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Review

Holy Shroud in Turin: Bloodstains on the Neck's Nape and Possible Traces of Myrrh

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ABSTRACT

This study investigates the origin of the bloodstains in the occipital region of the Holy Shroud in Turin (HST), combining image processing and experimental analysis. Through multidisciplinary tests, the formation of these particular blood traces is simulated.

The main findings are the following: it was ruled out that the stains resulted from simple vertical fluid flow; the presence of well-defined angular profile suggests the possible involvement of leaves trapped in the hair after the removal of a crown of thorns made from leafy branches; the light stains with dark borders are consistent with the use of myrrh granules placed between the hair and the cloth; the experimental models, although based on simplified hypotheses, show notable similarities with the original traces of the HST.

Thus, the study proposes new interpretative scenarios and suggests the possibility of future experimental verification using human biological samples, offering a significant contribution to the understanding of this aspect of the Relic.

Keywords: Turn Shroud; burial bloodstains; Crown of thorns; Nape of the neck; Myrrh

Introduction

A few studies [1-10], show that the HST is a handmade 3:1 twill linen cloth, 4.4 m long and 1.1 m wide, on which the front and back images of a human body are permanently and mysteriously imprinted [5,6,11,12].

According to Pope Julius II [13], who approved the Mass and the Office of the HST in 1506 and declared that it had to be not only venerated but also adored and the subsequent Catholic Christian tradition, the HST is the burial cloth in which the body of Jesus Christ was wrapped before being placed in a tomb in Palestine about 2000 years ago, **(Figure 1)**.

The Catholic Christian Church does not impose any veneration requirements of the HST, even though science has been unable to refute what is reported by tradition.

There are some indications that the HST was in Palestine in the first century A.D. and then taken to Edessa [14,15] (present-day Sanliurfa in Turkey) but other scholars hypothesize different paths for this Relic [16].

Several features found on the facial image on the HST accurately coincide with those found on depictions of Christ

on Byzantine coins starting from the VII century A.D. which provides evidence that the HST was seen during the Byzantine Empire [15]. After disappearing during the Sack of Constantinople in 1204, the "Shroud of Christ" then, later, appeared in Europe in 1353 in Lirey in France. In 1532, a fire damaged it at Chambéry in France. In 1578, it was taken to Turin where it has remained until now, apart from some short periods of time when it was hidden during wartime.

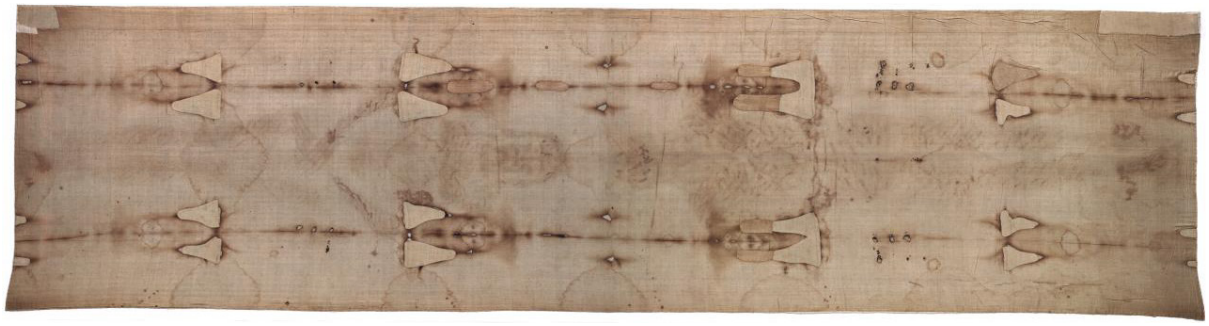

Figure 1: HST photographed by G. Durante in 2000 (Archdiocese of Turin).

In 1988, radiocarbon dating of the HST yielded an inaccurate date range of 1260-1390 AD [16]. This result remains a subject of ongoing debate [3,17-22], with multiple studies challenging its reliability due to very probable contamination especially caused by environmental factors.

Recent findings, including the detection of Beta radioactivity and fluorescence in the bloodstains on the HST [1,23-25] further confirm the inaccuracy of the radiocarbon dating results. These discoveries suggest that neutron reactions related to the body image formation may have skewed the radiocarbon measurements.

The presence of selective radioactivity detected in the HST serves as a strong indication that the 1988 radiocarbon dating results is biased by an intense neutron flux that altered the isotopic composition of the linen fibers, leading to a younger apparent radiocarbon age. Such a neutron flux could be easily associated with the Resurrection of Jesus Christ.

Recent studies [23,24] have demonstrated that, from a medical perspective, it is virtually impossible for a medieval artist to have produced the bloodstains observed in correspondence with the double-body image on the HST.

These stains, which exhibit distinct morphological variations, can only be coherently explained by considering the HST as having been wrapped around a human body that underwent severe torture and crucifixion in accordance with execution practices of Roman types, as described in the Christian Holy Bible (CHB).

Moreover, specific characteristics of these bloodstains, such as the absence of smearing, further suggest the presence of a phenomenon that remains scientifically unexplained, potentially pointing to a miraculous occurrence.

Recent analyses of blood samples collected from the HST [1,3,4,23-29] have provided novel insights into the physiological state of Jesus Christ during His Passion, crucifixion and entombment described in the CHB. One of the key conclusions emerging from this research is the hypothesis concerning the mode of Christ's departure from the HST following the estimated 30 to 40 hours post-mortem. The study proposes a novel interpretation based on the concept of material transparency, demonstrating that Jesus' body came out of the HST in a way that did not touch the integrity of the cloth.

Numerous studies have been conducted on the bloodstains of the HST [1-11,14,23-29], but curiously, few specific analyses have been conducted on the characteristics of the bloodstains on the nape of the neck corresponding to the top of the dorsal image of the HST. Therefore, this paper analyses these bloodstains through both visible and UV photos which, among other, present peculiar evidences slightly different from the others, because they highlight small circular shapes within them that are not easy to explain at a first sight.

Through experimental tests aimed to reproduce these peculiar bloodstain marks, this paper not only tries to give a preliminary explanation to the presence of these small circular shapes also considering the possible presence of spices mentioned in the Gospels (Jh 19:39), but also tries to explain some localized lacks of bloodstains in reference to the possible presence of leaves as hypothesized by O. Scheuermann [32].

Comments on a Recent Article About the HST Bloodstains

Very recent is Ref. [30] which, through experimental tests, states that in correspondence with the bloodstains *"serum borders would be absent if the body had been washed prior to wrapping it in the cloth"* and concludes that: *"These data provide evidence that formation of serum edges/halos is prohibited under conditions that are characteristic of post-mortem blood excretion from washed wounds, findings which suggest that the washing hypothesis is not consistent with what is observed on the Shroud."*

Since the HST shows both bloodstains surrounded by serum halos and bloodstains lacking it, it is considered important to better clarify this finding, which is also useful for the present analysis.

The finding that the formation of serum halos does not occur for post-burial bleeding of blood from washed wounds implies that only some of the bloodstains present on the HST-specifically, those lacking serum-originate from cleansing of the corpse (a quick and superficial cleansing because the Sabbath was approaching, a day of rest for Jews).

In contrast, those showing serum halos on the HST derive from unwashed bloodstains likely dripped from the corpse while still hanging on the cross (according to Jewish law, in fact, post-mortem blood was not to be washed away).

Given the result obtained in Ref. [30], it is now easier to distinguish on the HST, at least as a first approximation, between

bloodstains with serum-halos attributable to the body still on the cross (for example that of the chest due to a lance, those of the wrist and on the feet due to nails and some on the nape of the neck due to a crown of thorns and some scourge marks on the back) and non-serum bloodstains related to post-burial bleeding that occurred in the sepulcher after a superficial cleansing.

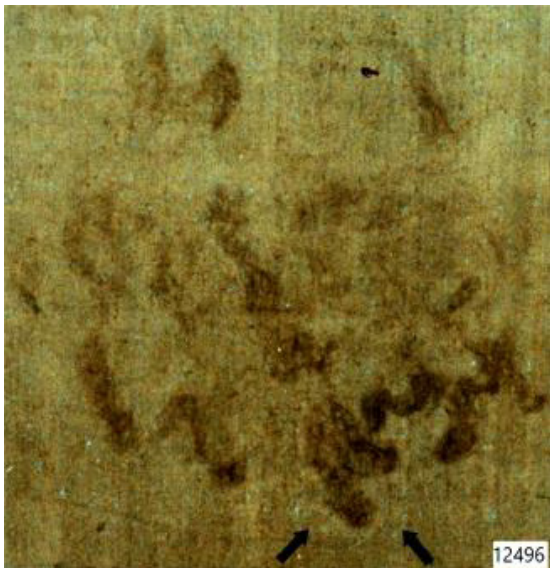

Figure 2: Bloodstains at the nape of the neck photographed under UV [31]. The bloodstain at the bottom centre (see arrows), shows a halo that could be of serum.

It seems therefore possible to more clearly distinguish which areas were subjected to a probable quick cleansing and which were not washed in accordance with Jewish law.

Regarding the bloodstains on the nape of the neck, **(Figure 2)** highlights the brighter outline of a bloodstain that could be traced back to a serum halo. This would therefore show that this bloodstain on the nape of the neck was not washed, as one might expect.

Materials and Methods

For the analyses, the following photos were used: colour photographs taken in visible light by Gian Durante in 2000 and 2002 and photographs taken by V. Miller in 1978 [31], which were recently made available on the Web (Ref. [31]). As is known, these UV photographs highlight the fluorescence of the serum that often surrounds bloodstains of the HST and enhance the contrast between the bloodstains and the background.

To improve the digital images and thus highlight the details of interest, contrast and brightness were adjusted. Filtering was applied both through histogram adjustments on the individual R, G and B channels and through the direct and inverse Fourier Transform (FFT), using the following software: Matlab®, ImageJ®, GIMP® and Jasc Paint Shop Pro®.

Specifically, an attempt was made to reduce the effect of the fabric weave through FFT filtering, as well as by subtracting the analysed image from the same image post-processed with Sobel filters to highlight edges. However, it was observed that these filtering methods also made the relevant details less visible. Therefore, it was preferred to refer to the images containing the original fabric weave to avoid losing important information.

For the experimental tests, the first step was to select the fluid intended to simulate human blood. A mixture was prepared consisting of vinyl glue and water in a 10:1 ratio, enriched with a red dye to achieve a blood-like coloration that would leave a visible halo on the cotton fabric used as a model to represent the HST.

These choices were informed by physical parameters such as viscosity-which should be equal to 4 for human blood-and by forensic-medical hypotheses, which posit that post-mortem blood has a higher density than circulating blood.

To simulate the effect of blood dynamics exiting wounds, a PVC balloon-previously perforated and filled with the red experimental fluid-was used. This balloon, wrapped in the cotton cloth, was then placed under appropriate internal pressure. Finally, to simulate hair, synthetic locks were used.

Bloodstains and Hypotheses of their Formation

Given that the authors believe in the authenticity of the HST, they assume that the bloodstains visible on the forehead, temples and back of the head-characteristic of injuries caused by sharp, perforating objects—are related to a crown of thorns made from an irregular, flexible weave of thorny branches, likely also leafy, posed on the head of Jesus Christ during His Passion.

The correspondence between the frontal and dorsal images of the HST anatomically consistent with the alignment when the cloth envelops a body reinforces this hypothesis.

Based on the distribution of wounds around the head, the hypothesis of a crown of thorns consisting of approximately three intertwined branches appears much more plausible than the hypothesis proposed by some authors of a helmet-like structure made of thorny branches.

Among thorny plant species, hawthorn is one of the most plausible, particularly a species such as *Rhamnus lycioides*, a plant native to the Jerusalem area.

Observing **Figure 2**, a certain directionality of the bloodstains can be noted, especially concerning the more vivid blood trickles shown in the lower part of the same figure. These bloodstains probably correspond to the last discharges from the scalp in temporal terms and were produced when the crown of thorns was removed from Jesus's head.

According to the Gospels (Matt 27:29; Mark 15:17; John 19:2-5), the crown of thorns was placed on Jesus's head after the flagellation, but it was obviously removed during the undressing before crucifixion. If, as is likely, it was then placed back again on His head during the crucifixion, this crown would have caused additional injuries, which would have produced the darker trickles of blood once it was removed before burial.

This directionality-from top to bottom and from left to right-most likely depends on the local gravitational force consistent with that orientation of the head. Considering that the HST image is a mirror image, this suggests that Jesus's head was tilted to the left at the moment those trickles formed.

This could have happened when Jesus was taken down from the cross-perhaps during the un-nailing of the right hand, causing the body to rotate to the left-or when the corpse, laid on the burial slab, was partially rotated to the left, possibly for a hasty cleansing.

It is interesting to observe that Ref. [28] reports, in Section 4.2, a leftward directionality of the bloodstains in correspondence

with the side wound. It is inconceivable that this confirmation of the directionality of a 3D body in both frontal and dorsal images would have been considered by a hypothetical artist intending to produce the HST.

In agreement with Ref. [30], since some of these bloodstains' present serum halos, as indicated by the arrows in the same **Figure 2**, it is assumed that this blood flowed after death but did not originate from post-burial trickling following a subsequent cleansing.

To better highlight certain details of the bloodstains located at the nape of the neck, an image processing technique based on the adjustment of contrast and brightness was performed, see **Figure 3**.

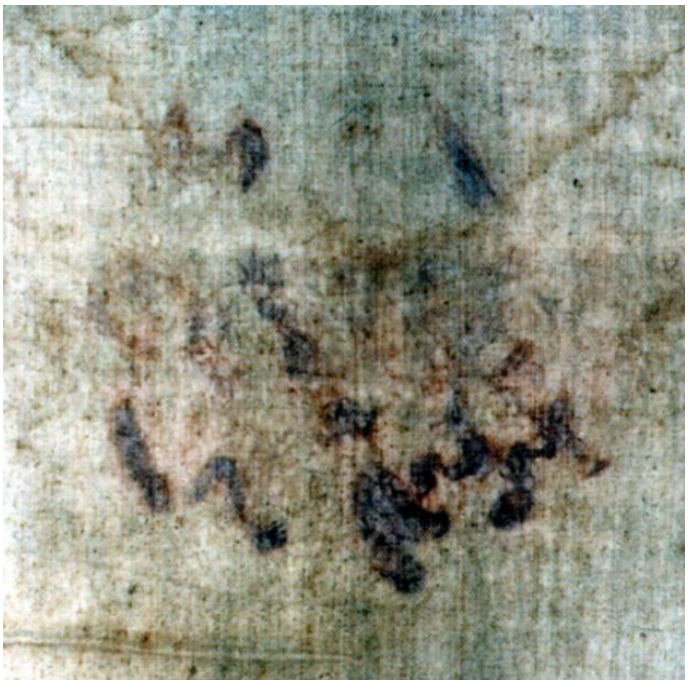

Figure 3: Image processing of Fig. 2 to evidence the bloodstains on the nape of the neck.

The peculiar angular profile of some bloodstains suggests the presence of objects interposed between the back of the head and the HST. These objects would have influenced the path of the blood flows in the occipital area. If the branches were leafy, it is easy to identify these objects as leaves, as hypothesized by O. Scheuermann in 1983 [32]. It can thus be assumed that some leaves possibly of *Rhamnus lycioides*, see **Figure 4** remained tangled in the hair, due to adhesion to clots and that these then interfered with the path of the blood fluid. For example, **Figure 5** shows a possible interference between bloodstains on the HST and leaves.

At the top, the peculiar angular profile of some bloodstains on the back of the head in the post-processed image of **Figure 3** does not rule out the presence of leaves. At the bottom, possible overlap of *Rhamnus lycioides* leaves on these bloodstains.

Finally, it is worth noting the peculiar nature of many bloodstains on the nape of the neck. They exhibit irregular circular shapes characterized by a light central point and a darker outer contour, often serrated because they follow the linen twill of the HST, see **Figure 6**.

These shapes suggest the possible presence of external corpuscles, such as small stones or aromatic substances like myrrh (perhaps mixed with aloe), which are also mentioned in the Gospel of John (19:39-40).

Unlike other bloodstains present on the HST, those on the nape of the neck display two distinct chromatic areas imprinted on the linen: a lighter rounded zone, which appears to represent the imprint of the corpuscles in question, surrounded by a darker outer area that frequently blends with the rest of the bloodstains.

Figure 4: Leaves of *Rhamnus lycioides* (actaplantarum.org/forum/viewtopic.php?t=38880).

Figure 5: Possible interference from objects interposed between the HST and the back of the head.

These circular shapes are present both in the more pronounced bloodstains, which can be attributed to trickling that occurred during burial and in the fainter, lighter ones, which are believed to have formed at an earlier moment.

We can therefore think that direct contact between the cloth and hair soaked in blood and ointments may have generated these particular formations. However, the light, rounded imprints suggest the addition of corpuscles of a different nature distributed almost uniformly across the entire posterior region of

the head, which somehow reduced or prevented the soaking up of blood onto the linen of the HST.

To better understand how these rounded shapes may have formed, attempts were made to experimentally reproduce them starting from the bloodstains of the nape of the neck.

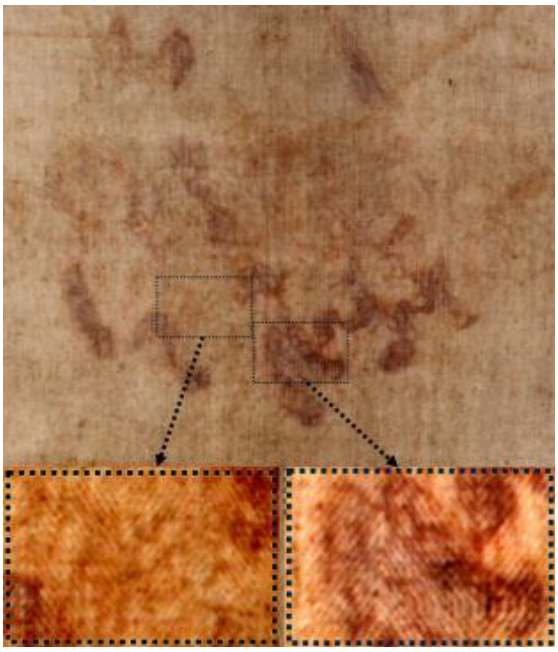

Figure 6: Image enhancing of bloodstains on the nape of the neck evidencing irregular circular shapes characterized by a light central point and a darker outer contour. They are both evident in both in the more pronounced bloodstains on the right and in the fainter, lighter ones on the left.

Experimental Tests and Results

To better interpret the peculiar bloodstains on the nape of the neck, which display sharply defined edges, experimental tests were conducted using a red vinyl fluid diluted with water.

The first test aimed to verify whether the bloodstains could have resulted from a simple dripping of blood through the hair under the sole influence of gravity. A synthetic lock of hair was placed on a flat horizontal surface, with fabric positioned beneath it. The red fluid was then allowed to fall freely from above.

A partial filtering effect by the hair was observed; however, the shape of the stain produced on the fabric differed significantly from that of the actual bloodstain. Specifically, the shapes and distribution of the stains obtained did not match in terms of either quantity or directionality, thus ruling out the hypothesis of simple vertical dripping.

The second test was then performed to simulate the slow leakage of blood from a wound in the occipital area, taking into account the contact force exerted by the weight of the head on the sheet through the humid hair.

To do this, the occipital region of the head was simulated using a PVC balloon, pierced in the area of the nape with pinpoint cuts compatible with wounds caused by a crown of thorns. The aqueous mixture of red vinyl glue was introduced into the deflated balloon, which was then inflated, placed over a lock of hair and finally pressed to simulate head-to-sheet contact, see **(Figure 7)**.

The result, shown in **Figure 8**, evidenced drips that were less abundant as in the first test and more regular compared to simple dripping.

The third test attempted to reproduce the observed well defined shapes, characterized by a central unstained lighter area surrounded by an angular profile with a very well-defined outline.

To conduct this test, the hypothesis was based on the idea that these marks could have been produced by leaves, placed between the hair and the cloth as suggested by O. Scheuermann [32].

Figure 7: Experimental test performed simulating the occipital region using a PVC balloon. The balloon filled with red fluid (top) was then pierced (center) and, pressurized, brought into contact with hair and fabric.

A leaf was therefore placed between the hair and the fabric, as shown in **Figure 9**. Using the same procedure as the second test, with the addition of leaves between the hair, the experiment yielded shapes morphologically very similar to those observed on the HST, with angular edges and a central area without traces of color.

In agreement with O. Scheuermann [32], this result is therefore not inconsistent with the hypothesis that plant material was placed between the back of the head and the fabric on the HST and it provides support to the hypothesis that plant materials contributed to the formation of some traces on the HST.

Figure 8: Simulated bloodstains on fabric during the second test.

Figure 9: Third test: on the top experimental setup, on the bottom shapes morphologically very similar to those observed on the HST, with angular profile and a central area without traces of color.

The fourth test, perhaps the most significant one, was conducted to experimentally reproduce an interesting characteristic observed on the HST. The bloodstains display small, irregular, rounded shapes within them, with a dark border and lighter spots inside, as highlighted in **Figure 6**. These shapes are evident both in the more pronounced bloodstains and in the fainter, lighter ones and are not easy to reproduce.

Several experiments were therefore carried out using various materials placed between the hair and the cloth or positioned beneath it. In particular, small spheres such as fishing lead weights, discs and pebbles a few millimetres in diameter were initially used, placed either between the support surface and the cloth under the PVC ballon with hair simulating the human head or between the cloth and the PVC balloon with hair. Tests with these materials placed between the support flat surface and the cloth yielded negative results, while those simulating the presence of rounded objects placed between the hair and the cloth appeared promising.

Based on these results, it was then hypothesized that, given the documented use of myrrh as a substance employed in funeral rites, grains of natural myrrh might have been placed beneath the head with hair, to better preserve the corpse.

In this final configuration, after the experimental red fluid had dried, the result obtained showed a remarkable resemblance to the pattern observed on the HST: the stains appeared light in the centre with a dark border, matching both in shape and size, **(Figure 10)**.

It is thought that myrrh, composed of essential oils, gum resins and phenolic compounds, partially dissolved upon contact with the red fluid (and thus also with contact of human blood), forming a viscous reddish-brown fluid similar to the outlines of the marks detected on the HST.

Therefore, to explain the dark border of the rounded stains, the following hypothesis is proposed: during the burial, half of the HST was laid on the stone, upon which, at least in the area corresponding to the head, several grains of myrrh-possibly mixed with aloe for enhanced anti-putrefactive action-were placed. The corpse was then laid down and then the second half of the HST was placed over it.

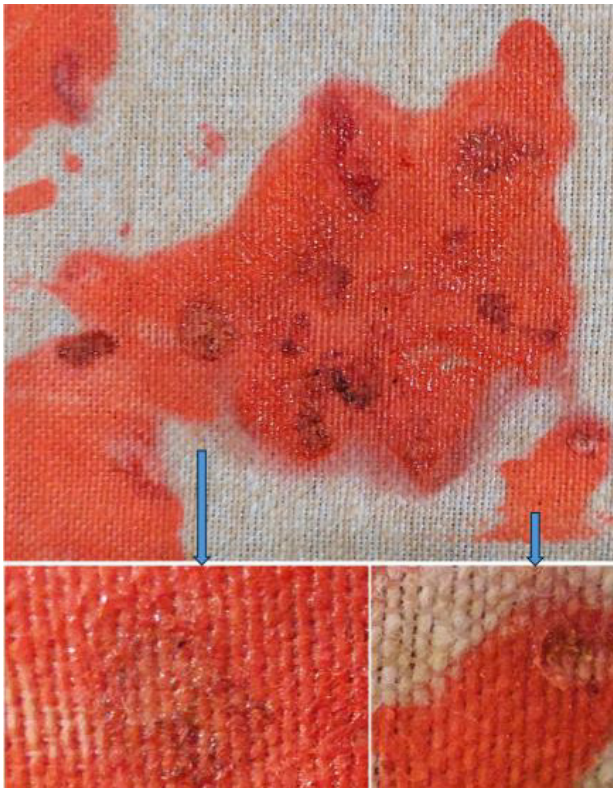

Figure 10: Fourth test: red stains produced by grains of natural myrrh interposed between hair and cloth.

Conclusive Remarks

This study has investigated the origin of the bloodstains present in the occipital region of the body image of Jesus on the HST, based on both image processing and experimental analysis. The multidisciplinary approach, conducted through numerous experimental tests, sought to reproduce the particular bloodstains visible at the back of the head.

It is important to recall that the tests performed are based on models developed from simplified hypotheses, which, while providing valid support, do not yet allow for the absolute faithful reproduction of the complexity of the original events. Nevertheless, many similarities were observed between the results obtained from the experimental tests and the features observed in the analysed areas of the HST.

The initial experimental phases ruled out the possibility that simple vertical fluid flow could explain the traces present on the HST. To achieve a more realistic and consistent fluid distribution with the analysed image, a punctured balloon containing pressurized red fluid was placed in contact with the fabric.

This experimental setup allowed for the exploration and simulation of more complex and realistic conditions, including the insertion of leaves between strands of hair to simulate the angular yet well-defined profile of some bloodstains on the HST. One may therefore hypothesize that the crown of thorns was made of leafy branches, which left some leaves trapped between the hair, blood and sweat after its removal.

The attempt to reproduce the light stains with dark borders visible in the examined area of the HST using solid objects, such as small weights and discs, led to the hypothesis that granular myrrh was used, placed between the strands of hair and the HST. Due to its physical properties, the myrrh produced patterns compatible—both geometrically and chromatically-with those evident on the HST.

Given the interesting results obtained, similar tests could be conducted in the future using a cadaver and human blood. The work carried out thus provides a new contribution to the analysis of the bloodstains on the HST in the occipital region.

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Conflicts of Interest

The authors declare no conflict of interest.

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