

# Assessment of Nail Growth by Election Ink Mark in Normal and Co-morbid Individuals: A Prospective Observational Study

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## ABSTRACT

**Introduction:** During an election, an individual who casts a ballot is identified by the indelible electoral ink on their left index fingernail. Since nails are thought of as a window to internal organs, the disappearance of this ink mark from the nail and skin can be seen as a surrogate sign of the growth of nail and skin tissue in both healthy and diseased individuals.

**Aim:** To investigate nail growth by observing indelible election nail ink marks in normal nails and in patients with systemic illnesses that affect the nails.

**Materials and Methods:** This prospective observational study was conducted during India's 18<sup>th</sup> Lok Sabha General Election, which took place from 19 April 2024 to 1 June 2024. Approval was obtained prior to the study. Participants were split into two groups: those with healthy nails and those with systemic disorders that impact the nails. Consent was obtained from the participants, who were asked to take serial digital photographs of the left index fingernail on four occasions (on voting day,

once after the ink mark had left the skin and remained on the nail, once after approximately one month  $\pm 2$  days and once at the end when the election ink mark had vanished).

**Results:** Out of 312 participants (168 males and 144 females), 198 were healthy and 114 had co-morbidities. The mean time for the disappearance of the ink mark for participants with co-morbidities affecting the nails was  $57.8 \pm 14.6$  days, which was less than the mean time for disappearance for healthy participants ( $60.9 \pm 13.1$  days). The findings, however, lacked statistical significance ( $p\text{-value}=0.06124$ ). The disappearance of skin marks in both normal and co-morbid individuals was approximately a week. It was observed that patients with clubbing exhibited a faster rate of disappearance than those with other co-morbidities, with an average of  $52.8 \pm 12.2$  days.

**Conclusion:** The development of nails slows down with age, although it can accelerate under systemic conditions. The findings, however, lacked statistical significance.

**Keywords:** Clubbing, Nail growth, Systemic illness

## INTRODUCTION

Silver nitrate is the basis for one of the popular election ink formulas, which is typically placed on voters' forefingers during elections and may leave a stain for several weeks. By reacting with skin proteins, silver nitrate creates a firm bond. It does not damage the skin, but it creates a black stain that lasts for days or even weeks. The mark will only disappear after the old skin cells start to die and are replaced by new ones. Older ink may have a higher concentration of silver nitrate due to alcohol evaporation, which might result in skin burns. Burning can occur from repeatedly applying silver nitrate-containing ink to the fingers. Blisters may result from an exothermic chemical reaction caused by repeated chemical contact with the skin [1].

There are two parts to the election ink stain: the portion on the skin and the portion on the nail. The stain on the skin typically lasts for 72-96 hours, while it will remain on the cuticle area of the nail for two to four weeks. It has been reported that it may take up to four months (120 days) for the mark to completely disappear from the nail, as it is replaced by new nail growth [2]. The officer at the voting station applies the purple ink to the voter's left index finger. No chemical, detergent, soap, or oil can erase the ink for several months after it has been applied. After the ink is applied to the left index finger, the voter casts their ballot and leaves the booth. The ink cannot fade out since it is allowed to dry sufficiently. However, some people may use greasy substances like petroleum jelly to prevent the ink from reacting with their skin [3].

Nails are epidermal in origin and are a specialty of dermatologists. However, various medical conditions can also cause changes in the nails. Nails are affected by various systemic disorders, manifesting as clubbing, koilonychia, leukonychia, half-and-half nails and others. Nails

are considered a window into systemic diseases and can be affected in respiratory, cardiovascular and gastrointestinal conditions, as well as in diseases such as Graves' disease and sarcoidosis [4-6].

Numerous studies have investigated the relationship between nail growth in normal individuals and in those with systemic disorders [2,7], but very little research has compared the nail growth of normal individuals to that of those with systemic disorders.

Thus, the aim of this study was to compare nail growth by observing indelible election nail ink marks in normal individuals and in patients with systemic illnesses. This study hypothesised that if the nail growth of all individuals is the same, then election ink should disappear at the same time in all individuals. The current study used election ink as a tool to investigate nail growth in the local Gujarati Indian population, similar to a study conducted by Abraham A et al., [3]. The current study included serial photographs of the ink mark to observe the behaviour of nail growth.

## MATERIALS AND METHODS

This prospective observational study included 312 voters (using a purposive sampling method) from Vadodara and Ahmedabad, conducted at Dhiraj Hospital, Vadodara, Gujarat, India, from May 2024 to July 2024. The study was approved by Institutional Ethics Committee (IEC) (IEC approval number: SVIEC/ON/Medi/RP/April/24/47).

**Inclusion criteria:** Participants above 18 years of age who were willing participate, participants with normal nails, participants with systemic illnesses such as hypertension, diabetes, ischaemic heart disease, hypothyroidism, liver diseases, lung diseases, etc., which can affect the nails were included in the study.

**Exclusion criteria:** Individuals under the age of 18 years who were not entitled to vote, individuals who were unwilling to take part in this research, participants using nail paints or nail accessories, pregnant females, individuals who dropped out of the study were excluded from the study.

## Study Procedure

A convenience sample of 312 patients who voted and attended Dhiraj Hospital on the day of the Lok Sabha election held on 7 May 2024 were included in this study. Participants were divided into two groups: those with normal nails and those with co-morbidities/systemic illnesses, such as diabetes, cardiovascular disorders, hypothyroidism, liver diseases and lung diseases, which may affect the nails [4-6]. All participants were asked to send photographs of their nails and accompanying data via email, WhatsApp (an online messaging application), or other social media platforms. Participants were instructed to send a digital photograph of their left index fingernail on the day of the election, one photograph once the ink disappeared from the skin but remained on the nail, one photograph taken after one month ( $\pm 2$  days) to observe any changes on the nail and a final photograph when the election ink mark had disappeared completely.

## STATISTICAL ANALYSIS

All the data collected were maintained using a Microsoft Excel spreadsheet and the data of all the participants, along with all the photographs, are preserved with us. With a p-value of  $<0.05$  as the threshold for statistical significance, the independent t-test was employed.

## RESULTS

Out of the 312 participants (who visited the hospital on the day of the election and fulfilled all inclusion and exclusion criteria), 168 were male (53.84%) and 144 were female (46.16%), indicating that the male to female ratio in this study was 1.12:1. A total of 125 participants (40.06%) were in the 18-40 years age group, 104 (33.34%) were in the 41-60 years age group, and 83 (26.60%) were in the over 60 years age group. This indicates that more young adults were included in this study. Out of the 312 participants, 198 (63.46%) were normal healthy individuals, while 114 (36.54%) had systemic illnesses affecting the nails [Table/Fig-1].

Age group (years)	Participants with healthy/normal nails	Participants with systemic illnesses which affects the nails	Total participants
18-40	102 (M-56) (F-46) (32.70%)	23 (M-13) (F-10) (7.37%)	125 (Male-69) (Female-56)
41-60	76 (M-40) (F-36) (24.35%)	28 (M-16) (F-12) (8.97%)	104 (Male-56) (Female-48)
>60	20 (M-8) (F-12) (6.41%)	63 (M-35) (F-28) (20.20%)	83 (Male-43) (Female-40)
Total	198 (63.46%)	114 (36.54%)	312

[Table/Fig-1]: Participants according to age and gender.

[Table/Fig-2] presents the co-morbidities/systemic illnesses in 114 study participants, of whom some had multiple co-morbidities. Hypertension was the most common co-morbidity, present in 52 participants (45.61%). Different stages of ink disappearance in normal healthy individuals are depicted in [Table/Fig-3a-d], while the stages in participants with systemic co-morbidities are shown in [Table/Fig-4a-d].

[Table/Fig-5] indicates that in normal healthy participants, the mean time for disappearance of election ink in the 18-40 years age group ( $n=102$ ) was  $57.2 \pm 16.4$  days; in the 41-60 years age group ( $n=76$ ) it was  $56.5 \pm 16.9$  days; and in the >60 years age group ( $n=20$ ) it was  $69.2 \pm 10.7$  days. It appears from this study that the time for the disappearance of marks was delayed in older age group individuals

Co-morbidities/systemic illnesses which affects the nails in participants	n (%)
Hypertension	52 (45.61)
Diabetes	41 (35.96)
Ischaemic heart disease/Coronary artery disease	24 (21.05)
Clubbing	18 (15.79)
Hypothyroidism	12 (10.52)
Dyslipidaemia	12 (10.52)
COPD/Asthma	11 (9.65)
Chronic kidney disease	11 (9.65)
Hepatitis	6 (5.26)
Tuberculosis	5 (4.38)
Parkinsonism	3 (2.63)
Rheumatoid arthritis	2 (1.75)
Anaemia	1 (0.88)
Generalised Tonic Clonic Seizures (GTCS)	1 (0.88)
Poliomyelitis	1 (0.88)

[Table/Fig-2]: Co-morbidities/systemic illnesses which affects the nails in participants.

			
[Table/Fig-3a]: Photograph of the left index finger nail on the day of election in a normal healthy participant. 7/5/24	[Table/Fig-3b]: Photograph of the left index finger nail when mark disappears from the skin and remains on the nail in a normal healthy participant. 15/5/24	[Table/Fig-3c]: Photograph of the left index finger nail after a month in a normal healthy participant. 7/6/24	[Table/Fig-3d]: Photograph of the left index finger nail at the end when the election ink mark totally disappeared in a normal healthy participant. 16/7/24

[Table/Fig-3]: Changes/growth of nail using election ink in healthy individual.

			
[Table/Fig-4a]: Photograph of the left index finger nail on the day of election in a participant with clubbing. 7/5/24	[Table/Fig-4b]: Photograph of the left index finger nail when mark disappears from the skin and remains on the nail in a participant with clubbing. 15/5/24	[Table/Fig-4c]: Photograph of the left index finger nail after a month in a participant with clubbing. 7/6/24	[Table/Fig-4d]: Photograph of the left index finger nail at the end when the election ink mark disappeared in a participant with clubbing. 6/7/24

[Table/Fig-4]: Changes/Growth of nail using election ink in participants with co-morbidities/systemic illnesses which affects the nails.

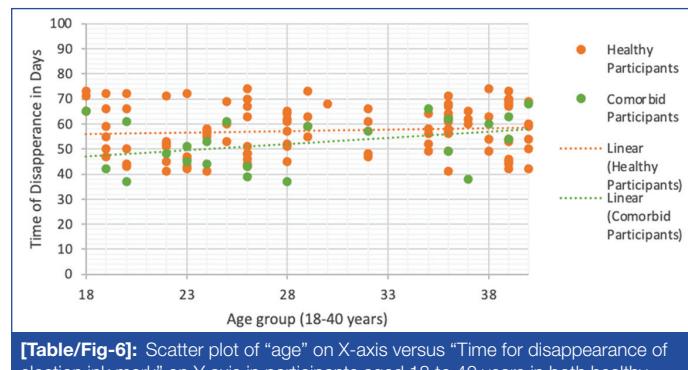
Age groups of normal healthy participants	Mean time for disappearance	Age groups of participants with co-morbidities/systemic illnesses which affects the nails	Mean time for disappearance	p-value
18-40 years (n-102)	$57.2 \pm 16.4$ days	18-40 years (n-23)	$52.4 \pm 15.4$ days	0.07678
41-60 years (n-76)	$56.5 \pm 16.9$ days	41-60 years (n-28)	$54.7 \pm 14.2$ days	0.06684
>60 years (n-20)	$69.2 \pm 10.7$ days	>60 years (n-63)	$66.4 \pm 9.7$ days	0.07258
Total mean	$60.9 \pm 14.6$ days		$57.8 \pm 13.1$ days	0.06124

[Table/Fig-5]: Mean time for disappearance of election ink in healthy participants and participants with co-morbidities/systemic illnesses which affects the nails.

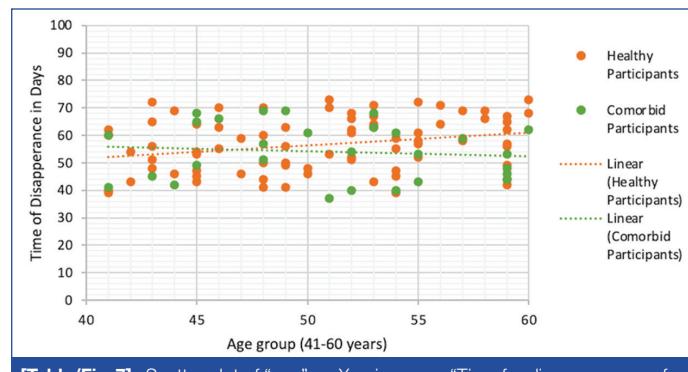
compared to younger age group individuals. However, the results were not statistically significant ( $p$ -value=0.05545).

In the participants with co-morbidities/systemic illnesses, the mean time for disappearance in the 18-40 years age group ( $n=23$ ) was  $52.4\pm15.4$  days; in the 41-60 years age group ( $n=28$ ) it was  $54.7\pm14.2$  days; and in the  $>60$  years age group ( $n=63$ ) it was  $66.4\pm9.7$  days. It appears from the study that the time for the disappearance of marks was delayed in older age group individuals with co-morbidities compared to younger age group individuals. However, the results were not statistically significant ( $p$ -value=0.05156).

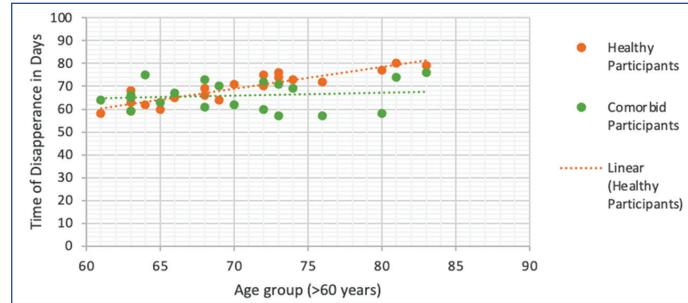
The mean time for the disappearance of the mark from only the skin for both groups was  $6.8\pm1.6$  days. When comparing the results from both groups, the mean time for disappearance in participants with co-morbidities/systemic illnesses ( $57.8\pm14.6$  days) was less than the mean time for disappearance in the normal healthy participants group ( $60.9\pm13.1$  days). However, the results were not statistically significant ( $p$ -value=0.06124) [Table/Fig-6-8].



**[Table/Fig-6]:** Scatter plot of "age" on X-axis versus "Time for disappearance of election ink mark" on Y-axis in participants aged 18 to 40 years in both healthy ( $n=102$ ) and co-morbid group ( $n=23$ ).



**[Table/Fig-7]:** Scatter plot of "age" on X-axis versus "Time for disappearance of election ink mark" on Y-axis of participants aged 41 to 60 years in both healthy ( $n=76$ ) and co-morbid group ( $n=28$ ).



**[Table/Fig-8]:** Scatter plot of "age" on X-axis versus "Time for disappearance of election ink mark" on Y-axis in participants aged  $>60$  years in both healthy ( $n=20$ ) and co-morbid group ( $n=63$ ).

[Table/Fig-9] indicates that in participants with clubbing, there was a rapid disappearance of ink from the nail ( $52.8\pm12.2$  days) compared to all other individuals.

Participants with clubbing	Mean time for disappearance
18	$52.8\pm12.2$ days

**[Table/Fig-9]:** Growth of nail using election ink in individuals with clubbing.

## DISCUSSION

The pace of nail development has been the subject of several studies [2,8,9], such as those by Kathroliya V et al., Motswaledi M and Mayayise M, and Conway J and Lipner SR [2,8,9]. Although their methods vary, one common finding from their research on nail development is that nail growth is extremely sluggish [7].

In this study, election ink was used as a marker for nail growth while observing its disappearance in both healthy individuals and individuals with co-morbidities. Mysore Paints, a Karnataka government company, and the Election Commission reached an agreement for the provision of indelible ink for the Lok Sabha and assembly elections. The deal was negotiated in cooperation with the Law Ministry, the National Physical Laboratory and the National Research Development Corporation. This ink has been used for all of India's elections. It leaves colour imprints on the skin and nails, which can change as a result of exposure to UV radiation from the sun. Until the outer skin cells and nails are replaced, this ink leaves a mark that cannot be washed off. In addition to a few pigments and aromatic components, the indelible voters' ink comprises 10-18% silver nitrate [1].

Age may have an impact on nail growth. According to Orentreich N et al., the linear nail growth rate can be utilised to gauge the ageing process. As the nail matures, it may serve as a non invasive way to evaluate the biological function of the body as a whole. Consequently, it may be considered one of the indicators of ageing [10]. Age is the primary factor that determines the rate at which fingernails and toenails develop; they grow more slowly as individuals become older. This study did not reveal a significant decline in the nail growth rate; however, the scatter plot indicated that nail growth slows down with age. This finding corresponds with a previous study conducted by Kathroliya V et al., and is similar to one of the supporting documents provided by Bean WB, a researcher who shared his findings from 30 years of study [2,11]. Two significant facts are suggested in the study by Bean WB, the first is that nails grow very slowly, and the second is that nail development slows down with age. He studied nail growth from the cuticle to the tip [11].

The current study also discovered that the election ink on the nail disappeared very slowly, taking an average of  $57.2\pm16.4$  days in the normal healthy participants group and  $52.4\pm15.4$  days in the co-morbid participants under the age of 40 years. For the 41-60 years age group, the average disappearance time was  $56.5\pm16.9$  days for normal healthy participants and  $54.7\pm14.2$  days for co-morbid participants. In the age group above 60 years, the average disappearance time was  $69.2\pm10.7$  days for normal healthy participants and  $66.4\pm9.7$  days for co-morbid participants. The average days for the disappearance of ink in the normal healthy individuals group was  $60.9\pm14.6$  days, whereas it was  $57.8\pm13.1$  days in the co-morbid individuals group. However, it was observed in this study that the electoral ink disappeared from the skin within a week in both groups. In a case report by Conway J and Lipner SR it was noted that nail growth in psoriasis patients was rapid, which correlates with the current study's findings of rapid nail growth in the co-morbid individuals group [9].

Nail abnormalities may result from conditions such as onychomycosis, 20-nail dystrophy and inflammatory dermatoses. Nail abnormalities may also be a symptom of systemic diseases such as clubbing, cyanosis, jaundice and splinter haemorrhages. Such nail alterations may present as a characteristic feature before additional symptoms of a systemic disease become clinically apparent [8].

## Limitation(s)

The study included various co-morbid conditions, which may have contributed to the non statistically significant results. However, this study has also provided an opportunity for researchers to further investigate specific co-morbid conditions that could yield statistically

significant results. The study was conducted solely on the left index fingernail and variations in other fingernails may also present a scope for future studies. Additionally, this study was carried out in a specific area of Gujarat, and there may be variability in the results in other parts of the country.

## CONCLUSION(S)

The study concluded that the mean time for the disappearance of marks in participants with co-morbidities affecting the nails (approximately  $57.8 \pm 13.1$  days) was less than the mean time for disappearance in the normal healthy participants group (approximately  $60.9 \pm 14.6$  days), although this difference was not statistically significant. Additionally, the study also found that as age advances, nail growth slows. However, once again, the results were not statistically significant.

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