

Tear Duct Size Differences of Age, Sex and Race

RICHARD H. POST

*Department of Human Genetics, University of Michigan Medical School,
Ann Arbor, Michigan*

ABSTRACT Measurements of the external opening of the tear duct (naso-lachrymal canal) of skulls of American colored males and white males indicate larger apertures among the former at corresponding ages. Duct length is somewhat shorter among colored males. In both racial samples the older skulls have slightly larger apertures than those under 40. A sample of white female skulls corroborates this, and manifests smaller average size than the white male skulls at ages below 50 whereas older skulls reveal no sex difference. The race difference in aperture size among male skulls is highly significant statistically and may reflect ecological adaptation.

Dacryocystitis (inflammation of the nasolachrymal canal, or tear duct) is associated with stenosis of the tear duct (Garfin, '42; Schaeffer, '20). Its rarity among Negroes, contrasted with prevalently high frequencies among whites, suggests that some of the normal racial differences in skull morphology may rank among the underlying factors which produce differential predisposition to the disease. The incidence of dacryocystitis at some time of life among white London clinic samples has run at about 3% (Traquair, '41, page 165; Dalglish, '64). It is almost unknown among American colored patients (Santos Fernandez, '21; Garfin, '42). There is no sex difference in frequency prior to the menopause, following which female cases become considerably more numerous, about 5 to 1 (Traquair, '41, page 166; Tyrrell, '47; Stallard, '65, page 280), which is often attributed to mucosal shrinkage. Evidence for genetic basis has been reported by Schnyder ('20), Traquair ('41), Sorsby ('51, page 196 and '53, page 367), Viers ('55, page 73), Waardenburg ('61, part 6, chapter 4, page 295-297) and others. Since chronic dacryocystitis may lead to and augment infection in several other regions (nose, sinuses, throat, eustachian tube) it would seem plausible that tear duct size has been subject to natural selection, prior to the era of modern therapy.

The tear ducts of Negroes are typically shorter, larger in diameter and straighter in their course than those of whites, according to Martin ('28, Vol. I, page 970).

Without entering the controversy of the relationship between duct obstruction and disease as to which is cause and which is effect (Schaeffer, '20), and with no consideration of socioeconomic or any other environmental explanations of the apparently marked differences in morbidity between these races, the present study has been aimed only to look into Martin's statements, which are not substantiated by data. The study is limited to comparisons between samples of skulls of American colored ("Negro") male and white male and female skulls of known age, in measurements of (A) area in cross section of the external opening; and (B) length of the canal.

MATERIAL AND PROCEDURE

Macerated skeletons of the Terry Collection of Washington University Medical School, St. Louis,¹ were made available through the kindness of Professor Mildred Trotter. The age at death, sex and race of each skull was taken from carded records. Neolithic skulls were examined in five European museums, classified for age and sex by the author.

Size of the external aperture of the canal was estimated by comparison with a series of holes in a metal sheet, standardized for measuring the sizes of knitting needles. This method is more quick and accurate than measurement by sliding caliper. Classification categories are in terms of square millimeters of cross sectional area of each hole, rather than diameter.

¹ The Terry Collection is presently in the U. S. National Museum, Washington, D.C.

Length of the canal was measured with a flexible wire bent at right angles at the tip end to form a projection or elbow about 0.5 mm long, which was inserted into the canal and hooked against the bottom of the inferior nasal concha at the point giving the minimal measurement. The length of wire left projecting above the aperture was then measured and subtracted from the total length, the difference being the length of the canal. Care must be taken to ascertain that the concha is intact. This is not a satisfactory measurement, and no improvement in technique could make it so, since it is largely a reflection of the length or size of the concha.

In order to avoid unconscious bias toward the expected results of the investigation — the larger canals of males contrasted with females, and the greater diameter but shorter length of the canals of American colored compared with those of whites — the assistant presented the observer with each successive skull face downwards, drawn at random from each collection, which was well shuffled as to sex, race and age. The observer deliberately tried to avoid looking at the telltale signs of these three variables, but if he inadvertently noted one, the skull was reshuffled.

The Washington University skulls of each sex are reported in two groups by age: "younger" (adults under 49) and "older" (60 and over). Since female skulls of the white race are few, those of ages 50-59 are also reported. Female colored skulls are not reported since very few are available in the collection. Neolithic skulls are not grouped by age since the estimates of age are not considered sufficiently reliable.

RESULTS

(A) Size of right external opening, or lumen, in units of square millimeters of area of cross-section of the superior aperture

Results are reported in tables 1 and 2. Measurements are shown for the right side only, since they are almost identical with those of the left side, yet the two cannot be pooled without making corrections for correlation, which would be laborious.

The "older" age groups have larger apertures than the corresponding "younger" within each of the three comparisons — white females, American colored males and white males. The first and second of these differences are significant near the 0.01 level, i.e., for American colored males and white females; that for white males is not significant at the 0.05 level.

Males have larger apertures than females in all three comparisons, but the differences are not statistically significant among the Neolithic skulls, nor the "older" whites, and are significant at only the 2% level for the "younger" whites.

American colored males have larger duct apertures than white males, in racial comparisons of either "younger" or "older" age groups, the former being significant at the 0.001 level and the latter, well below it.

(B) Length of the canal

Many canals could not be measured on one side, some on neither side, due to broken conchae. This diminished the numbers, and frequently caused a substantial difference in mean result between left and

TABLE 1
Size of tear duct

	N	Duct, cross section (square millimeters)		Average age
		\bar{x}	σ	
Female, white, X-49	31	13.00	3.63	39.6
Female, neolithic	52	14.28	3.94	
Female, white, 50-59	35	14.79	4.55	54.0
Male, white, X-49	96	15.18	4.67	40.5
Female, white, 60-X	23	15.83	4.62	62.6
Male, neolithic	80	16.01	4.97	
Male, white, 60-X	96	16.62	5.26	69.4
Male, Negro, X-49	110	17.68	5.43	29.5
Male, Negro, 60-X	70	19.93	5.66	65.8

TABLE 2

Difference of age, sex and race in size of tear duct. Significance of each difference is estimated by Student t-test

	$\bar{x}_1 - \bar{x}_2$	t	Approx. P	Age difference
Age: "older" skulls' ducts are larger than "younger" skulls'				
Negro males	2.25	2.67	< 0.02	36.3
White females	2.83	2.52	0.01	23.0
White males	1.44	—	—	28.9
Sex: males' ducts are larger than females'				
"Younger" whites	2.18	2.38	0.02	0.9 ¹
Neolithics	1.73	1.20	> 0.05	
"Older" whites	0.79	—	—	6.8 ¹
Race: Negroes' ducts are larger than whites'				
"Older" males	3.31	4.36	< 0.001	3.6 ²
"Younger" males	2.50	3.24	0.001	11.0 ²

¹ Males older than females.

² Whites older than Negroes (American colored).

right sides. Therefore the results are here presented for both sides (table 3).

Age differences are consistent in five of the six comparisons, the older skulls having slightly shorter canals, but the differences are not of statistical significance.

Female skulls' canals are shorter than males' in comparisons within both younger and older samples, lefts and rights, all four differences being significant at the 4% level or better.

American colored canals are shorter than those of whites by substantial margins in both age groups of males.

The differences between the means of corresponding pairs of subsamples are shown in table 4.

DISCUSSION AND CONCLUSION

The larger lumen of older age groups' canals contrasted with younger is impressive in two of the comparisons — American colored males and white females — and appreciable in white males. While the numbers are too small to justify subdivision of age groups, they suggest that the increase in size of the lumen is progressive after the fifth decade. The decreased length in older ages, while limited to the right side and too small to be significant statistically, may nevertheless be real. It may be attributed to the bone absorption typical of later years.

The sex differences in the canal size might appear more closely associated with overall sex differences in skull size than with

lachrymal function, since there is little difference between males and females in the size of the orbit and thus, one might presume, little difference in the volume of lachrymal secretion. The smaller canals of females parallels their higher rates of dacryocystitis, which in turn suggests that the risks of infection may be inversely associated with lumen size.

The larger and shorter canals of both younger and older American colored male samples in contrast with white males are pronounced. They are minimal reflections of race differences, considering the substantial white ancestry of the American colored population. They fully confirm the assertions of Martin ('28). And they pose a number of questions. The shorter length of the American colored canals may be purely an anatomical correlate with the Negroes' shorter face, although this suggestion cannot be pursued here since facial length was not measured. But the larger lumen of the American colored ducts is strongly suggestive of adaptation. Is it associated with greater tear flow? Is it an adaptation to a warmer and/or more humid environment? Is it associated with their larger nares, either anatomically or physiologically, or both? Since the lachrymal discharge into the nares provides an important supplement to the secretions of the nasal mucosa, a larger volume of discharge might be an adaptation to the Negro environment of the past.

TABLE 3
Length of tear duct

	Left			Right		
	N	\bar{x}	σ	N	\bar{x}	σ
Negro males, 60+	67	14.66	2.00	58	14.43	2.07
Negro males, X-49	102	14.80	2.24	86	15.07	1.99
White females, 60+	47	15.13	1.53	47	14.87	1.50
White females, X-49	30	15.13	1.48	30	15.17	1.68
White males, 60+	85	16.06	1.91	77	15.64	2.25
White males, X-49	93	16.12	2.27	81	16.27	2.21

TABLE 4
Differences of age, sex and race in length of tear duct. Significance of each difference is estimated by Student t-test

	Left			Right		
	$\bar{x}_1 - \bar{x}_2$	t	P	$\bar{x}_1 - \bar{x}_2$	t	P
Age: "older" skulls have shorter ducts than "younger"						
Negro males	0.14	—	—	0.64	—	—
White males	0.06	—	—	0.63	—	—
White females	0.00	—	—	0.30	—	—
Sex: Female skulls have shorter ducts than males'						
"Older" whites	0.93	2.86	< 0.01	0.77	2.09	< 0.04
"Younger" whites	0.99	2.23	< 0.03	1.10	2.47	< 0.02
Race: Negroes' skulls have shorter ducts than whites'						
"Younger" males	1.32	4.08	< 0.001	1.20	3.68	< 0.001
"Older" males	1.40	4.40	< 0.001	1.21	3.21	0.001

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