# STUDY OF TREMULOUS SIGNATURES IN DEVANAGARI NEPALI SCRIPT

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**Abstract:** Signatures, as one of the behavioral human characteristics are generally recognized as legal means for verifying an individual's identity by administrative and financial institutions. A signature is developed by a person and it can change over time. Signatures are prone to influences by age, physical and mental conditions. In this study tremulous signatures including questioned and standards related to 50 real cases resolved by National Forensic Science Laboratory of Nepal were collected. The time interval between questioned and standard signatures was up to ten years. Sixteen major characteristics along with their forty-one sub characteristics of each case were studied. Among sixteen major characteristics in the tremulous signatures, study shows that the characteristics like the style of writing in hand printed form, pen pauses, medium pen pressure, poor line quality, pen lifts are most prominently observed. Tremors were absent mostly in the terminal strokes of letters. The letters written were varied in size and those were 6% small, 70% medium and 24% large. Interestingly no any retouch attempts were found to complete the shape of letters.

**Keywords:** Signatures; Tremors; Tremulous signatures: Pen pauses.

## INTRODUCTION

A handwritten signature is a highly developed, skilled reproduction of a piece of writing which can be defined as the scripted name or legal mark of an individual, executed by hand for the purpose of authenticating writing in a permanent form. The handwritten signature is particularly important type of biometric trait, mainly due to its ubiquitous use to verify a person's identity in legal, financial and administrative areas. In other words, signatures are identity of individuals and can be used to prove authenticity of a person. Signatures are learnt and acquired over a period of time and are influenced by age, physical and mental conditions. Alignment, letter formation, slant, initial and terminal strokes, pen pause, pen pressure, line quality, speed, size of letters, spacing, style of writing, retouching, connecting strokes, pen lifts etc. are various features that are used to make a meticulous comparative study of signatures to identify its authorship and to distinguish whether they are genuine or forged. Tremors in handwriting or signatures have significant implication for the field of forensic document examination. Osborn defines tremors as " Deviations from uniform strokes, which are apparent without magnification, may be due to lack of skills of writers, self-unconsciousness of the writing process or the hesitation as the result of copying or imitating"[1]. Harrison defines it as" Frequent deviations and discontinuities in the line quality of writing which are caused mainly when an attempt is made to disguise the writing of the penman or to imitate that of another and secondly due to loss of muscular control of the pen. " [2]. Hilton maintains on the other hand that a tremulous signature or writing may exhibit sporadic moments of freedom and fluency [3]. Tremor can be defined as lack of smoothness in the writing which may arise due to lack of skill, loss control of the writing element or involuntary movement (eg illness). Tremor if it is genuine will be consistent and continuous throughout a writing.

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Tremor can be produced due to age, illness, diseases, brain injury, weak neuromuscular coordination, forgery, illiteracy[4]. In addition, tremors in the writing may be due to use of drug including nicotine, alcohol, lithium, caffeine, thyroid hormone and cardiac antiarrhythmic[3]. Lack of vitamins, increased stress, writers' cramp and pathological or psychiatric disorders also cause tremors in writing[4]. Tremor of age or extreme weakness usually shows unusual and erratic departures of the line from its intended course, abrupt recovery and general indication of weakness or of movements beyond the control of the writer. Such writing shows awkward digressions or distortions, general irregularity and often characterized by abbreviations or even omission of letters or parts of letters[1]. The tremor of illiteracy is often characterized by a general irregularity due to hesitation because of uncertainty as to form and to muscular clumsiness resulting from unfamiliarity with the whole writing process[1]. Tremors due to forgery are seen with clubbing up with other inherent signs of forgery like blunt starts and endings, abnormal pen pauses, abnormal pen lifts, retouching, patching etc., which can be significant in discriminating such forms of tremors from genuine tremors[4,5].

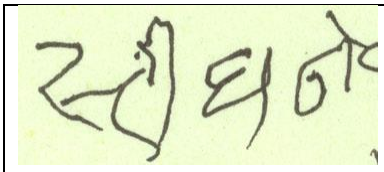
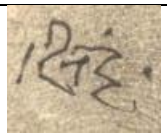
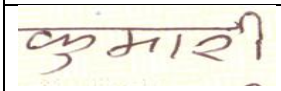
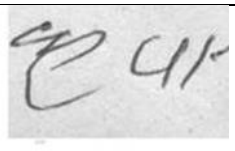
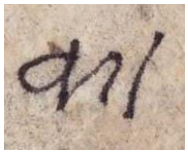
**METHOD AND METHODOLOGY**

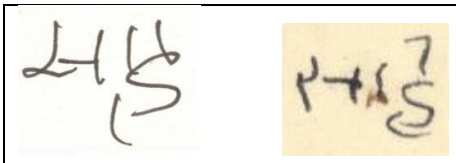
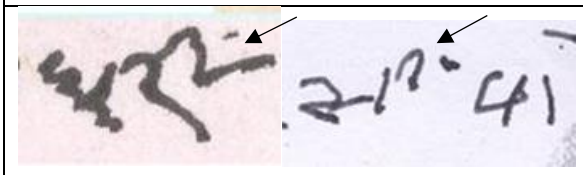
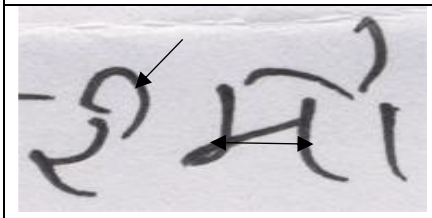
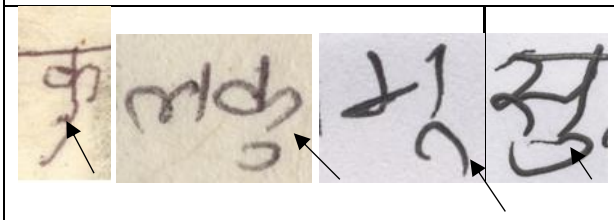
The present study was aimed to find the prominent characteristics as well as other characteristics in the signatures that contain tremors. Signatures including questioned and standards related to 50 real cases resolved by National Forensic Science Laboratory of Nepal were collected and comparative study was made. All those collected signatures in Devanagari Nepali script were genuine tremulous samples. The time interval between questioned and standard signatures was up to ten years. Among the samples collected, 16% samples were of tremor of age and weakness and 84% samples were of semi-literates (i.e. poorly literate)[1]. The study was focused on characteristics that were evident in the samples rather than the actual causes like age, mental or physical illness, weak neuromuscular coordination, illiteracy, use of drugs that generate tremors in signatures. The study was based on the basic writing characteristics such as alignment, letter formation, size of letters, speed, slant, initial and terminal strokes, pen pause, pen pressure, line quality, size of letters, spacing, style of writing, retouching, connecting strokes, pen lifts etc. Sixteen major characteristics along with their forty-one sub characteristics of each case were studied and those data were framed in bar and pie diagrams to conclude the results.

**INTERPRETATION OF DATA:**

Some pictures of the characteristics observed are tabulated below:

**Table 1: Table showing the pictures of the characteristics observed in tremulous signatures.**

| | |
|---|---|
|  | Tremors in Signatures |
|  | Angular letters |
|  | Rounded Letters |
|   | Letter क 'Ka' with large width |

| | |
|---|---|
|  | Letters स 'Sha' and ह 'Ha' with large width |
|  | Letters ध 'Dha' and भ 'Bha' with large width |
|  | Ikar ' ि ' small in form |
|  | Letter म 'ma' with large width |
|  | Wukar [ ु ू ] incomplete i.e. without smooth rounded curve |

The data observed from the study and analysis of characteristics of signatures containing tremors including questioned and standards related to 50 real cases are tabulated as below:

**Table 2. Table showing data for characteristics in Tremulous signatures.**

| SN | Characteristics Observed | Sub Classification of Characteristics | Total No of Samples | Percentage Within the Characteristics observed |
|---|---|---|---|---|
| 1 | Alignment (A) | Uphill | 7 | 14% |
| | | Downhill | 2 | 4% |
| | | Upward curve | 10 | 20% |
| | | Downward curve | 9 | 18% |
| | | Baseline | 11 | 22% |
| | | Wavy | 11 | 22% |
| 2 | Slant(Upward)(SU) | Right | 18 | 36% |
| | | Left | 6 | 12% |
| | | Vertical | 26 | 52% |
| 3 | Dika[ किताब](D) | With Dika | 24 | 48% |
| | | Without Dika | 26 | 52% |

| | | | | |
|---|---|---|---|---|
| 4 | Pen Pause(PP) | Present | 48 | 96% |
| | | Absent | 2 | 4% |
| 5 | Letter Formation(LF) | Rounded | 44 | 88% |
| | | Angular | 6 | 12% |
| 6 | Pen Pressure(PPr) | Low | 2 | 4% |
| | | Medium | 45 | 90% |
| | | High | 3 | 6% |
| 7 | Wukar [ ু ূ ](W) | Completely written | 2 | 11% |
| | | Incompletely written | 16 | 89% |
| 8 | Ikar [ ি ী ] ( I ) | Rounded | 34 | 87% |
| | | Angular | 5 | 13% |
| 9 | Speed (S) | Low | 13 | 26% |
| | | Medium | 37 | 74% |
| | | High | 0 | 0% |
| 10 | Initial and Terminal Strokes (I&T S) | Both Initial and Terminal blunt | 10 | 20% |
| | | Initial blunt and Terminal tapering | 40 | 80% |
| | | Both Initial and Terminal tapering | 0 | 0% |
| 11 | Line Quality(LQ) | Less poor | 11 | 22% |
| | | Poor | 39 | 78% |
| 12 | Connecting Strokes(CS) | Present | 3 | 6% |
| | | Absent | 47 | 94% |
| 13 | Spacing between Letters (Sp) | Equally spaced | 28 | 56% |
| | | Not equally spaced | 22 | 44% |
| 14 | Size of Letters (SzL) | Small | 3 | 6% |
| | | Medium | 35 | 70% |
| | | Large | 12 | 24% |
| 15 | Pen lift(PL) | Present | 44 | 88% |
| | | Absent | 6 | 12% |
| 16 | Style of Writing(SW) | Hand-printed | 49 | 98% |
| | | Cursive | 1 | 2% |
| | | **Total** | 757 | |

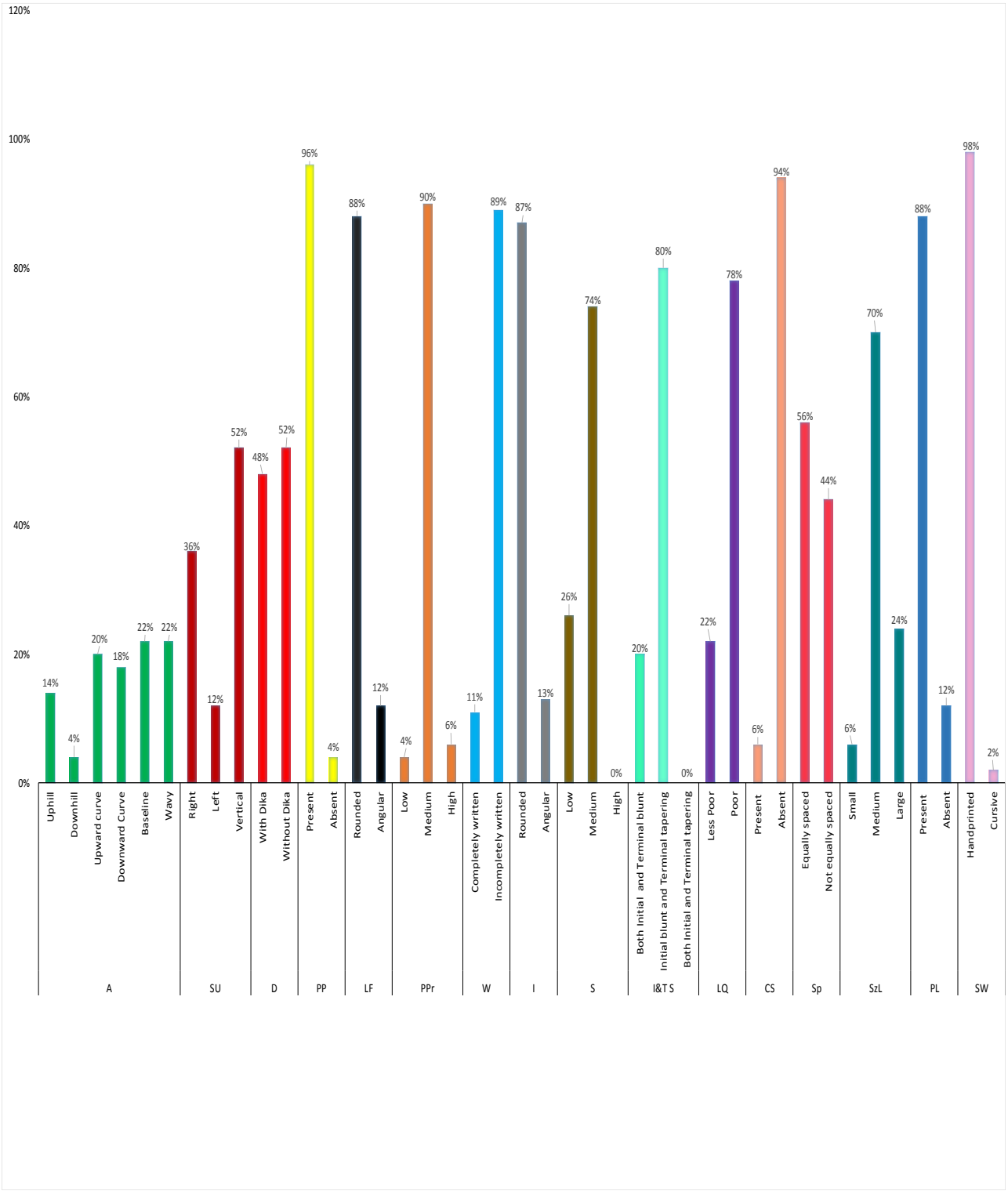



**Figure 1: Bar diagram showing characteristics in Tremulous signatures.**

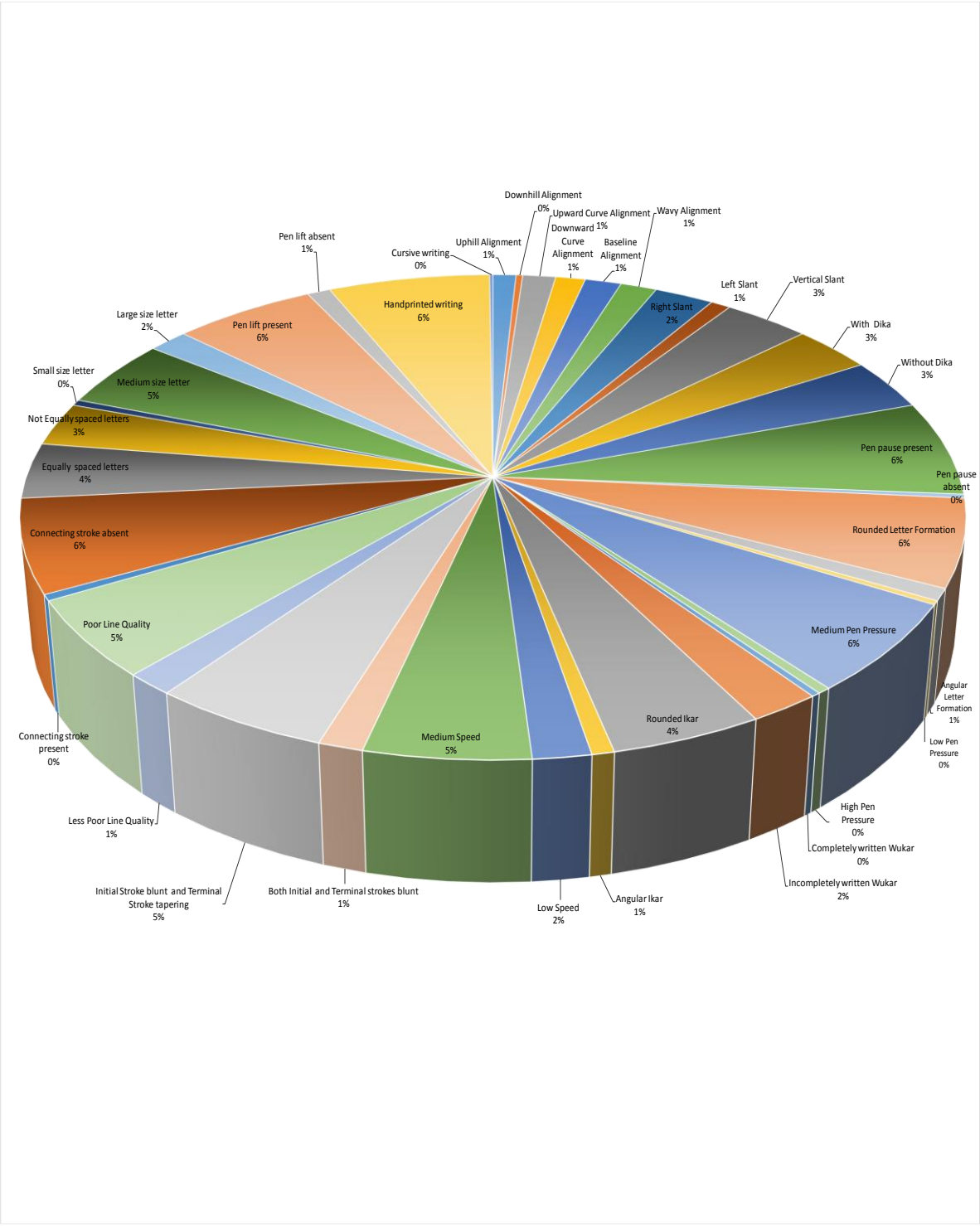



**Figure 2: A Pie chart showing characteristics in tremulous signatures.**

## RESULTS AND DISCUSSIONS:

Among the characteristics studied, one of the prominent characteristic in tremulous signatures in Devanagari Nepali script was the style of writing which was observed in hand-printed (98%) and in cursive (2%). Another prominent characteristic observed was pen pause which was present in 96% samples and absent in 4% samples. Pen pressure was observed with wide range of variation and those were 4% low, 90% medium and 6% high. Furthermore, pen lifts were made while writing certain letters like (ह, भ, स, क, ल, ज) in Devanagari Nepali script which were observed in 88% samples and absent in 12% samples. Another important aspect is the line quality in tremulous signatures which was

observed to be poor (78%). Similarly, most of writings in those signatures were observed in medium speed (74%) and those written in high speed were absent. The letters of the tremulous signatures having initial strokes blunt and terminal strokes tapering were in 80% samples and that having both initial and terminal strokes blunt were in 20% samples. The size of letters written in these signatures was relatively small (6%), medium (70%) and large (24%). Also letters written in rounded form were 88% and in angular forms were 12%. The structures used in letters like wukar (89%) was written completely and 11% was written incompletely. 87% showed the rounded form of Ikar whereas 13% showed angular form. Most of the tremulous signatures were observed without dika (line that is drawn above the letters) (52%). The most observed alignment was baseline (22%) and wavy (22%). The slant observed was as vertical (52%), upward right (26%) and upward left (12%). The spacing between letters that are not equally spaced was observed around 44% samples. In 94% of tremulous signatures connecting strokes were absent. Retouching done in letters was absent in all the tremulous samples.

## CONCLUSION:

Among sixteen major characteristics in the tremulous signatures, present study shows that the characteristics like the style of writing in hand printed form, pen pauses, medium pen pressure, poor line quality, pen lifts are most prominently observed. Dika is missing in most of signatures even though letters are written completely. Tremors are absent mostly in the terminal strokes of letters. Large sized letters have more height compare to width of the letters. Also some letters like (ह, भ, स, क, ल, म) have more width compare to height. Wukar with smooth rounded curve is absent and Ikar [ि ] is in small form in these signatures. Connecting strokes are rarely found. Interestingly no any retouch attempts are found to complete the shape of letters.

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