

Gaining Closure: Do Cranial Sutures Fuse at Reported Age Ranges?

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INTRODUCTION

Within the craniostenosis literature, it is accepted as dogma that cranial sutures achieve complete fusion in early adulthood.¹⁻⁵ Numerous book chapters, academic articles, and patient educational resources reiterate this teaching, commonly stating that the metopic suture achieves total fusion by the second year of life, whereas the remaining sagittal, coronal, squamosal, and lambdoid sutures close between the fourth and fifth decades of life. Despite this, our anecdotal experience reviewing head computed tomography (CT) scans suggests that patients maintain patent cranial sutures much further into adulthood than expected. Herein, we sought to quantify our experience by analyzing the frequency and extent of cranial suture fusion across each decade of life.

We conducted an institutional review board-approved retrospective study examining three-dimensionally reconstructed head CT scans performed between 2017 and 2022 at a tertiary academic medical center. Beginning at age 18, five male and female patients from each decade of life were included. Inclusion criteria required CT imaging of the head for nontraumatic indications. Patients with any history of bony craniofacial trauma or surgery were excluded. The metopic, sagittal, coronal, squamosal, and lambdoid sutures from each scan were graded on a scale of 0 to 4 according to the following scheme: grade 0 (open), grade 1 (1%–33% fused), grade 2 (34%–66% fused), grade 3 (67%–99% fused), and grade 4 (completely obliterated). Mean closure grades from each decade were compared with timeframes reported in the literature for suture fusion.

Among 85 patients with CT imaging of the head, 77 met inclusion criteria. The cohort was equally divided by gender (women 39/77, 50.6%), and the mean age was 61.7±25.7 years. Nearly all patients across each age group demonstrated complete synostosis (grade 4) of

the metopic suture (72/77, 93.5%). Complete absence of the remaining sutures was significantly less frequent, with greatest occurrence among the sagittal suture (5/77, 6.5%), followed by the squamosal (9/154, 5.8%) and coronal sutures (4/154, 2.6%). In only one patient, total closure of a single lambdoid suture was achieved (1/154, 0.65%). For the few patients with complete fusion of these sutures, the mean ages were 73.6±27.7 (sagittal), 64.3±21.2 (squamosal), 91.3±12.3 (coronal), and 63.0 (n = 1, lambdoid). The mean closure grades across decade of life by suture type are summarized in Table 1. Apart from the squamosal sutures, the remaining cranial sutures demonstrated greater degree of closure with each increasing decade of life (Fig. 1).

Current craniostenosis pedagogy suggests that cranial sutures completely fuse in early adulthood.¹⁻⁵ Our findings challenge this teaching, suggesting that reported time intervals of suture loss are inaccurate. Although there is an association between increasing adult age and gradual closure of the sagittal, coronal, and lambdoid sutures, complete obliteration of these sutures rarely occurs. Even in patients aged 100 or older, most sutures apart from the metopic remained patent. Our results thereby question the previous pedagogy of cranial suture biology. Additional study is necessary to examine the complex factors contributing to both age-related and pathologic cranial suture fusion.

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DISCLOSURE

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Table 1. Mean Age and Closure Grade by Decade of Life and Skull Suture

Decade of life	Mean Age ± SD (y)	Closure Grade							
		Metopic	Sagittal	R Coronal	L Coronal	R Squamous	L Squamous	R Lambdoid	L Lambdoid
18–29	21.9±3.1	4.0	0.8	1.0	0.8	1.4	2.0	0.4	0.7
30–39	34.4±3.9	3.6	0.1	0.2	0.1	0.9	1.2	0.3	0.3
40–49	43.3±2.8	3.6	0.7	0.3	0.2	1.6	1.8	0.2	0.4
50–59	52.9±3.3	4.0	0.4	0.4	0.4	1.3	1.6	0.4	0.4
60–69	64.1±2.7	4.0	1.1	0.6	0.5	1.5	1.6	0.9	0.9
70–79	74.9±3.4	4.0	1.3	0.8	0.6	1.9	1.6	1.0	0.8
80–89	86.1±2.6	3.3	1.1	1.0	0.9	0.8	0.7	0.7	0.7
90–99	93.3±3.0	3.9	1.2	1.2	1.0	0.7	1.6	0.4	0.4
100–109	101±1.4	4.0	1.6	1.8	1.4	0.6	1.2	1.0	0.8
Overall Cohort (n = 77)	61.7±25.7	3.78±0.27	0.88±0.46	0.78±0.49	0.63±0.40	1.20±0.45	1.47±0.38	0.58±0.29	0.59±0.19

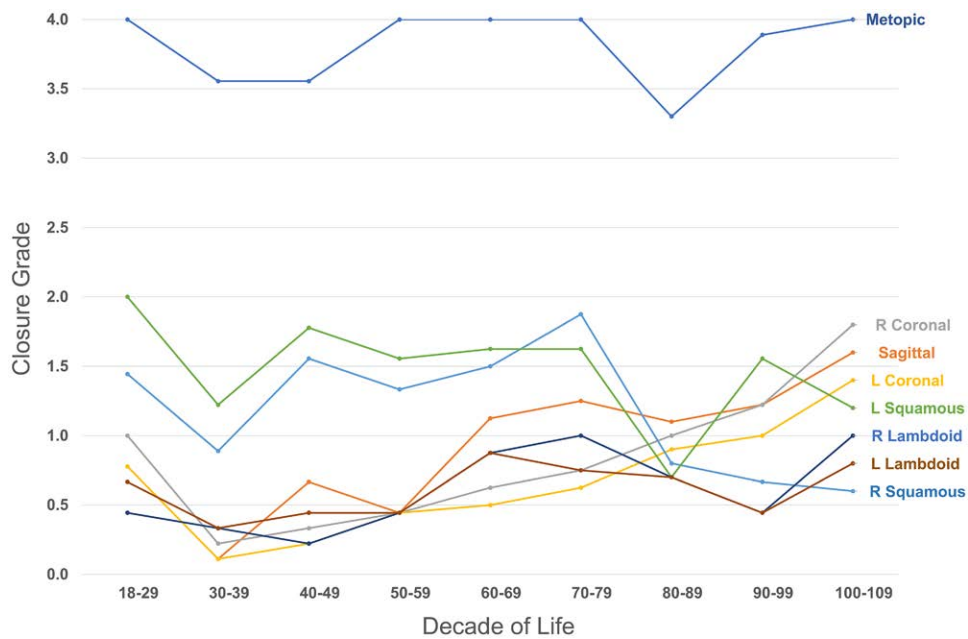


Fig. 1. Mean closure grade for major cranial sutures plotted by decade of life. Note that the metopic suture is the only suture approximating complete fusion grade 4 across each age group, whereas the remaining sutures remain patent.