Excerpt from

Radiological Aspects of the Shroud of Turin

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There are two aspects of radiological concern in studying the Shroud of Turin that we are considering in this paper. The first aspect results from a study of the radiographs (x-ray pictures) that were made of the Shroud during the major research investigations in Turin in1978, and the foci of our examinations have to do with the side strip and the area from which the specimen was taken for the C14 radiocarbon dating in 1988. The second aspect has to do with the Shroud body images themselves that show various of the skeletal structures. We illustrate these with various photographs and video clips. *(Editor's Note: Only the first aspect is included in this excerpt).*

(Figures 1 & 2) The details of the 1978 radiographic study are described in the paper "Radiological Examination of the Shroud of Turin – A Preliminary Report by Mottern, Landon and Morris, (Ref.: Mottern et al, 1979) In summary, the purpose of the radiographs, as one of many non-destructive tests, was to collect data on the body images, on the other markings, and on the linen itself. A Baltograph 5-50 x-ray unit was operated at 15 kVp with filtration to obtain maximum contrast for the delineation of the features. The specially designed examination table to which the Shroud was attached by magnetic strips had removable panels, so that only the fabric was between the film packets and the x-ray source. Positioned just above the Shroud was an open frame with wires strung horizontally and vertically to provide orientation and measurement. The examinations were made by a series of three exposures of the film packets across the width of the cloth, with some overlaps. Two different types of x-ray film were in each packet to provide good contrast and resolution characteristics. A total of forty-two dual-film packets were exposed. For the many technical details, the original paper should be consulted. The resolution of images was felt adequate to visualize the individual linen threads of the Shroud which are about 0.15 mm in diameter.

(Figure 3) In the initial report a number of observations were made. The details of the Shroud and a backing cloth were observable, but neither the body images nor the bloodstains were discernible. The water stains are seen, as are the various patches, stitches, creases, seams, and some tiny foreign objects. Of particular interest to us was the observation on the seam that runs the full length of the Shroud about 8 cm from the edge on the anatomic left side of the Man of the Shroud. This seam is about 4-5 mm in width. It was not completely clear, but it was felt initially that this was a so-called flat-fell seam attaching two pieces of fabric together.

We are reporting on three observations on the set of copies of the Shroud radiographs to which we had access. This set was not complete, consisting of only thirty-five of the radiographs (i.e., seven were missing). We examined them on our own and in conjunction with Dr. Alan Adler and several radiologists.

(Figure 4)First, we examined the so-called side strip and its seam, about which there have been questions and disagreement. In 1982 after studying the radiographs taken in 1978, Schwalbe and

Rogers reported that there is continuity of the threads from the Shroud into the side strip and concluded that the Shroud and the side strip are of one piece. (Ref.: Schwalbe & Rogers, 1982) We studied the same area also, trying to discern whether the side strip is 1) a completely different piece of linen which had been joined to the edge of the Shroud, 2) a piece of the original Shroud which had been detached but was then carefully reattached by the seam, or 3) an integral, continuous part of the Shroud fabric with the seam being really a tuck in the cloth for some reason.

(Figure 5) A joint paper, "Concerning the Side Strip on the Shroud of Turin," (Ref.: Adler et al, 1997) was presented at the May 1997 Nice Symposium in which we reported our findings from tracing several thousand of some 15,000 weft threads from the body of the Shroud through the seam and into the side strip that there is near-perfect alignment of nearly each thread in position, thickness, and intensity. Also, we found no evidence of frayed thread ends either in the seam or along either side of it. Our conclusion then was that the side strip is continuous with the rest of the Shroud.

In March 2000, Flury-Lemberg presented a paper, "The Linen of the Turin Shroud," (Ref.: Flury-Lemberg, 2000) dealing with technical and archaeological characteristics of the fabric. She had worked directly with the Shroud as a fabric specialist. She felt that originally the fabric had been cut into three lengthwise strips, two wide and one narrow, and that later the narrow strip (now the side strip) was expertly reattached to one of the wide strips by the seam to produce what we now know as the Shroud.

Later, we reexamined the radiographs as well as photographic enlargements of portions of them to get a better understanding of the side strip and the two missing corners (MC) at the frontal and dorsal ends on the anatomic left side of the Shroud.

Mary is very experienced in working with sewing and handling fabrics. Following the seam its full length on the Shroud, it is remarkably uniform for almost the entire length except for the two ends near the MC. The weft threads can be traced from the Shroud through the seam continuing into the side strip in near perfect alignment. The seam appears to be a simple tuck (a portion of the cloth folded over on itself) in the Shroud fabric, which is meticulously hand-sewed in place on both sides of the tuck.

(Figures 6) For most of the length of the seam, the sewing technique used to stitch the tuck in place might be called a wide, relaxed running stitch, an s-shaped stitch. Generally, on one side of the seam the needle carrying the thread was inserted under two or three threads of the body of the Shroud fabric, then skipping two or three threads, the needle was inserted under two or three threads in the tuck itself; then again skipping two or three threads, the needle was again inserted under two or three threads in the body of the Shroud; and so on for most of the entire length of the seam. (Figure 7) This type of s-shaped running stitch can be seen on both sides of the tuck, but generally on the lateral side (the side strip side) most of the stitches in the body of the Shroud are the distance of two or three warp threads away from the edge of the tuck, thus allowing more flexibility. Generally, the stitches into the body of the Shroud on the medial side of the seam (the body image side) are placed almost flush with the edge of the tuck, thus ensuring greater

stability. Mary suggests that the stitches on the medial side were placed first for stability, then the Shroud was turned over and the lateral edge was stitched.

(Figures 8) As the seam approaches each of the MC areas, it becomes irregular, more dense, and harder to interpret, possibly becoming a rolled seam. On the frontal end, this change begins about 1/3 inch (1.5 cm) above (cephalad, or toward the head) the junction of the end of the side strip at the MC. Variations in the radiodensity of the various bands of the Shroud fabric are noted. Various wrinkles and folds can be seen as well. The area where the Raes sample fabric was taken in 1973 can be seen extending distally from the tip of the seam. (Figures 9 & 10) This is an irregular band of threads with increased radiodensity immediately adjacent to much of the length of the seam that borders the MC, extending variably out about 5/8 inch (1.7 cm) into the Shroud fabric.

(Figure 11) On the dorsal side, the irregular changes in the seam begin about 1¼ inch (3 cm) above the junction of the side strip with the MC. It is much more difficult to trace the weft threads through the seam and the stitch pattern is unclear, but some whip stitches may have been used. There is definite increase in the radiodensity of some both warp and weft threads extending variably both into the body of the Shroud and the side strip for about 3/8 to 5/8 inch (1.5 to 1.7 cm) extending distally from the point where the structure of the seam changes. (Figure 12) The weave pattern in the side strip in this small area is irregular and some of the herringbone pattern is apparently lost, both in the body of the Shroud and in the side strip. The damage in the dorsal MC area appears more significant and the repairs less well done than in the frontal MC area. Some small folds contribute to the problem of interpretation.

(Figure 13) On the basis of these observations, we would make several speculations. We think that the two corners (the MC areas) were already damaged and possibly partially missing before the seam was put in. They may have been removed at the time the seam was put in as part of the process of repairing and strengthening the Shroud, and to make the areas neater (as well as to provide a source of relics). We suspect that the corners were damaged during ostensions (public displays) when the Shroud was always held up by the same edge, thus putting stress on the same side and especially on the corners. The fabric immediately adjacent to the two MC areas likely was damaged or weakened also, and so meticulous repair and reweaving of these areas may have been done to restore the general appearance and to prevent further damage. Our observations of the radiographs indicate that possible repairs or reweaving (other than the stitches and patches around the scorched and burned areas) were essentially limited to these two corner areas next to the sites of the MCs.

We speculate that the fabric repair and the creation of the seam were done at the same time, after which the Holland backing cloth was attached. We marvel at the extraordinary skill, care, and patience that were manifested during the process by those doing the work.

(Figure 14) The second focus of our examinations was the area from which the specimen was taken for the C14 radiocarbon dating in 1988. Our attention was directed to this area when the C14 test results dating the Shroud to AD 1260-1390 were announced in October, 1988. The original article, “Radiocarbon Dating of the Shroud of Turin,” published in *Nature* and referring to the sample used for dating stated that “the strip came from a single site on the main body of

the Shroud away from any patch or burned areas" and the test provided "conclusive evidence that the linen of the Shroud of Turin is medieval." (Ref.: Damon et al, 1989)

We knew the announced date was incorrect because we had previously dated the Shroud to AD 30 by the presence of two identifiable Jewish coins over the eyes both dating to AD 29 and by the abrupt appearance of art works influenced by the Shroud in AD 31. In addition, the presence on the Shroud of images of multiple flowers substantially supported by identifiable pollen grains also from the Shroud of spring-blooming plants, all of which grow in Israel, indicated the place of origin to be the Near East and not Europe. (Ref.: Danin et al, 1999) Wondering how such an erroneous dating could have happened, we obtained a copy of the videotape of the taking of the single specimen. (Figures 15 & 16) On examining the videotape in detail frame by frame, we noted that the sample contained the seam and that, as the sample was pulled taut and cut, there were many weft threads that stood out very prominently from the seam extending across the sample used for the radiocarbon dating and into the Shroud fabric as far as 1½ inches (3.5 cm). These threads appeared to be very stiff, and it occurred to us immediately that this area had been rewoven, repaired, or reinforced. We unofficially presented this finding and our interpretation of it at the Shroud Conference in Paris in 1989. We published these findings in 1998. (Ref.: Whanger & Whanger, 1998)

There has been great controversy and difference of opinions and observations. For instance, Jackson, Propp and Fornof in 1999 stated that viewing the C14 sample area on transmitted light photographs disproved the hypothesis that the Shroud was rewoven in that area, or that on other observations there were no "alien threads intruding into the radiocarbon sample." (Ref.: Jackson et al, 2000) Again, after examining the Shroud during the conservation activities of 2002, Flury-Lemberg reported in Sindone 2002 (Ref.: Flury-Lemberg, 2003) that concerning the hypothetical reweaving of the 16th century, "there is no doubt that the Shroud does not contain any reweaving."

From the opposite viewpoint, Marino and Benford reported in a paper in 2000, "Evidence for the Skewing of the C14 Dating of the Shroud of Turin Due to Repairs," (Ref.: Marino & Benson, 2000) that there is definite evidence for repairs to the fabric at the area of the C14 sample. Most recent, the paper by the late Dr. Ray Rogers on "Studies on the radiocarbon sample from the Shroud of Turin" (Ref.: Rogers, 2005) showed aberrant coated threads in the C14 specimen. This was confirmed by the report by Brown, "Microscopical Investigation of Selected Raes Threads from the Shroud of Turin," that light and SEM microscopy showed the presence of dye-coated fibers and spliced threads in the sample, indicating late addition material. (Ref.: Brown, 2005)

(Figure 17) To help clarify this issue, we examined in detail the area of the C14 specimen on the radiographs. An irregular band of threads with increased radiodensity and extending variably about 5/8 inch (1.7 cm) into the Shroud fabric is noted immediately adjacent to much of the length of the seam that borders the frontal MC. In a close-up view of the area where the Raes sample and the single C14 sample were taken, irregularities in some of the weave pattern can be noted on the Shroud fabric adjacent to the seam. (Figure 18) There is significant variability in the radiodensity of both warp and weft threads in this area. Some of the threads angulate, and the continuity of a few seems to be broken. This area is denser and the 3:1 herringbone weave pattern is much less obvious than in the nearby body of the Shroud fabric.

Our conclusion is that the radiographs are strongly suggestive of significant alterations in the threads and weave of the Shroud fabric in the area from which the C14 specimen was taken, thus casting major doubts on the validity of the radiocarbon dating.

(Figures 19 & 20) A very interesting finding is that a single weft thread has been extracted at about the midway level of where the Raes sample was removed, beginning about 1 cm medial to the rolled seam that reattached the Shroud to the backing cloth. The space of the missing thread appears to be about 8 cm in length. We do not know the history of this particular thread, but Dr. Alan Adler had a thread about 8 cm in length that came from the Shroud that he acquired in the early 1980s from an unidentified source. He detected what he referred to as starch on one end of this thread. He then had a very unofficial and admittedly inadequate radiocarbon dating done on each end of this thread in 1983. Reportedly, the starched end tested about AD 1000 and the other end of the same thread tested about AD 200. At a minimum, this would indicate that carbon dating the Shroud might be very technically problematic. Assuming that the thread that Dr. Adler had might have been the one that had been extracted at this site, we may have a highly significant, even if inadequate, finding, since the lateral 1 to 2 cm of this thread would have been in the continuation of the area from which the 1988 specimen was extracted. If this scenario is correct, we may not only have evidence that the 1988 sample-extraction-area is abnormal, but we may also have a much more accurate dating of the body of the Shroud, namely, in the range of AD 200.

The implications of this are considerable, but will not be elaborated in this paper.

We were interested as to whether any of the body images could be detected on the radiographs. The radiographs were placed on a panel of light boxes in a University Department of Radiology and examined by a faculty radiologist in my presence. He and I concurred with the original observation by Mottern et al (Ref.: Mottern et al, 1979) that none of the body images could be discerned.

Conclusions

On studying the radiographs of the Shroud made in 1978, details of the seams and threads can be seen. It appears that the side seam was put in as a tuck, and that near the two missing corners there are variations in weave patterns and in thread densities which suggest that these two areas had been damaged and then repaired in some way. Examination of the site of the C14 single sample indicates that at least part of the sample was taken from one of these repaired or altered areas.

Acknowledgements

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We are well aware that many of our findings and interpretations are controversial, but we hope that they might lead to better studies with better materials and techniques to help better explore and understand the awesome mysteries of this unique object.

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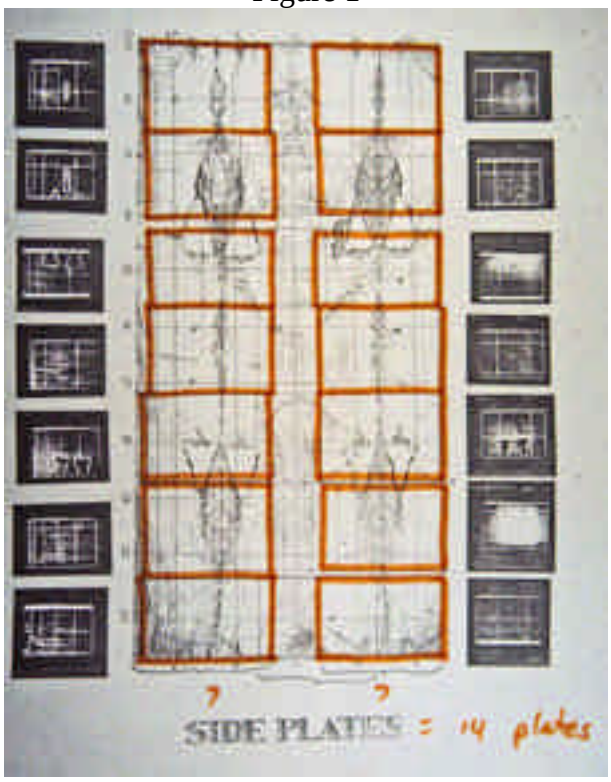
Figures

Figure 1



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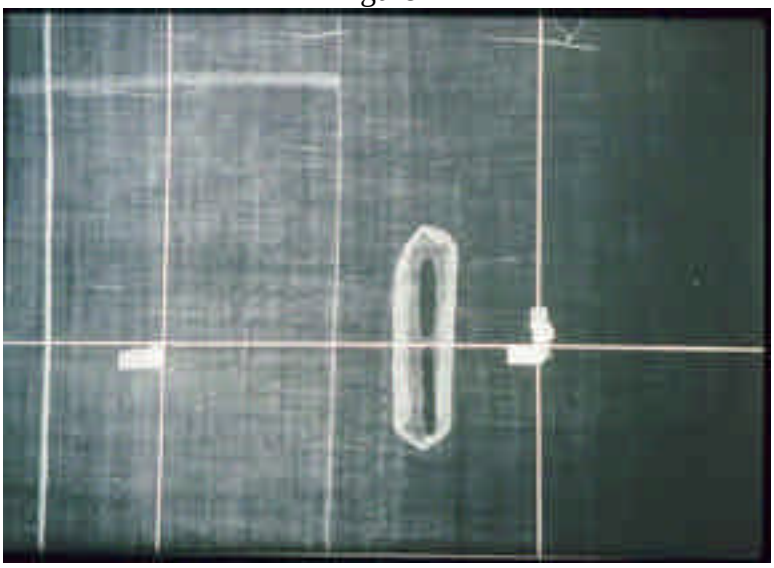

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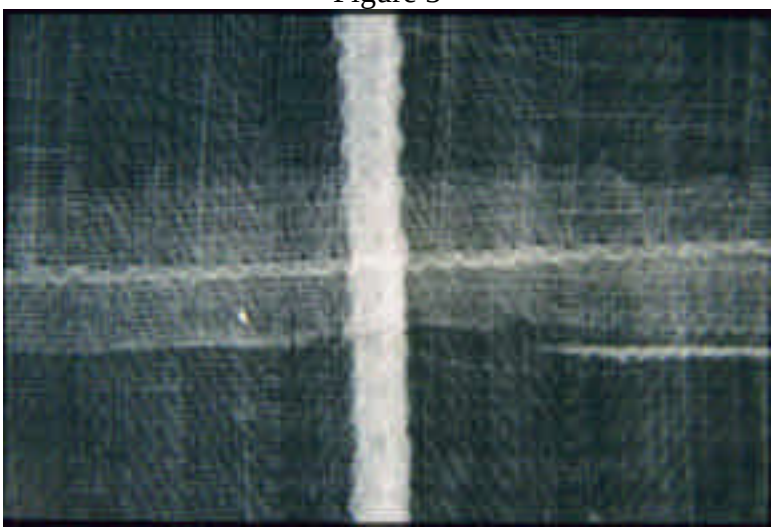

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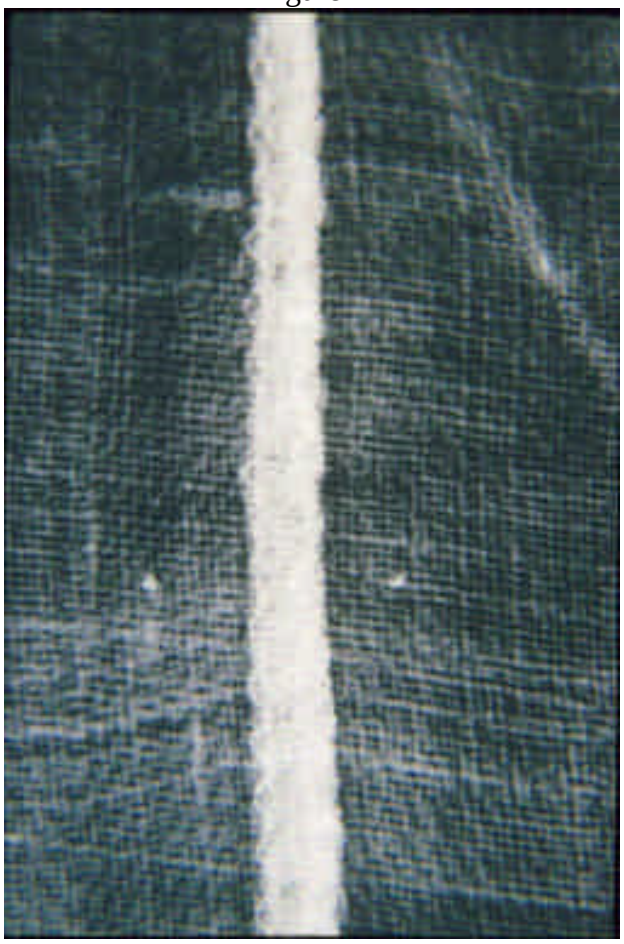

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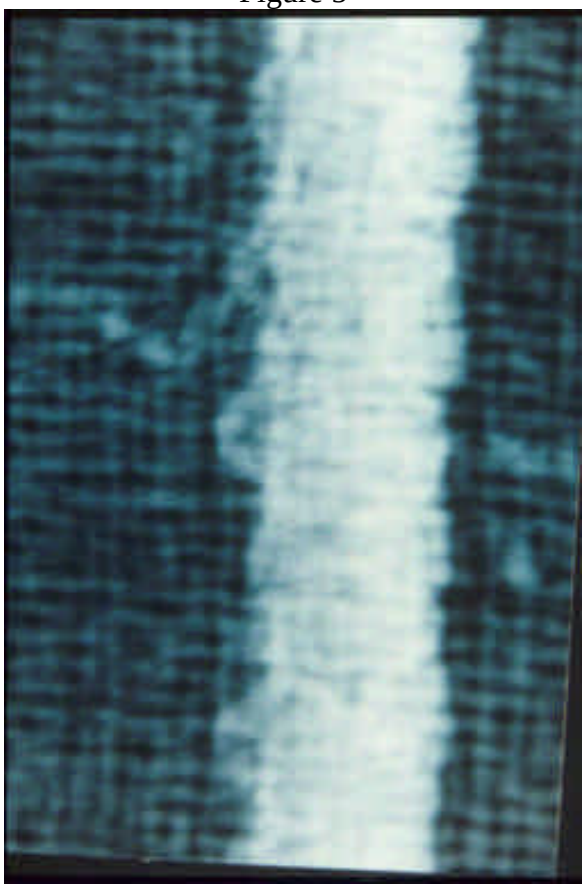

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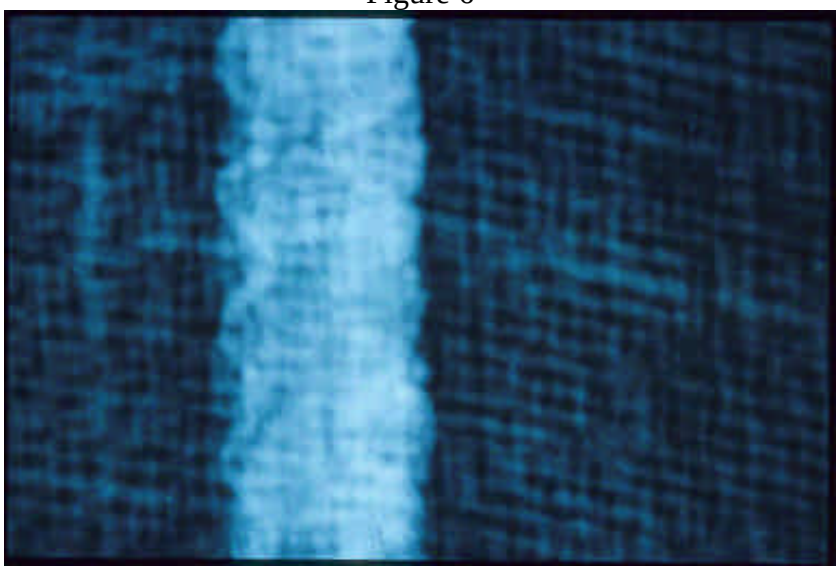

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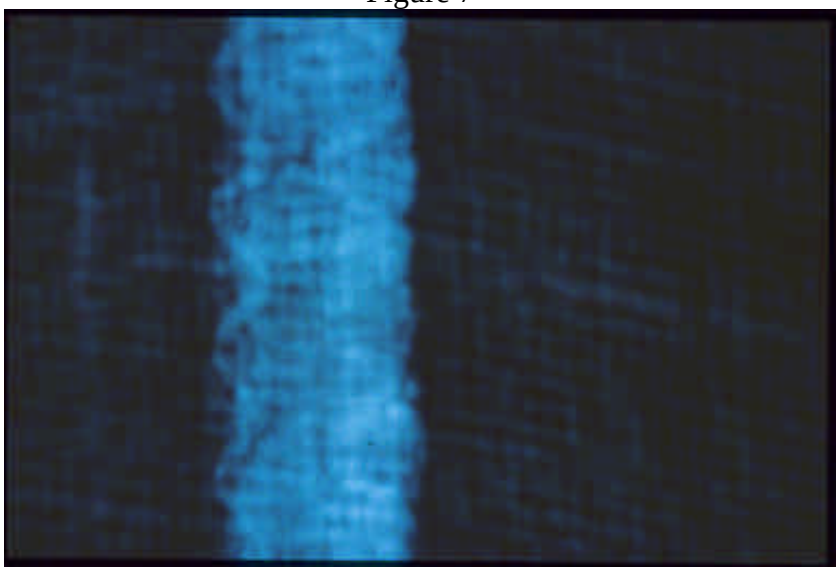

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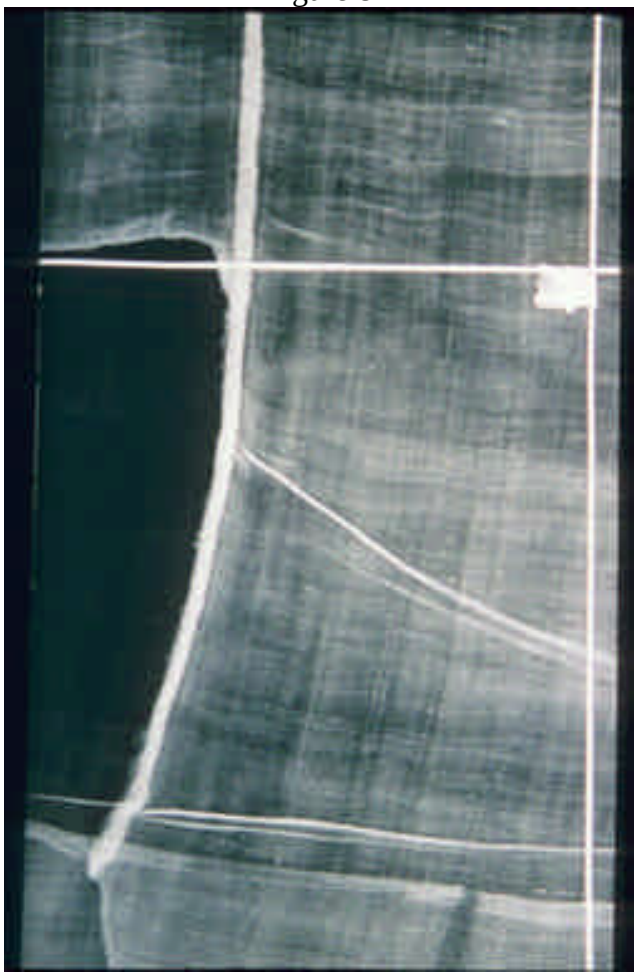

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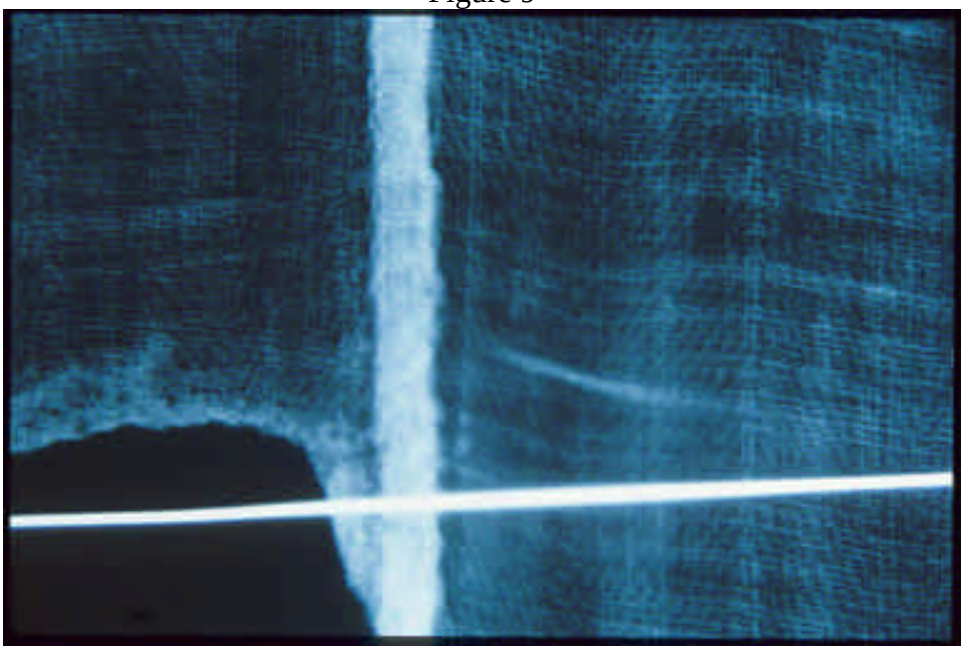

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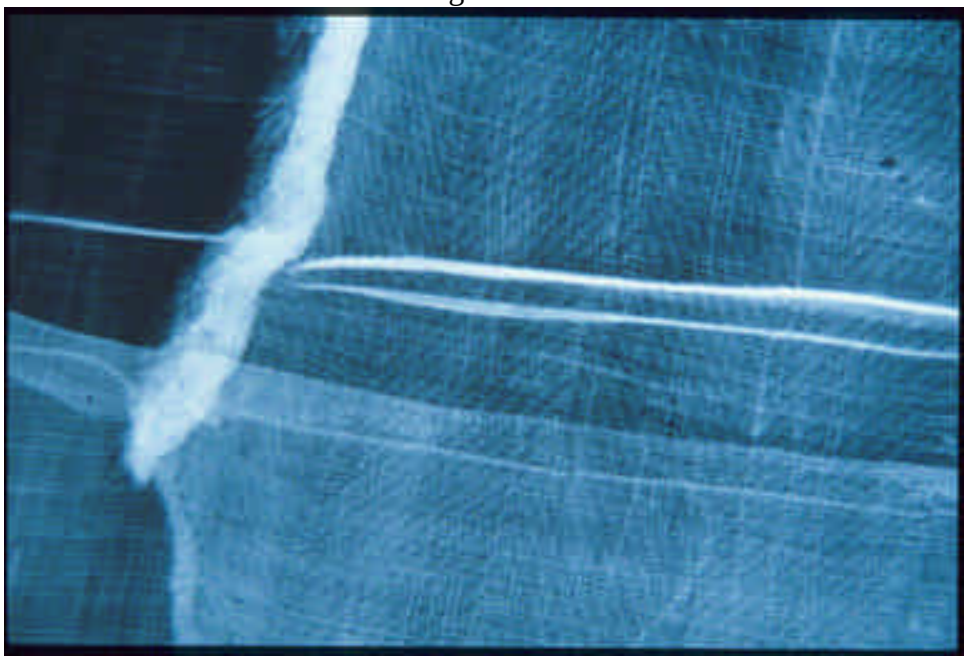

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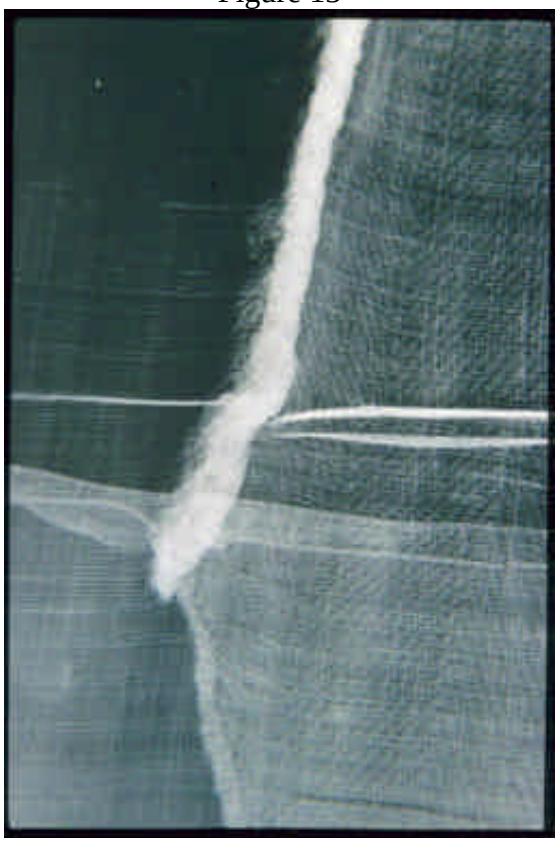

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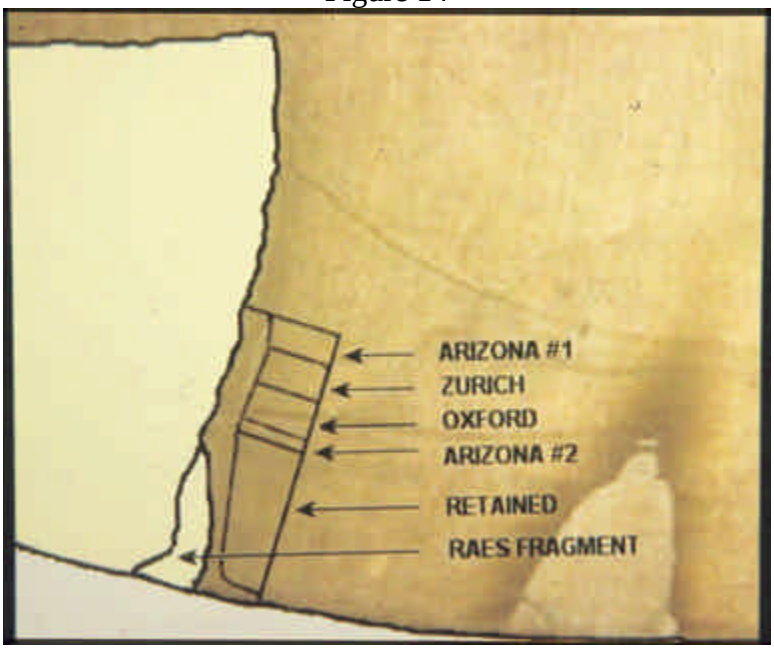

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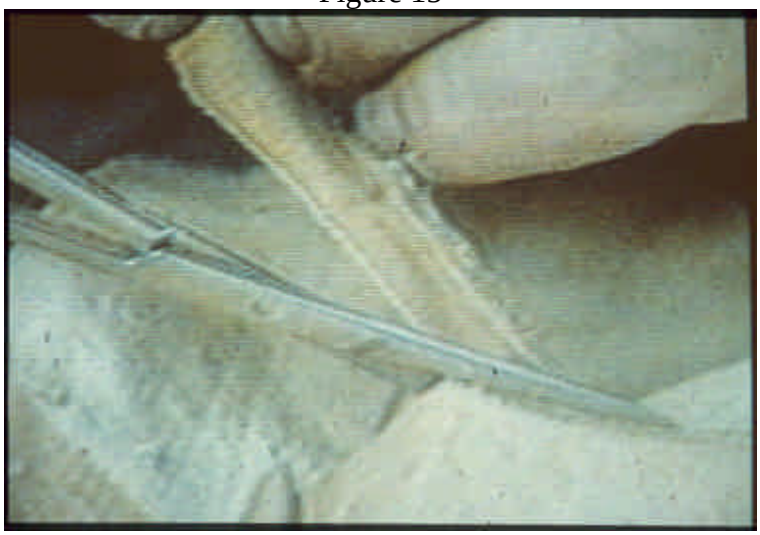

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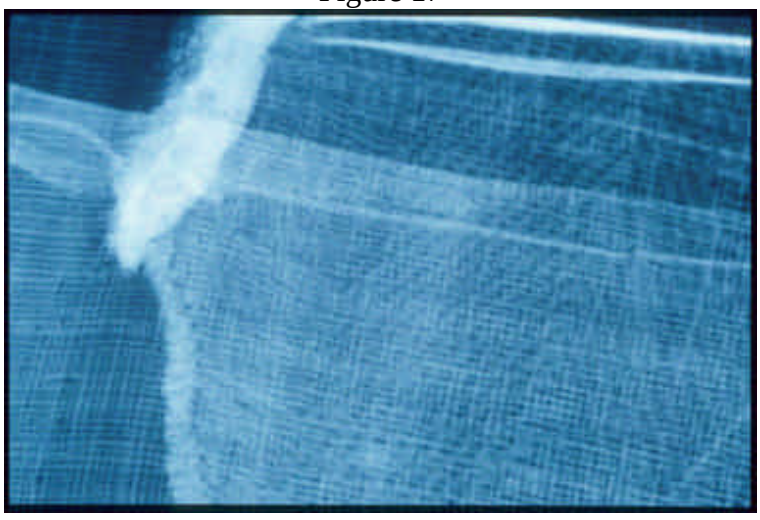
Figure 17



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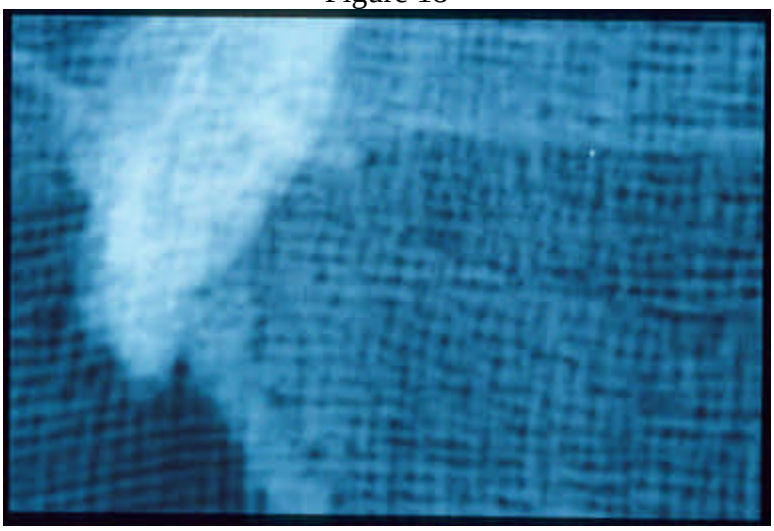

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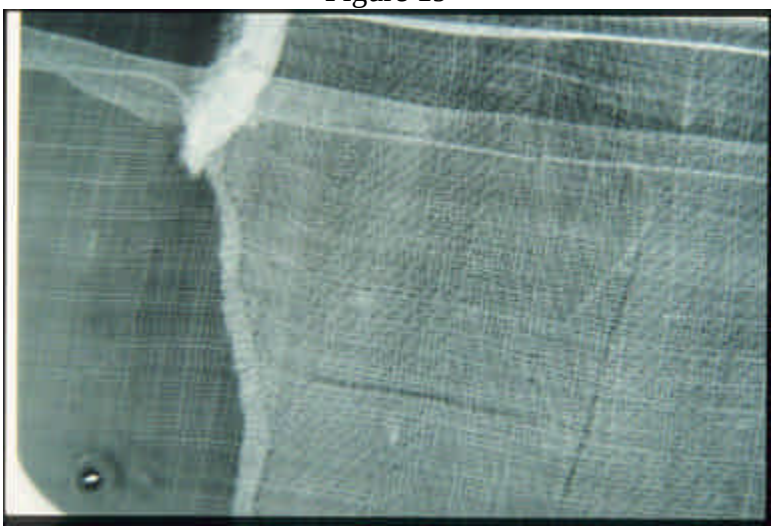

Figure 20