

Striation Patterns in New and Used Ballpoint Pens

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This study examined the incidence and individuality of striations in strokes produced by ballpoint pens. Ink strokes produced by various ballpoint pens were examined microscopically. Striation patterns produced by high-end (> \$10.00) versus low-end pens (< \$10.00) were also considered. Differences in the incidence of such ballpoint pen striations were assessed from samples of new pens versus samples of used pens. Photomicrographs illustrate the types of ballpoint pen striations observed.

Introduction

Ballpoint pen striations are fine non-inked streaks in ink strokes produced by ballpoint pens. They result from defects in or debris accumulating on the ball housing of the pens and cause an uneven ink line according to Ellen (1989). Black (1970) defined what ballpoint pen striations were not in saying "it is necessary to distinguish these individual striations from the grosser longitudinal blank streaks which are class characteristics of defectively operating ball pens and are not therefore individually identifying."

Striations have been used by forensic document examiners (FDEs) for a variety of purposes. Black (1970) suggested that striations could "provide the document examiner with a means of individualizing and identifying certain ball pens." Poulin (1985) went on to examine striation patterns as a means to identify ballpoint pens. Snape (1980) in his research reported that striations could be used to determine the direction of movement of the ball pen. Hung and Leung (1995) went on to observe that the sequence of strokes produced by ballpoint pens could be seen through a "memory effect." This occurs when the striations from a previous stroke are deposited at the beginning of a new stroke. These studies show the importance of ball pen striations in detecting alterations to medical records or employment documents.

The purpose of this study was to determine the incidence of ballpoint pen striations in new, used and high-end pens (>\$10.00). The individuality of the pattern of striations observed in new and used pens was also assessed.

Methods and Materials

The following materials were used in this study:

New Ballpoint Pens

- 12 Papermate Comfortmate medium black
- 12 Papermate Comfortmate fine black
- 12 Skilcraft medium black
- 12 Skilcraft fine black
- 12 Skilcraft medium blue
- 12 Bic Crystal Grip medium
- 3 Pentel RSVP medium black
- 12 Office Depot medium black
- 12 Papermate medium blue
- 12 Bic Softfeel medium red
- 12 Pentel RSVP medium black
- 1 Mont Blanc medium black
- 1 Lamy medium black
- 1 Cross medium black
- 1 Pelican medium black

- 1 Waterman medium black
- 1 Rotring medium blue
- 1 Sensa medium black
- 1 Sheaffer medium blue
- 1 Waterford medium black
- 1 Parker medium blue

Used Ballpoint Pens

One hundred seventeen used pens were collected from the Wisconsin State Crime Lab-Milwaukee and a home office. In many cases, the makes and models of these pens could not be determined because they were promotional pens that bore the names of organizations and hotels.

Paper

All writing samples in this study were prepared on Great White Multipurpose 20, 84 brightness, soft white, letter-size 8 1/2 X 11 inches.

Instruments

The following instruments were used to inspect pen strokes in this study:

- Leica MZ6 stereo microscope
- Olympus PM-10AD Photomicrographic System
- Bausch & Lomb Fiber Optics Illuminator

Methodology

The following method was used to prepare and examine the writing samples:

Of the 259 ballpoint pens chosen for this study, 142 were new pens and 117 were used. The pens contained black, blue, and red ink.

Writing samples were prepared using each pen and consisted of repetitions of the numerals "0" and "8" as well as the letters "T," "e," and "J." Each writing sample occupied 30-50% of a letter-sized sheet of white paper.

Each writing sample was examined microscopically at 20X to 32X magnification. Photomicrographs were taken to record striations observed during the microscopic examination.

Results

Table 1 illustrates the incidence of striations in new versus used ballpoint pen lines. Approximately 80% of the used pens examined exhibited striations while only 22% of new pens produced striation patterns. Approximately 50% of new high-end pens tested exhibited striations in their ink lines.

Examples of typical ballpoint striations can be observed in Figure 1. In many instances, differences in the morphology of striation patterns were observed. An example of differences between two distinct ball pen striation patterns is illustrated in Figure 2.

Writing Instrument	Number of Pens	Striations Observed	Percentage of Pens
New BP	132	30	22.7%
Used BP	117	94	80.3%
High-End BP	10	5	50%

Table 1. Incidence of striations observed in new, used, and high-end (>\$10.00) ballpoint pens.

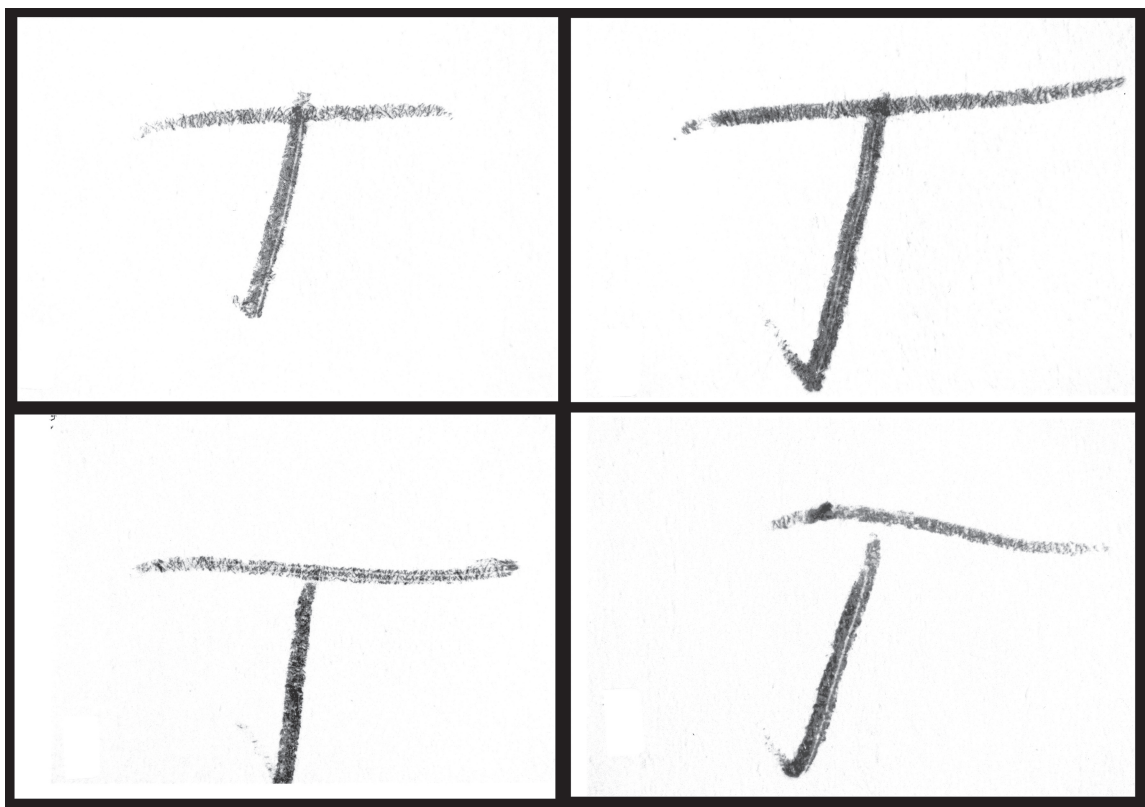


Figure 1. Images clockwise from upper left: a. new Bic Crystal Grip medium point blue ballpoint pen, b. new Bic Crystal Grip medium point blue ballpoint pen, c. used insurance company medium point blue ballpoint pen, d. used realty company medium point black ballpoint pen.

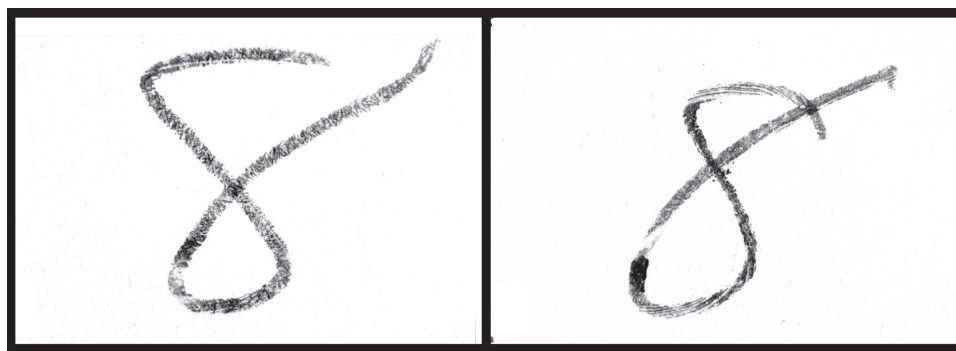


Figure 2. Individual striation patterns from: a. used Bic Round Stic black medium ballpoint pen and b. used Bic round Stic fine blue ballpoint pen.

It was observed that striation patterns do not necessarily appear in sequential letters within the same sample. The two letter "T"s in Figure 3 were written sequentially in the same writing sample with a used Papermate Comfortmate medium blue ballpoint pen. The striations from these letters are different.

Discussion

The results of the study broaden Forensic Document Examiners' (FDEs') understanding of the incidence and individuality of ballpoint pen striations. In applying these findings to casework, FDEs will view ballpoint pen striations with new sensitivity in comparing one ink stroke with another.

As expected, used pens generally produced more striations than new pens because dirt and damage to the ball housing increases with use.

Striations were also found in pen strokes produced by some new pens. New pens which produced the most striations were Bic red Softfeel medium ballpoint pens (6 of 12) and Papermate Comfortmate fine point black ballpoint pen (5 of 12). New pens that produced no striations were Papermate Comfortmate medium black ballpoint pens and 12 Skilcraft medium rubberized retractable refillable blue ballpoint pens.

The high percentage (50%) of striation patterns produced by high-end (>\$10.00) new pens may be skewed due to the limited sample size. This area could be examined in future research.

Differences between the two sequential letters shown in Figure 3 are evidence of variation in striations produced by the same pen. Hilton (1982) described variation in handwriting as resulting from "the lack of machinelike precision in the human body." This study suggests that like handwriting, striations from ballpoint pens also exhibit variation. Black (1970) observed:

Each section of the circumference of the housing holding the ball of a ball pen has its own characteristics, and only about an eighth of it registers on the paper via the ball in any one ink stroke. Thus it is possible to have different patterns produced by the same pen, all of which may possibly be of use in identifying strokes made by that pen. A single writing may thus have more than one such pattern.

A wide array of striation patterns was observed in this study. Many of the striations consisted of a single thin line while others consisted of complex patterns of non-inked and inked areas. Elaborate striations are of considerable value for

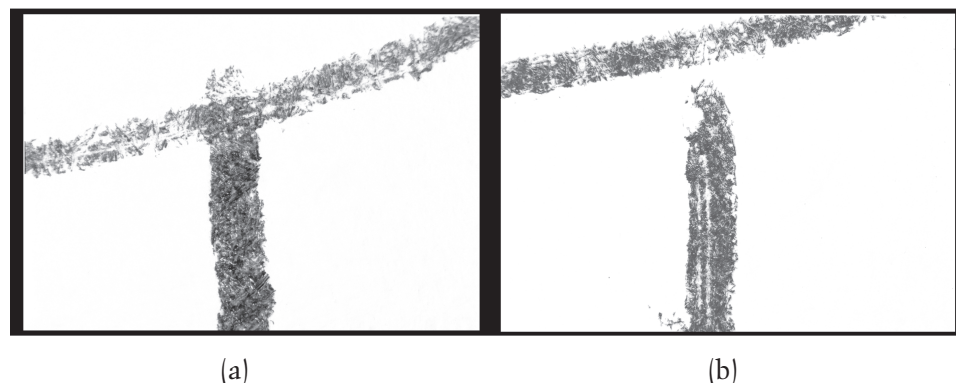


Figure 3. Sequential letters written with a used Papermate Comfortmate medium blue ballpoint pen from the same writing sample exhibiting different striation patterns: a. exhibits a horizontal striation and b. exhibits double track vertical striations.

identifying an ink line while the single thin lines are much less significant.

Conclusion

The study indicates that striations are quite common in strokes produced by used ball pens and occurred in approximately 80% of the sample tested. The incidence of striations in strokes produced by new ballpoint pens was 22%. Patterns of ballpoint pen striations ranged from simple to elaborate and striations in consecutive strokes produced from individual pens were found to vary.

Forensic document examiners should exercise caution when using ballpoint pen striations to identify pen strokes written by a particular writing instrument. Such identifications should be limited to extended writings containing a complex series of striation patterns.

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