The Effect of Water Soaking on Ballpoint Pen Writings

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A forensic document examiner may be confronted with the problem of restoration and examination of water-soaked documents. Various methods have been recommended by different individuals and are being applied to restore water-soaked documents. The present study has been conducted to determine the effect of water soaking on ballpoint pen writings on different types of paper; at different intervals; and in neutral, acidic, and alkaline aqueous media.

Introduction

For a forensic document examiner, the problem of examining water-soaked documents can be perplexing and complicated. In disaster cases (building fires, floods, and destruction of archival records) and cases where deliberate destruction of documents was attempted by soaking the documents in water, proper care must be taken to restore and identify such documents. It is known that paper has a normal hygroscopic capacity for absorbing water (Waters 1979); and the water may affect all the components of a document such as paper, ink, and other marks. In the case of handwritten documents, feathering, lateral spreading, or transfer of ink onto the facing or subsequent pages may be present and may affect the legibility of the handwriting to a certain extent. Conway (1959) observed that if the parent paper was not seriously damaged, success is met frequently in proportionate to the constituents of the original writing agents.

Taylor (1986) applied a vacuum freeze dehydration method for restoration and identification of contents of a wallet found in pond water and was able to restore its contents. McCleary (1987) prepared some guidelines on vacuum freeze drying for archives administration and records management. Tremain and Grattan (1989) used vacuum freeze drying along with parylene treatment for restoration of aircraft log books and documents recovered from the Air Ontario Dryden crash. Similarly, Steggall (1992) reported the freeze drying method for restoring the writings of a booklet recovered from a pond and concluded that the freeze drying technique minimizes further destruction of the document. Horton (1994) successfully used the freeze drying technique for restoring and deciphering the ball pen writings on water-soaked toilet tissue paper. Santcroche (1999) reported a study involving freezing of water-soaked documents with liquid nitrogen and then drying them with lyophilisator. He concluded that the drying of previously frozen documents with lyophilisator is complete, relatively rapid, and easy to employ.

It has been concluded that if a water-soaked document is dried correctly and a charred document handled properly, the chances of deciphering useful information is considerably increased. Bluher, Haberditzl, and Wimmer (1999) discussed the problem of water-sensitive inks while dealing in conservation of 20th century archival records. The aforementioned studies were mainly conducted on the preservation, restoration, and identification of water-soaked/damaged documents. The present study deals with the effect of water soaking on ballpoint pen writings on different types of paper immersed in neutral, acidic, and alkaline aqueous media for various time periods.

Materials and Methods

Forty-five booklets of 15 leaves each were prepared with 3 types of paper: bond paper (60 gm wt.), map litho paper (58 gm wt.), and rice paper (32 gm wt.). Each booklet was serially numbered. Writings were written on the 8th leaf of each booklet using 10 different blue ballpoint pens: Reynolds, Today's

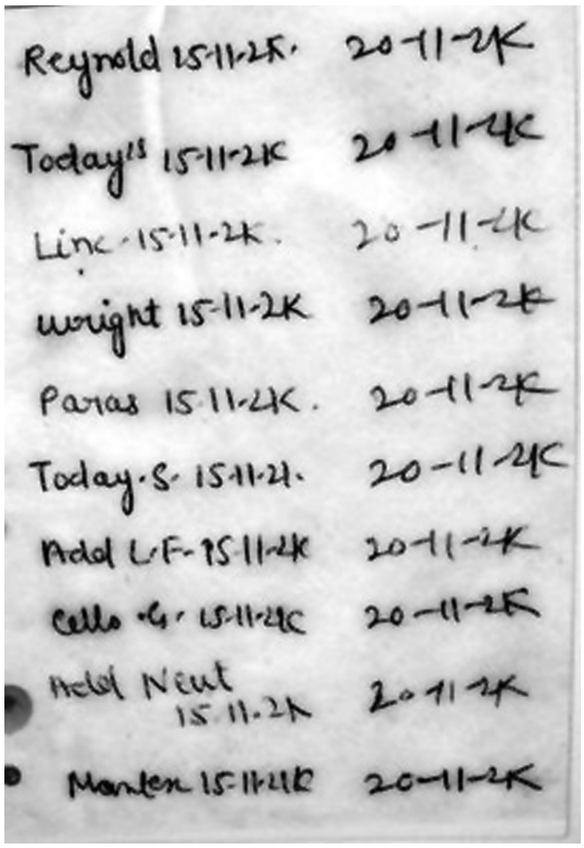

Figure 1. Ballpoint pen writings on map litho paper immersed in neutral medium for 20 days, showing lateral spreading of ink. Some of the inks have more spreading than others.

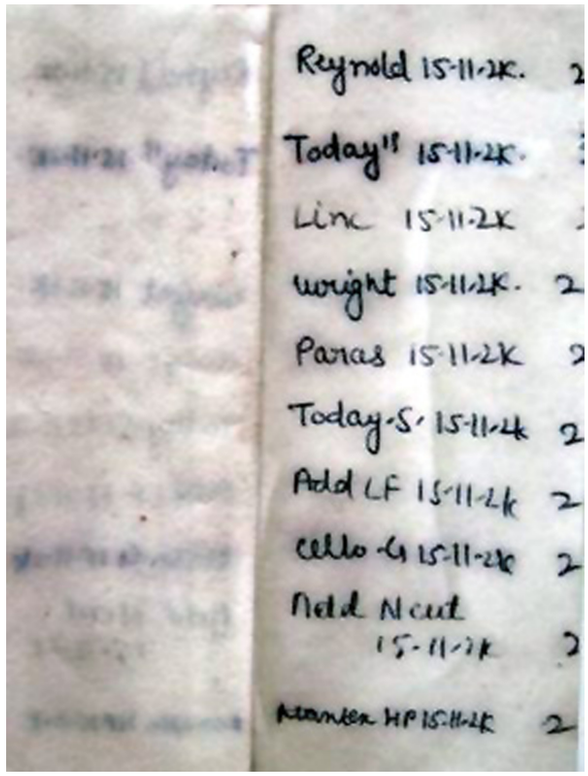

Figure 2. Ballpoint pen writings on bond paper immersed in alkaline medium for 54 days, showing transfer of ink onto the facing paper.

0.5, Linc, Wright, Paras, Today's Stepny, Add L.F., Cello Gripper, Add Neut, and Montex Hygrip.

Three types of aqueous media were prepared in different glass jars for immersion of the booklets:

(a) Neutral medium (pH 7): Pure tap water
(b) Acidic medium (pH 4): Tap water with HCl
(c) Alkaline medium (pH 10): Tap water with NaOH

Booklets of each paper type were immersed in neutral, acidic, and alkaline aqueous media for up to 54 days. Before immersion, these booklets were examined in daylight and under short UV (254 nm) and long UV (366 nm), and the observations were recorded. Four booklets of each paper type were immersed in neutral, acidic, and alkaline aqueous media at room temperature. The 5th booklet of each paper type was not immersed in water and was preserved as control sample. One booklet was taken out from each medium after 6 days, 13 days, 20 days, and 54 days respectively. Each booklet was air dried and examined in daylight and under short and long UV rays. Various observations of change in color of ink, lateral spreading of ink, transfer of ink dyes/pigments on other papers, change in sheen of ink, intensity of ballpoint pen grooves, and seepage of ink were recorded and compared with the observations recorded from the control samples.

Results and Discussion

The immersion of ballpoint ink writings in different types of aqueous media for different time periods has shown characteristic features as described below.

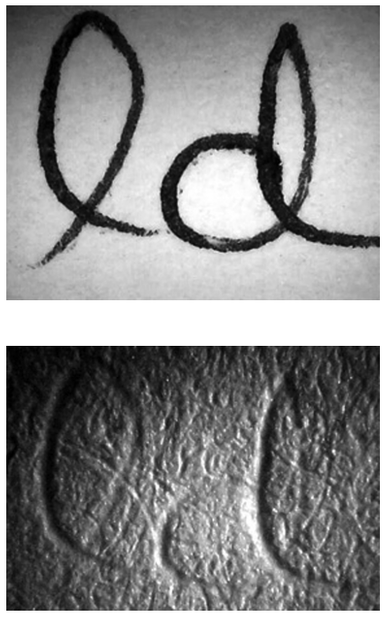

Figure 3. Ballpoint pen writings before soaking in water. The upper photograph was taken under daylight, and the lower photograph showing ballpoint pen grooves was taken with oblique infrared rays.

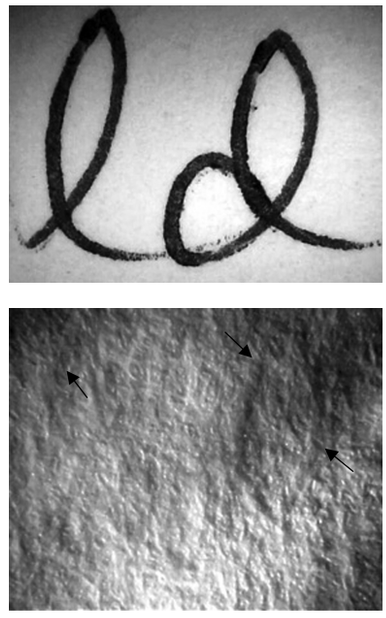

Figure 4. Ballpoint pen writings on bond paper soaked in alkaline medium for 20 days. The upper photograph was taken under daylight, and the lower photograph was taken with oblique infrared rays. Note marked decline in the intensity of grooves.

Lateral Spreading

After immersion in water, most of the ball pen inks exhibited the phenomenon of lateral spreading alongside the margin of strokes. Depending upon the nature of the aqueous media, the period of immersion, and type of paper, different inks responded differently. This lateral spreading was found to be more in the neutral and alkaline media and to a lesser extent in the acidic medium. There was an overall increase in the lateral spreading with the increase in the time of immersion. Some of the inks, such as Wright, Addneut, and Reynolds, did not respond in acidic medium, while the other inks showed lateral spreading in the same medium and the other media. The inks from Cello Gripper and Today's 0.5 showed lateral spreading after the 6th day; whereas the inks from Wright and Reynolds started showing lateral spreading only after the 20th day of immersion.Lateral spreading was also affected by the type of paper. Some inks displayed the presence of lateral spreading on 1 type of paper but not on another. For example, Add L.F. ink exhibited lateral spreading on bond paper and map litho paper, but the lateral spreading of this ink was missing on rice paper (Figure 1).

Transfer of Ink

After immersion, the ballpoint inks did not show significant change in their primary color; however, most of the writings exhibited characteristic transfer of dyes/pigments from primary ink strokes to the facing paper(s) and seepage to the reverse of paper and to the subsequent pages extending up to 3 pages. This transfer and seepage of ink are greater in neutral and alkaline media than in acidic medium. In some ball pen writings, the secondary color tint of the transferred ink was found to be different from the shade of the parent strokes. The extent of transfer of ink was found to be similar in the 3 types of paper used in the study. The intensity of transferred ink is more on the facing papers than on the subsequent papers (Figure 2).

Sheen

The ballpoint pen writings before immersion and after immersion were examined under stereomicroscope to determine changes in the sheen of strokes. There was decline in the sheen of strokes proportional to the time of immersion. However, the writings still revealed some sheen

in the strokes even after immersion for 54 days in different aqueous media. The decline in sheen was found to be similar in neutral, acidic, and alkaline media.

Ballpoint Pen Grooves

The intensity of ballpoint pen grooves in similar letters and strokes in water-soaked writings and control samples was examined and compared under a stereomicroscope. A pronounced decrease in the intensity of grooves was observed that was proportional to the time of immersion. After immersion, the grooves tended to flatten and become less sharp at their margins. Similar phenomenon was observed in all the writings irrespective of the nature of aqueous media (Figures 3 and 4).

Examination of Inks Under UV Radiations

No significant change was noticed in the ballpoint pen writings under short UV and long UV radiations after immersion in different aqueous media.

Conclusions

The 1st phase of research on the effect of water soaking on ballpoint pen writings has provided fruitful results. The ballpoint pen writings showed characteristic phenomena of stability and legibility, including lateral spreading alongside the margin of strokes, transfer of dyes/pigments on the facing papers, and seepage of ink to the subsequent pages of booklets. These observations may help to resolve issues relating to examination and comparison of ballpoint pen writings on water-soaked documents.

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