Hair Follicle Counts in Thai Population: A Study on the Vertex Scalp Area

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Objective: *To assess the normal value of the hair follicle counts in a 4-mm punch biopsy on the vertex scalp area from the Thai population. To compare the hair follicle count in the present study with those in previous described reports.*
Material and Method: *Twenty autopsy patients of clinically normal scalp were obtained for study from the Department of Forensic Medicine, Siriraj Hospital, Mahidol University. A 4-mm punch biopsy was performed on each patient on the vertex area of the scalp and, subsequently, horizontally bisected at the level of 1 mm below the skin surface and studied by hematoxylin-eosin staining. The total number of hair follicles, the phase of each hair follicle in a normal hair cycle, the number of terminal hairs, intermediate hairs, vellus hairs, and hair follicular unit were also included in this study and compared to those in previously described reports.*
Results: *Of our 20 studied cases, the mean numbers of total hair follicle counts, terminal, intermediate, and vellus hair follicles were 28.3±9.2, 16.5±8.4, 5.0±4.6, and 6.9±7.0 respectively. The density of hair follicles in our study was statistically less than those found in Caucasians (p-value = 0.002) but more than those in African-Americans (p-value = 0.004) and in Koreans (p-value <0.001).*
Conclusion: *Data collected from previous publications provided only the number of hair follicles in other ethnic groups, but not from the Thai population. The number of hair follicles described in those studies may be unreliable and invalid in the interpretation of scalp biopsies in alopecia Thai patients. They may lead to a misdiagnosis of the disease. The density of hair follicles in Caucasians, African-Americans, Koreans, and Thai population were authentically different according to their ethnic backgrounds. This is important because the number of hair follicles should be considered when a pathologist evaluates the scalp biopsy specimens of alopecia patients.*

Keywords: *Hair follicle counts, Vertex, Thai population*

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Patients with alopecia have become a daily concern in the outpatient clinic in the department of Dermatology, Siriraj Hospital, Mahidol University. In general, hair loss or alopecia can simply be classified as scarring and non-scarring alopecia and this disease usually necessitates scalp biopsy to accomplish an accurate diagnosis. The meager previously published reports stated the ethnic differences in hair density in African-Americans, Caucasians, and Koreans[1,2]. Although the Thai population is an ethnic in relative proximity to the Koreans as described by Lee[2], we are uncertain whether the hair follicle parameters in Koreans can be considered with certainty in the interpretation of scalp biopsies in Thai alopecia patients. This present study aims to explore the mean number of the total hair follicles, the amount of terminal hairs, intermediate hairs, vellus hairs, and the number of hair follicular units. These numbers will be presumed as the "normalcy" that every pathologist should consider in the interpretation and evaluation of a scalp biopsy to ascertain the causes of hair loss in Thai alopecia patients.

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Material and Method

This study was approved by the Siriraj Ethics Committee. A 4-mm punch biopsy was performed on the vertex area of each autopsy patient in the Department of Forensic Medicine, Siriraj Hospital, Mahidol University. Demographic information

(patient's age, race, sex) were recorded. Although there are no relevant literatures about the exact time autolysis in hair follicles happens after a patient is deceased, we found that the hair follicle structures were well-preserved and showed no autolytic change eight hours after death. Therefore, we used this 8-hour period as exclusion criteria.

Inclusion criteria

Cadavers grossly showing regular distribution of hair density in the vertex area were included in the study.

Exclusion criteria

The following cadavers were excluded from the study, unknown age, death of more than 8 hours, cadavers with known systemic diseases that may affect the hair follicles i.e. connective tissue diseases, lupus erythematosus, etc., cadavers with abnormal clinical scalp findings, i.e. skin infection, scar, or evidences of inflammation (substantial perifollicular inflammation or perifollicular fibrosis), and cadavers possessing non-infectious hair diseases that will affect the scalp hair density such as alopecia areata, trichotillomania, or telogen effluvium.

The biopsy specimens were sectioned horizontally 1 mm below the skin surface, a standard regimen described by Whiting[3], and applied for hematoxylin-eosin staining. At least 12 sectioning were studied on both sides of the specimen. Step sectioning were frequently necessary when there were tissue artifacts or loss of some hair shafts inside the follicular canals, separate variance, i.e. the number, size (terminal, intermediate, vellus), and phase (anagen, catagen, telogen) of the hair follicles as well as hair follicular units at various levels (infundibular, isthmus, suprabulbar portion) were evaluated (Fig. 1A, 1B, 2A, 2B) whereas Masson-Trichrome staining was sometimes useful to visualize the hair follicular units. Comparison to previous reports in Caucasians, African Americans, and Koreans[1,2] was performed. The statistical differences in the numbers of hair follicle counts between our study and those in previous studies were determined by using the t-test. All statistical tests were considered significant at p-value <0.05.

Results

According to Sperling and Whiting[1,3,4], hair density in both sexes and in his three different age-groups showed no statistical differences. In the present study, cadavers of both sexes and of all age groups were evaluated together. Table 1 showed the results of our study from 4-mm punch scalp biopsy specimens from clinically normal vertex areas. The summarization of hair follicle counts are shown in Table 1 and compared to those in previous reports in Caucasian, African-Americans, and Koreans Asians in Table 2. The age of the patients in the present study was between 28 and 93 years. The number of total hair count varied from 17 to 47 (mean 28.3±9.2), terminal hair follicles, 0 to 32 (means 16.5±8.4), intermediate hair follicles, 0 to 18 (means 5.0±4.6), vellus hair follicles, 0 to 30 (means 6.9±7.0), hair follicular units,

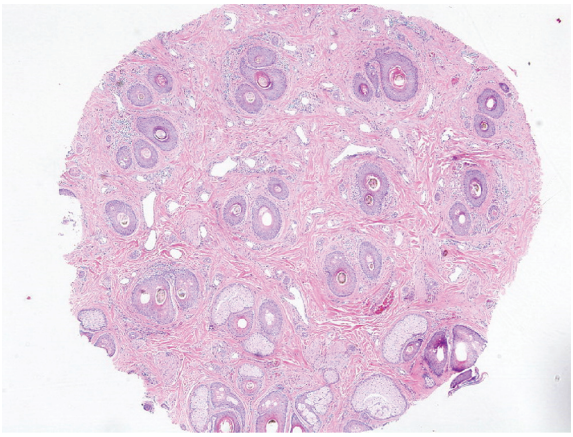

Fig. 1A A 4-mm punch biopsy from the vertex scalp area, horizontal study. At this level of about infundibulum, every hair follicles are visualized and arrangement of pilosebaceous structures into "hair follicular units" are appreciated.

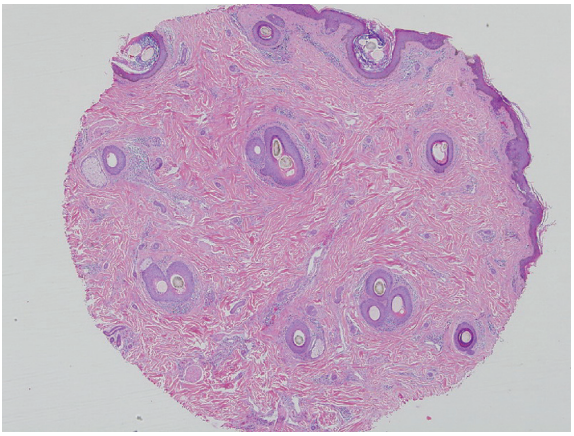

Fig. 1B A 4-mm punch biopsy from the vertex scalp area, horizontal study from another patient. The amount of the hair follicles and hair follicular units are less than those in Fig. 1A.

7 to 17 (means 10.7±2.6), and each hair follicular unit contained 1.7 to 3.9 hair follicles (means 2.6±0.6) (Fig. 2A, 2B). The ratio of terminal: intermediate + vellus hair follicles was between 0 and 6.7 (means 2.5±1.9) (Table 1).

Table 2 demonstrates the numbers of hair follicles in this present study compared to those in Caucasians, African-Americans, and Koreans[1,2]. The statistically significant value was justified by p-value <0.05. The mean number of hair follicles in Thais (28.3±9.2) was significantly less than those in Caucasians (35.5±5.5, p-value = 0.002) but more than those in African Americans (21.4±5.0, p-value = 0.004) and in Koreans (16.1±3.6, p-value <0.001).

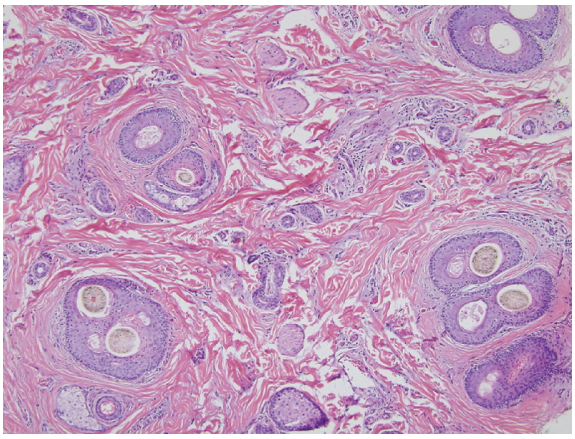

Fig. 2A A 4-mm punch biopsy from the vertex scalp area, horizontal study about the level of isthmus. There are 4 hair follicular units in which contain 2-3 hair follicles.

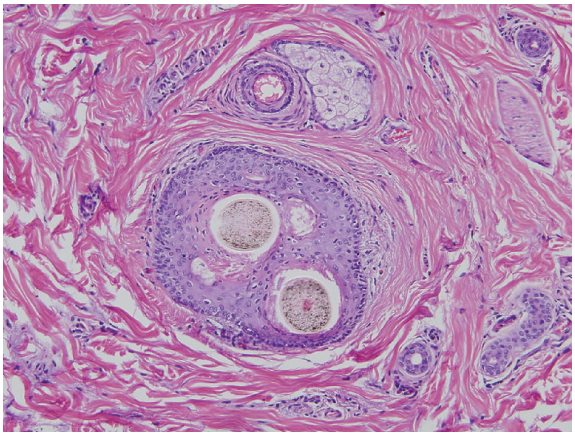

Fig. 2B Higher magnificatiion of Fig. 2A. This hair follicular unit contain 2 terminal hairs, defined by a hair shaft diameter that is 0.06 mm or greater and 1 vellus hair, a hair shaft diameter that is equal to or less than the thickness of the inner root sheath, 0.03 mm or less (top).

Discussion

A horizontal study of a 4-mm punch scalp biopsy, firstly proposed by Headington[5], was the standard method. It had more advantages than the traditional vertical study[1,3-10] in the determination of hair follicular structures. They were classified as anagen, catagen, and telogen hair follicles in the normal hair cycle and as terminal, intermediate, and vellus hair follicles according to their hair shaft size. As an example, the size of hair shaft of more than 0.06 mm was classified as terminal hair follicle, 0.03 to 0.06 mm as intermediate hair follicle, and less than 0.03 as vellus hair follicle[3,5]. The hair density or the amount of hair follicles inside the sections as well as hair follicular units was also recorded. The quantitative determination of all follicular structures described above is very necessary for any pathologists desiring to be knowledgeable in the interpretation of the scalp biopsy and be able to assess the appropriate diagnosis of alopecia patients. As performed in the present study, horizontal or transverse sectioning of the biopsy specimens provided not only the accurate amount of hair follicles but also the size (terminal, intermediate, and vellus hair follicles) and the phases of the hair follicle (anagen, catagen, and telogen hair follicles) in a normal hair cycle.

Meager data about the density of hair follicles had been reported in the past. Sperling determined the hair density by the horizontal study of the punch scalp biopsy of clinically healthy scalp skin in 22 African-Americans and 12 Caucasian patients, but these were not site-specific. He compared the numbers of the hair follicles in both ethnic groups[1]. In contrast, the studies of specific scalp areas had been reported as occiput of the scalp by Lee[2] and vertex by Whiting[3]. As shown in Table 2, the mean number of the total hair follicles in our study (28.3±9.2) was statistically less than those in Caucasian but more than those in African-Americans (21.4±5.0, p-value = 0.004) and in Koreans (16.1±3.6, p-value <0.001). Although our present study was of limited cases (n = 20), it possessed statistically significant value as p-value for the standard t-test <0.05 and for the One-Sample Kolmogorov-Smirnov test = 0.679 (Table 2). Finally, the authors were uncertain whether the hair density in the different areas of the human scalp is equally distributed. Therefore, the density of the hair follicles at vertex area may be different from those at occiput

Table 1. Hair counts from 4-mm horizontal vertex punch biopsy specimens in Thais

Subject No.	Sex	Age	Vellus hairs	Intermediate hairs	Terminal hairs	Total hairs	Follicular units	Terminal hairs/vellus + intermediate hairs	Total hairs/ follicular units
1	F	73	9	8	29	46	17	1.71	2.71
2	M	37	4	1	21	26	11	4.20	2.36
3	F	44	12	3	32	47	14	2.13	3.36
4	M	48	6	5	11	22	9	1.00	2.44
5	M	46	2	3	22	27	10	4.40	2.70
6	M	58	5	18	15	38	12	0.65	3.17
7	M	52	30	9	1	40	15	0.03	2.67
8	M	60	6	2	17	25	10	2.13	2.50
9	M	47	3	2	14	19	8	2.80	2.38
10	M	93	8	1	22	31	8	2.44	3.88
11	M	74	3	11	10	24	11	0.71	2.18
12	M	28	0	3	20	23	9	6.67	2.56
13	M	52	2	4	22	28	9	3.67	3.11
14	M	50	8	9	5	22	12	0.29	1.83
15	F	71	2	1	16	19	11	5.33	1.73
16	F	35	2	2	17	21	7	4.25	3.00
17	M	72	19	4	16	39	10	0.70	3.90
18	M	65	4	0	13	17	8	3.25	2.13
19	M	48	8	11	0	19	9	0.00	2.11
20	M	48	4	2	26	32	14	4.33	2.29
Mean (SD)		55.1 (15.8)	6.9 (7.0)	5.0 (4.6)	16.5 (8.4)	28.3 (9.2)	10.7 (2.6)	2.5 (1.9)	2.6 (0.6)
(Min, max)		(28, 93)	(0, 30)	(0, 18)	(0, 32)	(17, 47)	(7, 17)	(0, 6.7)	(1.7, 3.9)

M = male; F = female

Table 2. Comparison of hair counts between Thais, Asians (Koreans), Blacks (African-American) and Whites

	Total hairs	p-value[#]
Thais	28.3 (9.2)	
Asians (Koreans)	16.1 (3.6)	<0.001*
Blacks (African-Americans)	21.4 (5.0)	0.004*
Whites	35.5 (5.5)	0.002*

Data expressed as mean (standard deviation)

[#] p-value for the comparisons between each of the previous published data and this study (Thais) were analyzed by t-test

* Statistically significant at p-value <0.05

or temporal area, etc. In the authors opinion, the density of hair follicles in our study could be correlated with certainty with those of Whiting[3] who studied the vertex, the same area as the present study, and reciprocal to those of Lee[2] whose study was performed on the occiput area of the scalp. The present study was a pilot study. Further studies to discover the actual amount of the hair follicles on different areas of the scalp should follow.

Conclusion

A horizontal study of a 4-mm punch scalp biopsy is the gold standard for both the pathologists and dermatopathologists to ascertain hair density in alopecia patients. This method not only provided the advantages of a better determination of the number and the size of the hair follicle but also the phases of the hair follicle in a normal hair cycle. Quantitative determination of "normalcy" of the number of hair follicles on any given scalp areas is very important for the pathologists to evaluate the causes of hair loss in

alopecia patients. The authors performed a scalp biopsy on the vertex area and, in our opinion, the number of hair follicles counted in our study were reliable only when the punch biopsy was taken from the vertex, but probably not analogous to the other scalp areas, e.g. frontal, occiput, or temporal area. Further studies to comprehend the amount of hair follicle on different areas of the scalp as compared to those of the vertex are necessary to elucidate this problem.

Potential conflicts of interest

None.

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การศึกษาจำนวนของเส้นผมจากบริเวณกระหม่อมในประชากรไทย

ปฐมพงศ์ ย่าพรหม, เจน มโนนุกุล, วชิรา สนธิไชย, จุฬาภรณ์ พูลเอี่ยม, สุภาวรรณ เศรษฐบรรจง

วัตถุประสงค์: *เพื่อประเมินจำนวนเส้นผมจากหนังศีรษะบริเวณกระหม่อมโดยวิธีการเจาะชิ้นเนื้อ (punch biopsy) ขนาด 4 มม. เพื่อเปรียบเทียบจำนวนเส้นผมในประชากรไทยกับงานศึกษาอื่น ๆ ที่มีการศึกษาก่อนหน้านี้*

วัสดุและวิธีการ: *ทำการศึกษาจากศพที่ได้รับการชันสูตรจากภาควิชานิติเวช โรงพยาบาลศิริราช จำนวน 20 ศพ โดยวิธีการเจาะชิ้นเนื้อขนาด 4 มม. จากหนังศีรษะบริเวณกระหม่อม แล้วนำมาศึกษาโดยวิธีตัดขวาง (horizontally study) จากด้านบนของผิวหนังลงมา 1 มม. และนำมาศึกษาโดยการย้อมสี hematoxylin-eosin และนับจำนวนเส้นผมทั้งหมด (total hair follicle count จำนวนยูนิตของเส้นผม (hair follicular unit) จำนวนเส้นผมขนาดใหญ่ (terminal hair) ขนาดกลาง (intermediate hair) และขนาดเล็ก (vellus hair) แล้วจึงนำมาเปรียบเทียบกับงานวิจัยอื่นที่ผ่านมา*

ผลการศึกษา: *พบว่าจำนวนเฉลี่ยของเส้นผมทั้งหมด 28.3±9.2 ประกอบด้วยเส้นผมขนาดใหญ่ 16.5±8.4 เส้นผมขนาดกลาง 5.0±4.6 และเส้นผมขนาดเล็ก 6.9±7.0 และพบว่าจำนวนเส้นผมทั้งหมดในประชากรไทยน้อยกว่าในประชากรผิวขาว (p-value = 0.002) แต่มากกว่าในประชากรผิวดำ (African-American) (p-value = 0.004) และในประชากรเกาหลี (p-value <0.001)*

สรุป: *จำนวนเส้นผมในประชากรผิวขาว ผิวดำ เกาหลี และไทย แตกต่างกันตามเชื้อชาติ ซึ่งพยาธิแพทย์จำเป็นต้องพิจารณาจำนวนของเส้นผมดังกล่าวทุกครั้งในการแปลผลชิ้นเนื้อจากการเจาะ (punch biopsy) ในผู้ป่วยที่มีปัญหาเส้นผมลดลงหรือไม่มีเส้นผม (alopecia) และจำนวนเส้นผมทั้งหมดในประชากรผิวขาว ผิวดำ และเกาหลี อาจไม่เท่ากันกับประชากรไทย และอาจส่งผลทำให้การวินิจฉัยผิดพลาดได้*