometimes remaining patent after all the rest is obliterated. There can be no doubt that the accepted statement that the suture first closes externally at its simplest part, *i.e.*, at the obelion, is correct, though this is subsequent to the internal appearance of obliteration, and is often delayed till old age is reached. Picozzo says that in the male the obelion first closes, and in the female the middle of the sagittal suture, but if he is referring to the outside of the skull all our evidence goes against this statement as far as females are concerned.

The lambdoid suture closes later than the coronal and sagittal as a rule; this we are not surprised to find, when we remember its markedly serrated appearance. As far as the three sutures with which we have already dealt are concerned, the rule seems to be that the simpler the suture the earlier its closure, and this holds good with the speno-parietal and speno-frontal sutures, which are always closed when closure has occurred beneath the stephanion, though it does not apply to the squamous suture, which closes very late, if at all. Taking the entocranial closure of the lambdoid, we find that, out of twenty-six skulls below 40, it is only closed in five. After 40 closure is more usual, and a careful review of our records makes us believe that obliteration generally begins about midway between the lambda and the occipito-mastoid articulation, and that the upper part near the lambda closes last. On the outside of the skull the closure of this suture is later, and the upper part is often the earliest to close, thus bearing out Dwight's contention that the ecto and entocranial points of obliteration do not necessarily correspond. We have no evidence, on the other hand, that Dwight's statement that, when the

sutures close late, the lambdoid is usually in advance of the coronal ectocranially, is correct.

In our eighty-two skulls six showed signs of a metopic suture, and the evidence of this small number shows that, as in other sutures, entocranial precedes ectocranial closure. Apparently internal obliteration begins at the lower part. It is sometimes taught, though we are unable to trace the statement to its source, that when the metopic suture fails to close at its usual time it is the last of all to be obliterated. Our records, as far as they go, do not induce us to place much reliance on this.

With regard to the side on which closure first begins, Sauvage ("Sur l'état sénile du Crane," *Bulletin de la Soc. d'Anthropologie*, Paris, 1870) says that both in the coronal and lambdoid sutures the right closes before the left. In our records there are only two in which the obliteration has been caught in a unilateral condition, and in both these it is the left side on which it is commencing. We are in agreement with Picozzo that male skulls are obliterated somewhat earlier than female.