The oracle of old made it the top of wisdom to know oneself but did not fix credit to that fragment of self knowledge which enables a man to keep count of his own pulse.

—P. M. Latham, Collected Aphorisms, Edited by William B. Bean, Iowa City, Prairie Press, 1962

Nail Growth

A Twenty-Year Study

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Divide your attentions equally between books and men. The strength of the student of books is to sit still—two or three hours at a stretch—eating the heart out of a subject with pencil and note-book in hand, determined to master the details and intricacies, focusing all your energies on its difficulties. Get accustomed to test all sorts of book problems and statements for yourself, and take as little as possible on trust. The Hunterian "Do not think, but try" attitude of mind is the important one to cultivate. The question came up one day, when discussing the grooves left on the nails after fever, how long it took for the nail to grow out, from root to edge. A majority of the class had no further interest; a few looked it up in books; two men marked their nails at the root with nitrate of silver, and a few months later had positive knowledge on the subject. They showed the proper spirit. The little points that come up in your reading try to test for yourselves.

—W. Osler, The Student Life

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Osler's comments about students who do something when it is suggested to them or when they read and get an idea launched me on this study, but only after I had read his remark several times. I report here the second chapter—ten more years of monthly observations on nail growth. In the first paper I reviewed my data collected by a simple method for observing the rate of growth of my left thumbnail throughout a ten-year period between the ages of 32 and 42. My purpose now is to record the extension of these observations for the next decade, to comment about the secular changes in the rate of growth associated with aging, to comment on various methods of photographing and recording the growth of the nail, and to discuss other work in this field.

Method

Though the rate of fingernail growth may be measured in many ways, my method was simplicity itself. I used a file commonly employed to open small glass vials to score the base of the nail transversely where it emerges from under the cuticle. This was done on the first day of every month. A progression of the marks on the nail was observed as growth took place. The end of the growing time was noted each time the mark reached the place where the nail grew free from its bed at the distal end. The distance from the scored mark to the free edge was exactly 1.45 cm. No change in the dimensions of the nailbed have been observed over the 20-year period. Care was taken not to manipulate the cuticle.

During the latter phase of the study photographs were taken at weekly intervals. By suitable magnification detailed measurements of growth for short periods could be followed. Another point of reference was needed in the photographs because of slight variation in the connection between the nail and the nailbed at the free margin. Therefore, a small spot was tattooed in the skin at the base of the nail.

In an effort to get precision in the photography Mr. Jack Davis devised a small wooden frame into which the thumb fit snugly with the camera fixed on a rack so that focal distance and other variables

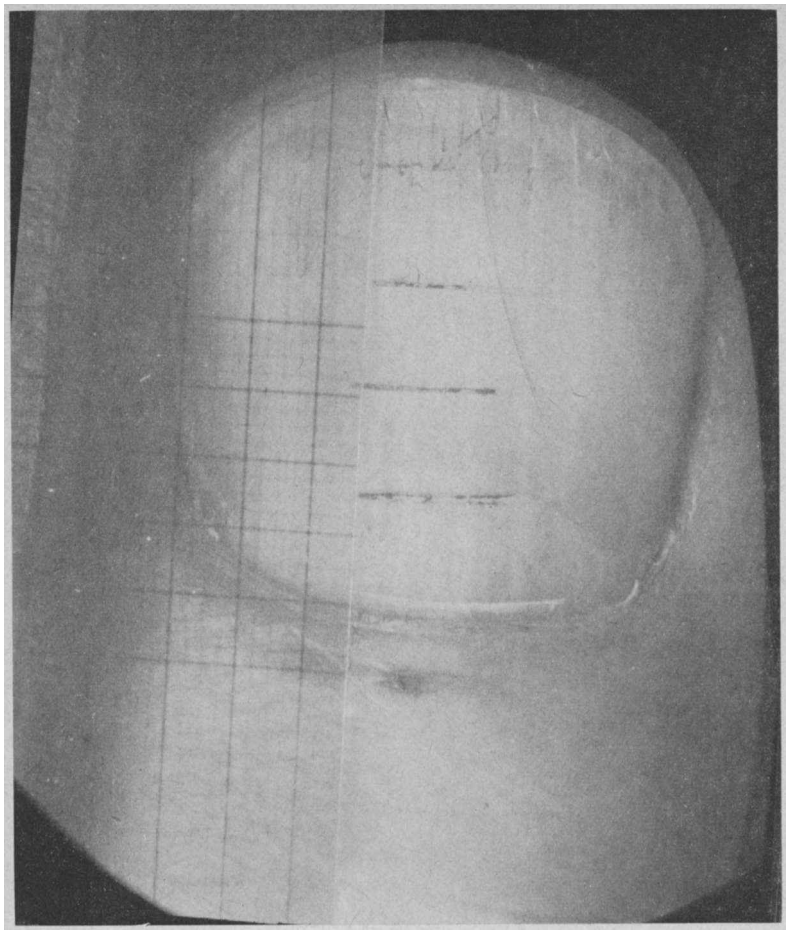

Fig. 1.—An example of the marks on the nail, and the tattoo as a point of reference.

were kept constant. A small bit of transparent film with marks in millimeters was held fixed against the nail to facilitate measuring (Fig. 1). Certain shortcomings of the method have been discussed previously. In an effort to accentuate the scored lines in the photograph, a red wax skin-marking pencil was pushed back and forth on the nail a few times and the surplus wax removed.

Observations

The data are presented just as they were in the first study. The accumulated experience consists of observations made over slightly more than 20 years. In Figure 2 the first bar indicates the number of days it took for the first mark to traverse the nailbed from Nov. 1, 1941, to Feb. 24, 1942. Each succeeding bar represents the number of days elapsing between the first day of the month when the mark was put down and its arrival at the free edge of the nail four to five months later.

Results

Again, no pattern of seasonal variation could be found. There was no regular trend for more rapid growth in summer and slower in winter. There were some unaccountable spurts and lags which were not associated with seasons of the year, nor were they associated with vacations or other travel in which rather sharp variations in climate and weather were encountered. No variation could be detected which bore any relationship to geographical location, physical activity, or anything else. No changes occurred during two summer trips to Europe which lasted six or seven weeks. During the period of observations I have engaged in some form of brisk physical activity almost daily: tennis in spring, summer, and fall and, for the last seven years, squash in the winter. During the second decade of these observations, I had

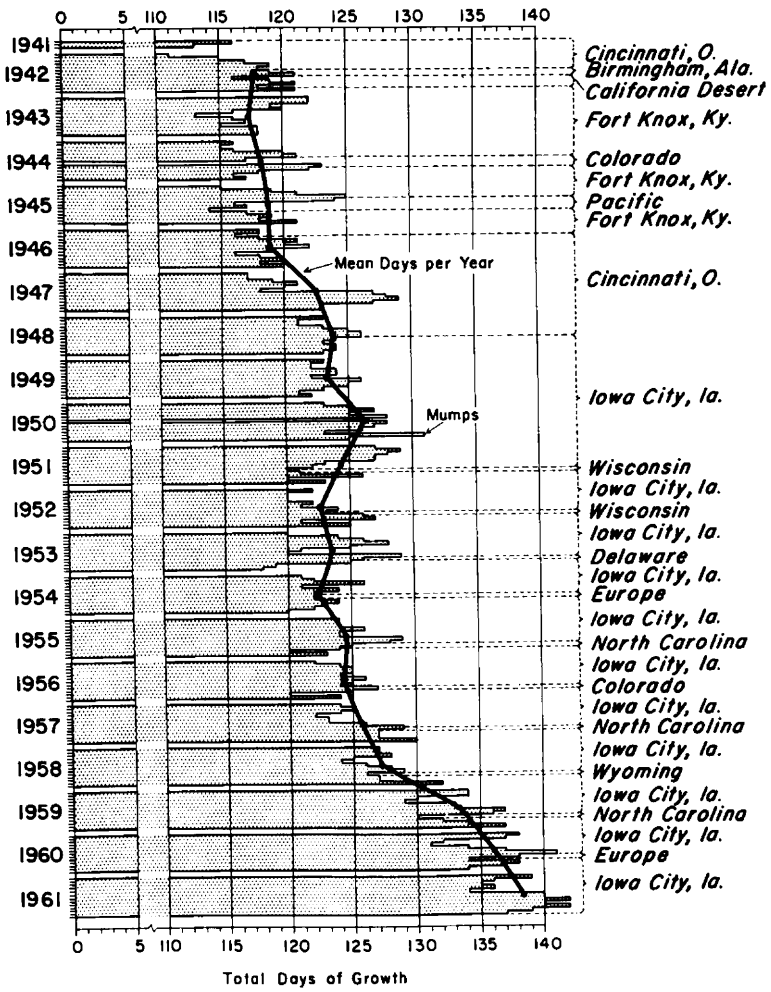

Fig. 2.—Chart of the number of days required for the mark on the nail to grow out to the free edge. The starting point was scored on the first of each month. The average number of days for each of the 12 months is indicated by the solid circles connected by the heavy black line.

no infection or illness of sufficient importance to allow me to miss work. Thus, there was no opportunity to repeat the observation of a sudden slowing or cessation in growth which occurred in 1950 when I had mumps. Over the ten-year period, 1951-1961, the average growth per day has varied from a rate of 0.132 mm. daily during certain stages

Length of Time Required for Mark to Arrive

Mo. of Growing	Jan.-May	Feb.-June	Mar.-July	Apr.-Aug.	May-Sept.	June-Oct.	July-Nov.	Aug.-Dec.
1952	122	120	120	120	122	121	124	123
1953	120	124	126	128	125	121	120	129
1954	121	122	126	121	124	122	122	122
1955	124	124	124	126	124	124	129	128
1956	122	124	125	125	124	126	125	124
1957	124	125	124	122	123	123	126	129
1958	127	127	128	125	124	126	128	129
1959	134	134	130	129	133	133	137	136
1960	138	137	132	131	134	137	141	138
1961	139	136	135	136	134	140	140	142
1962	136	133	135					
Av.	127.9	127.8	127.7	125.3	125.7	124.3	129.2	130.0

of the earlier study about 20 years ago and 0.102 mm. daily, during several months in 1961. In the entire span of 20 years, there was a period of fairly consistent rate of growth when the nail took on the average about 117 days to carry the mark to the free edge of the nail. Then there was a fairly consistent rate, somewhere between 122 and 126 days, which persisted until 1958. In the last 3 years of observations, there has been an increase in the average length of time required for the mark to arrive at the free edge: 133 days in 1959, 136 in 1960, and 138 in 1961. This objective evidence of a slowing in the process of nail growth has occurred at a time when I was not conscious of the general encroachment of old age in terms of a decline in those activities I could measure or count. I suspect that this is because those persons with whom I might compare myself in physical or mental activity were growing old at the same rate; thus, the slowing down of various processes was not borne in upon me with the same powerful objectivity of the little mark upon the nail. It now requires nearly a month more for the mark to reach the end of the nail than it did 20 years ago. Much more than the subtle graying of the hair, the encroachment of presbyopia, and the slower pace of running or walking, this memento, with its finite numbers, tells it tale of aging.

Other Observations

On two occasions during the past decade I had minor injuries to the left thumbnail and that of the index finger. Each time well-defined "splinter hemorrhages" appeared instead of the subungual accumulation of blood which soon turns back. The splinter hemorrhages grew out with the nail at the same rate.

My left thumbnail has a faint but definite longitudinal streak of slightly darker color. This part is thinner than the rest of the nail plate. When the nail is trimmed this forms a weak part in the trimming where it binds acutely when the two ends are pushed together. Growth of the whole nail is uniform.

Other Studies

I have made no attempt to collect all medical writings which deal with the growth of nails. Hamilton, Terada, and Mestler have covered this so well there is no need to repeat their commentary or their list of references. I have come across a few observations old and new which are mentioned here briefly. In 1899 Blake reviewed the problem of nail growth in his little book entitled "On the Study of the Hand for Indication of Local and General Disease." He quoted Beau's observation which gave the general rule that the nails of the hand grow 1 mm. per week which would require 105 days for the nail to grow out since the average length is 15 mm. Dufour gave the time as ranging between 121 and 138 days. Blake called attention to the fact that there was great individual variation not only in different ages but in different people and that nail growth was influenced by many external and internal conditions. He said that he had observed between subjects of the same age and sex the difference of 70 days in the length of time it took for the nail to grow out. He had a series of figures indicating the lack of any correlation between nail growth and age in a number of different persons taken at the same time. Another point which he made is that the rate of nail growth is normal in hysterical paralysis but is greatly slowed down in hemiplegia resulting from cerebral vascular lesions. On the whole Blake's views are not particularly helpful, but he did take the trouble to find out a good deal about the

at Free Edge of Nail

Sept.-Jan.	Oct.-Feb.	Nov.-Mar.	Dec.-Apr.	Av.
126	127	121	125	122.6
126	125	119	118	123.5
124	123	122	120	122.4
125	124	120	123	124.6
127	125	120	124	124.3
127	127	127	130	125.6
126	127	127	132	127.2
130	132	134	137	133.3
134	138	137	134	136
140	142	139	137	138.3
128.5	129.0	126.6	128.0	

growth of nails. His information was not collected in a systematic way, and he was perfectly content to echo a number of sources of confusion then current.

Schick made 250 measurements on the rate at which the "physiological nail line" of the newborn child moves toward the free end of the nail; and he found that from the 30th to the 39th day the line had grown out 0.5 mm.; from the 40th to the 49th, 1.4 mm.; from the 50th to the 59th, 23 mm.; from the 60th to the 69th, 3; from the 70th to the 79th, 3.3; from the 80th to the 89th, 3.6 mm., and from the 90th to the 100th, 4.2. There was so much individual variation that generalizations were difficult.

Babcock made an extended review of fingernail growth, citing work that goes all the way back to Robert Boyle in 1684 who made observations on nail growth. Babcock included Halban and Spitzer's observation that the rate of fingernail growth increased between a third and a fourth during pregnancy and Basler's observations of the slowing of the rate of growth at night.

Babcock then went through the various methods of measuring nail growth, scoring the nails, staining the nails, and taking photomicrographs. He finally developed a method by which the nails were marked with a material opaque to roentgen rays; a deep scratch in the nail was filled with bismuth amalgam, and x-rays were taken. By comparing two superimposed x-rays and comparing the observed changes with ordinary photographs in six subjects he found that there was no significant difference between the rate of growth measured by the x-ray technique and ordinary photography which, of course, is much simpler.

Babcock's study gives an excellent analysis of the several methods which had been used up to the time he made his report and some interesting new techniques and variations he introduced. The figures he quotes for nail growth are in the general range of those recorded in this study.

Hamilton, Terada, and Mestler have made by far the most comprehensive study of nail growth in a large population group, observing it in nearly 300 Japanese men and boys and in approximately the same number of women and girls of various ages. It was their purpose to establish standards for nail growth in successive ages of Japanese subjects and compare them with similar studies in 1,000 Caucasians.

Despite the observations I had made in the first study, several others had failed to find a reduction in the rate of linear growth of the nail with aging. The study Hamilton reported gave unequivocal evidence for this reduction in the rate of growth of nails and hair in man and the desquamation of epithelium, as well as in the pelt of animals. This seems to represent a general biological truth as indicated by the decreased rate in regeneration of the liver and other tissues to grow in vitro. Also there is evidence that at the time when the spurt of adolescent growth occurs nails grow more rapidly and the healing of wounds in the skin is faster. It is not surprising that there are also familial tendencies for patterns of consistent rates of growth of the nails, some families having relatively fast, some relatively slow, rates. A comparable study of nail growth rate in Caucasians would indicate that in general what is true in the Japanese is true in the other groups that have been studied. A generalization which holds for all groups which have been studied intensively indicates that there is a slight but significant difference between the rate of nail growth in the sexes, males having a tendency to grow faster. Sporadic observations indicate that increased metabolism is associated with increased rate of nail growth. This is shown in pregnancy where the rate of growth may be increased by as much as one-third. I am not aware of any studies of the rate of nail growth in hyperthyroidism and myxedema. There is clear evidence that starvation is associated with conspicuous reduction in the rate of growth. Studies on animals indicate that partial starvation, lactation, and the use of antimitotic drugs consistently reduce the rate of the growth of nails or claws.

These studies throw some light on the process of aging. One school of thought has

championed the belief that the differentiation of cells results in their loss of proliferative ability and that this is a major factor underlying and accompanying the process of aging. But the fact that the process of aging affects the nail matrix and the growth of the nail without any alteration in differentiation would indicate that progressive differentiation is not a requisite for at least one of the characteristic alterations which occurs with aging.

Sibinga, using a modification of Babcock's photographic method for recording the rate of nail growth, was able to study the growth during measles, in people who had tuberculosis, in newborn infants, and in the presence of staphylococcal infections. He also made observations after death. The slowing of growth which I had observed during an attack of mumps seems to be characteristic of infections generally. Perhaps the most doubtful item in Sibinga's discussion deals with growth of nails after death. The growth of nails, the growth of hair, and other such eerie phenomena alleged to occur after death have been measured upon occasions. There seems to be good evidence that mitosis begun before death will be completed but that new mitotic activity does not begin. Thus, it is incredible that grossly measurable linear growth would occur in such structures. I accept Cowdry's demonstration that most of the growth is apparent, not real. It results from shrinking and drying of surface tissues after death. The cuticle shrinks back from the nail plate and the apparent growth results from contraction of the part which marks one of the end points in the linear dimension of the nail.

The striking observation that there was no clear-cut climatic or environmental effect is in contradistinction to observations made in Britain and in sharp disagreement with the interesting observations of Geoghegan, Roberts, and Sanford who compared 49 experimental subjects in the British Navy whose nail growth was studied in the temperate coastal waters of Britain and in an Arctic cruise. They found that the mean daily nail growth in the Arctic environment was 0.114 mm. per day, whereas in the temperate region it was 0.1194 mm. per day. By far the simplest explanation for this observation is that in temperate climates there is a greater degree of cutaneous vasodilatation; in cold environments the temperature regulating machinery of the skin reduces blood flow and thus the growth of cutaneous appendages is reduced. My own failure to produce changes in growth with the seasons probably reflects the fact that the average exposure to very cold weather rarely amounted to more than a half hour a day, and the rest of the time was spent inside centrally heated buildings. Furthermore, it made no difference whether the time from 8 A.M. to 5 P.M. in summer was spent in an air-conditioned office as it was during the last five years of the study or exposed to the summer heat which often reached a level of 90 F for most of the day.

Hale and Burch have contributed a classical review on the arteriovenous anastomoses and other vascular structures of the human finger, emphasizing glomus organs. The upshot of their study is that while the simple notion of glomus bodies as arteriovenous (A-V) shunts chiefly needed for temperature regulation probably has some merit, it oversimplifies a very complicated problem. Blood flow as a determinant of nail growth is implied but not explained.

More detailed but less exact consideration of the effects of hyperemia on nail growth was made long ago by Bier, but the details of his measurements are not recorded in his book *Hyperemia*. He said, "Without doubt both active and passive hyperemia lead to rapid growth of the covering epithelial structures. Thus, it is known that in summer when the skin is supplied with a greater quantity of blood than in winter, hair and nails grow faster. Besides there are numerous observations which prove that the same occurs in all chronic hyperemias." Bier refers several times to hyperemia and overgrowth of the nails.

Morton has described a special visual assessment of nail growth in which small index

holes are drilled into the nail with a hand drill and by very accurate photographic methods it is possible to determine linear growth. This is a modification of several of the methods used by various observers.

A very perceptive observation and the study it led to gave Kligman a clear clue about why nails grow out instead of up. Hair grows up and so does the epidermis. Kligman observed that nail and epidermal cells gain greatly in their lateral dimension as they grow toward the surface. As this surface expansion of nail cells occurs, instead of spreading in all directions like a drop of ink on the blotting pad, they can grow only outward. The cul-de-sac of the posterior nail grooves and the sides permits growth in only one direction. A drop of ink put at the end of a strip of blotting paper can move only away from the edge. Thus, a growth vector determined by fixed tissue in three of the four possible directions moves the nail toward the tip of the finger.

Conclusion

Growth of my left thumbnail, measured month by month for a second decade, again revealed no significant seasonal changes. The average rate of growth was 0.123 mm. daily at the age of 32, 0.111 at the age of 42, and 0.105 at the age of 52. A sharp decline began at the age of 49, and seems to be continuing.

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