A PRELIMINARY REPORT ON THE USE OF THERMOGRAPHY AS A DIAGNOSTIC AID IN PROSTHETICS

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The need for an objective method of evaluating the stump-socket relationship has long been recognized. Traditionally, the prosthetist has had to rely on such things as the evidence of his own senses, the patient's subjective reporting, and such fitting aids as balls of clay, lipstick, and powder placed within the socket. Sometimes these practices result in the rejection of the prosthesis and the prosthetist by the patient, and, as a consequence, the rehabilitation program for the patient is delayed. To provide more objective information, the Division of Prosthetics and Orthotics at the University of Virginia, the Department of Mechanical Engineering and the Department of Orthopedic Surgery are experimenting with the use of pressure transducers, transparent sockets, and thermography. The reader is undoubtedly familiar with the potentials inherent in the use of the first two aids, but the use of thermography to measure skin temperature as a diagnostic aid in prosthetics has been limited to a very few centers (1), and therefore should be of interest.

Essentially, thermography provides us with a method for measuring differences in skin temperatures and relating them to a uniform scale. Basically the apparatus utilizes a supercooled video scanner, a cathode ray screen, and a Polaroid camera (Fig. 1) (1) (2).

The area to be studied is scanned by the camera and its image is shown on the cathode ray screen in black and white and recorded on a Polaroid film when desired. Depending upon the mode selected, warm areas register as either light or dark, and the cool areas as the opposite. Commonly, we choose to portray the warmer areas on the light end of the scale and the cooler areas on the dark end, and this is the convention followed in this article (Fig. 2). The machine is usually set for a base temperature of 90°F with a range of ±5°. Temperatures of 95°F and beyond register as absolute white, while temperatures of 85°F and below register as absolute black. Temperatures between the two extremes register as shades of gray. Thus our base temperature of 90° registers as a neutral shade of gray in the middle of the two extremes (Fig. 3).

Localized areas with increased blood supply register "warm," and therefore lighter than areas

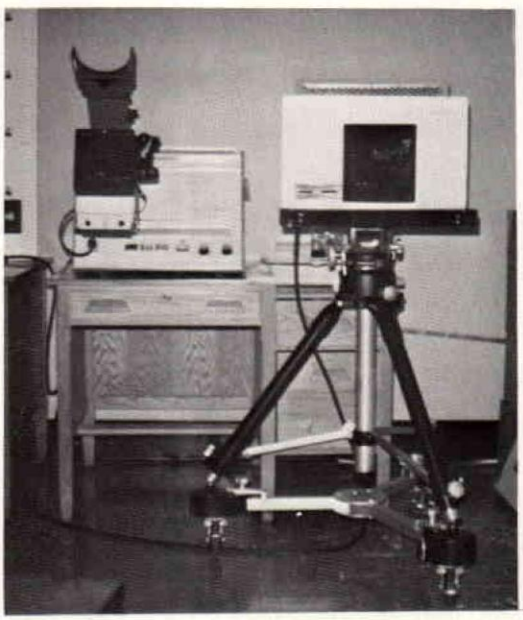

Fig. 1. Apparatus showing scanner on the right and cathode ray screen and attached Polaroid camera on the left.

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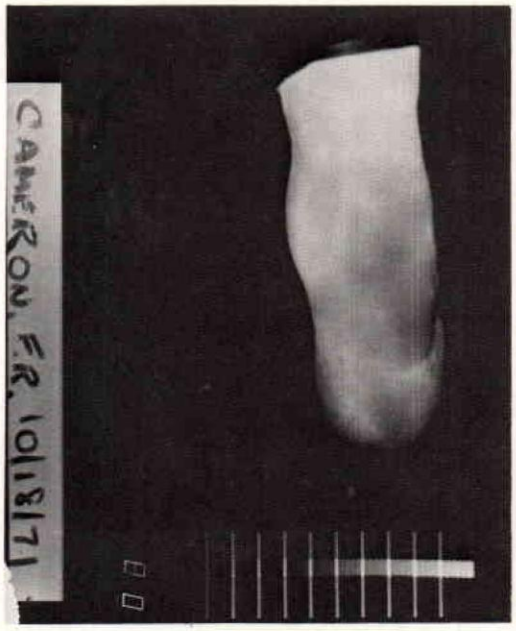

Fig. 2. Thermograph of a right BK stump, anterior-medial view, showing contrasts in gray. Scale on the bottom shows temperatures range from light to dark for comparison with the stump.

with a relatively poor blood supply which will register "dark," and therefore cooler. In the case of limb prosthetics these warmer areas can be attributed to localized pressure and irritation. (The use of thermography is also being evaluated

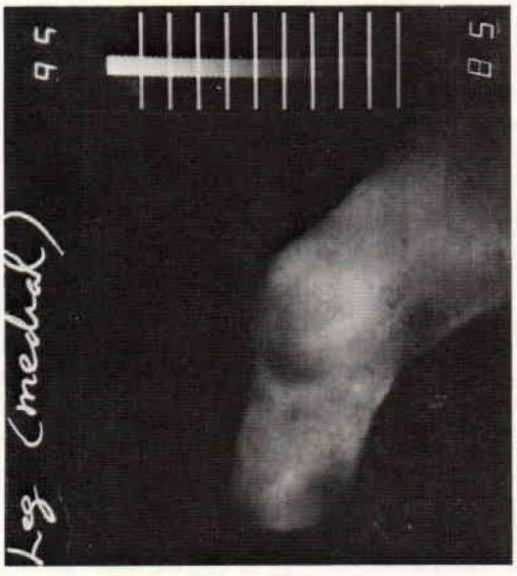

Fig. 3. This picture taken by the camera is a mirror image of the subject studied.

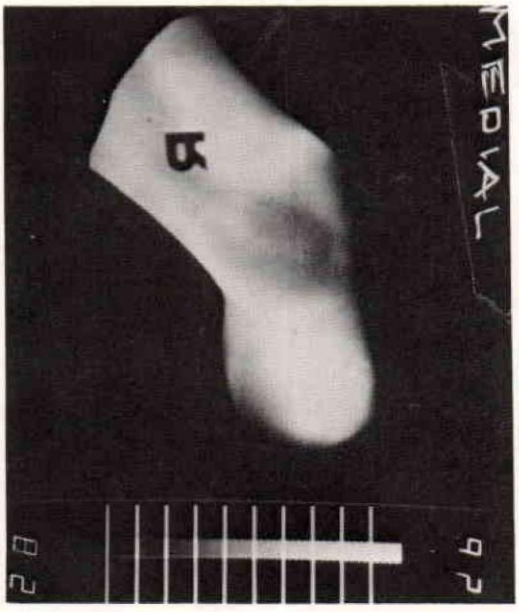

Fig. 4. BK stump showing area of concentrated pressure under the medial tibial flare. This picture is a reverse image of a right stump.

as an aid in determining levels of amputation in cases of arteriosclerosis.) Evidence of pressure over the area of the patellar tendon or the medial tibial flare is considered to be beneficial (Fig. 4). Conversely, evidence of pressure, or irritation, over the distal cut end of the tibia or some other sensitive spot, such as the head of the fibula, is considered to be a potential source of trouble (Fig. 5).

THE PILOT STUDY

In this study, we have attempted to record the surface temperature of the stump at the time of casting and immediately after delivery of the prosthesis. Thermographs of the stump are made from several angles, and serve as a reference should the patient return with complaints of irritation or pain in the stump. The pictures were also used as a basis for attempts at predicting future problem areas. By taking a thermograph later and comparing it with the reference photographs, it is possible to evaluate what effect the socket has had on the stump over a given period of time, and thus determine whether or not the patient really is experiencing trouble, and to locate the exact spot when the trouble is a mechanical one.

Our pilot study has presented us with several clear examples of the potential of thermography

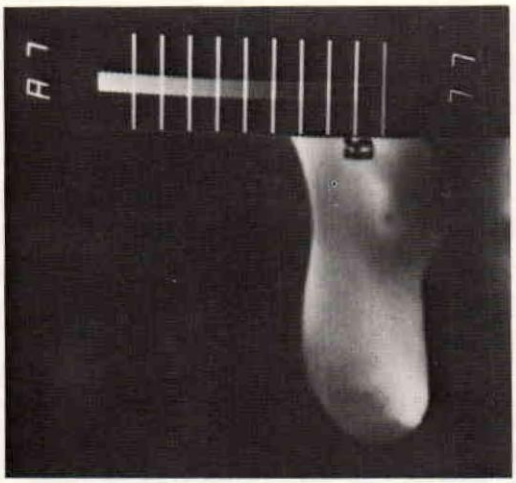

Fig. 5. BK stump showing irritation over the end of the tibia. This picture is a reverse image of a right stump.

as a fitting aid. J. D., an employee of the hospital and a bilateral below-knee amputee as well, was followed as one of the research subjects in this study. J. D. was fitted previously with PTB prostheses on both sides. His prescription was changed to PTS (supracondylar, suprapatellar prostheses) (3) (4). No reference thermographs were taken. After wearing the prostheses for several days, the subject complained of excessive pressure from the supracondylar wedge in the area of the adductor tubercle. He was sent to the prosthetist who advised him to wear the prosthesis as much as possible so he could "build-up" a tolerance to the new pressure areas. At this time a reference thermograph was taken. (It should be noted that the supracondylar wedges presented a

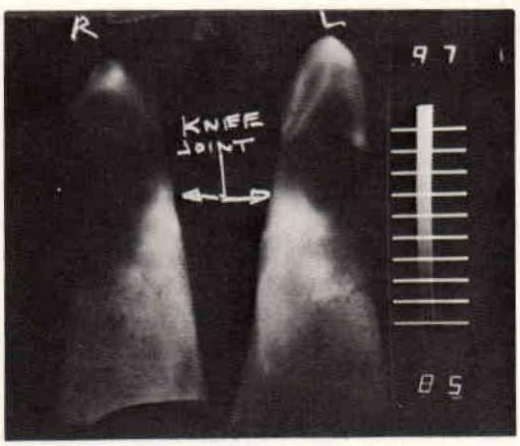

Fig. 6. Thermograph of J. D.'s stumps, showing areas of irritation above the medial epicondyles.

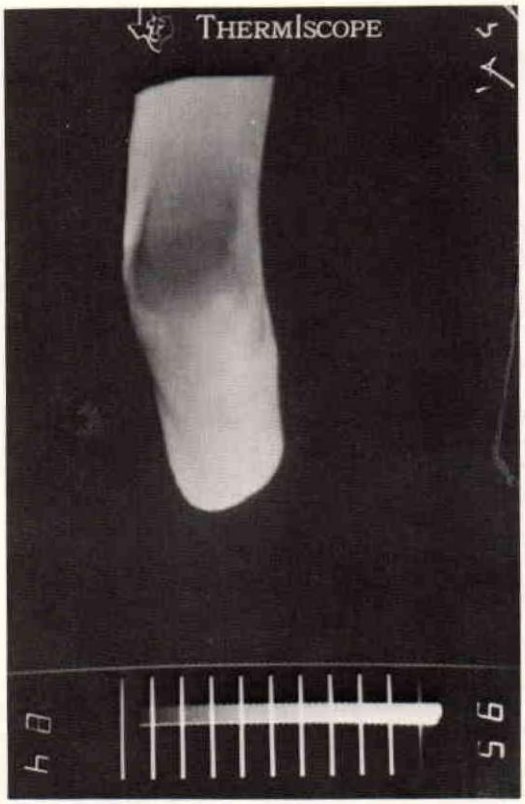

Fig. 7. Thermograph of F.C.'s stump at time of casting.

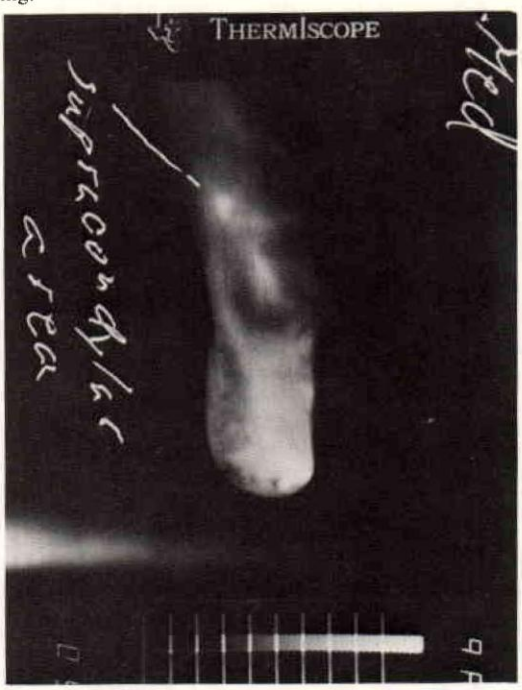

Fig. 8. F.C.'s stump and the area of irritation over the distal end of the tibia as well as some irritation above the medial epicondyle.

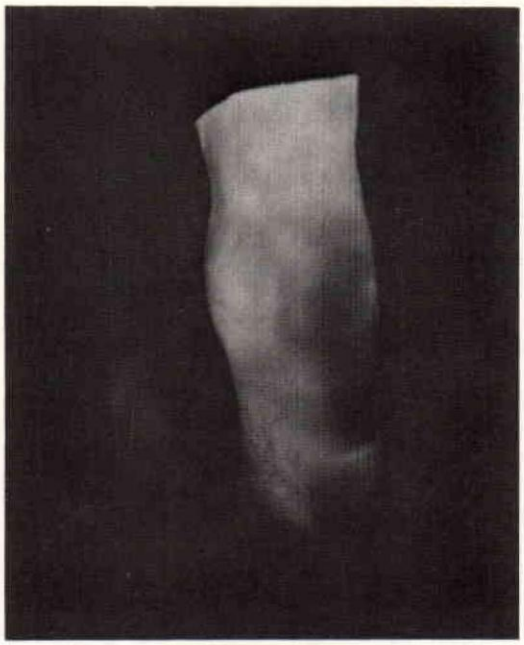

Fig. 9. F.C.'s stump after adjustments were made to the prosthesis. Note that the hot spots have disappeared.

sharp abrupt profile quite the opposite of the broad, flat profile Nitschke and Marschall (3) (4) advocate.) Two days later, the subject was seen again by the prosthetist and displayed an ulcer over the spot the thermograph showed as an area of localized pressure and irritation. A new thermograph of the affected stump confirmed that it was indeed the same area (Fig. 6). Because of these fitting problems, the patient rejected the new prostheses and went back to the use of the old PTB type even though they no longer fitted properly. Clinical use of thermography might have led the prosthetist to provide meaningful relief at the time of delivery, and not just reject the complaints of the patient on the basis that he was unaccustomed to the forces being exerted over the affected area.

F.C. was thermographed at the time of casting and again when the prosthesis was delivered (Fig. 7). After several days the patient returned with complaints of pressure over the anterior distal tibia and along the crest of the tibia. A thermograph was taken that revealed a hot spot in this area (Fig. 8). A "relief" was made by the prosthetist, and the patient was instructed to continue using the prosthesis. A thermograph taken later showed that the warmer spot had disappeared after adjustments to the socket were made (Fig. 9).

CONCLUSIONS

During this study, we had patients come to us and point to certain spots on the stump and state "it hurts here." In studying the thermograph afterwards, it was evident the pain originated in an area other than the one anticipated. It must be stated that the results of the procedure are not to be relied on absolutely, but, when related to visual evidence presented by the stump and to the subjective reporting of the patient, thermography can be a useful diagnostic aid.

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