Thermography: a new method for choosing the surgical approach in complications of compound fractures of the leg

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SUMMARY. **In a series of 12 operations conducted on 9 patients with complications from compound fractures of the lower limbs, thermography was used to select the surgical approach. The results were compared with those of a group of 31 operations conducted on 25 patients with the same complications.**

In the patients examined thermographically there were no cases of cutaneous necrosis following the surgery; but in the control group, in contrast, results were much worse with 12 cases of cutaneous necrosis. Therefore, in this situation thermography is the exam to choose.

Key words: compound fractures; leg; surgical approach; thermography.

Compound leg fractures, just as any fracture where bone is exposed, can lead to numerous complications: those complications that are most difficult to resolve are certainly the osteomyelitises, the pseudarthroses (whether infected or not), and cutaneous necrosis with or without secondary baring of bone.

All these complications can, in the worst cases, even lead to amputation of the limb.

They always carry the risk of superimposed infection, and often require extended healing times. They often require repeated operations [3, 4, 5, 6] which aim to:

a) sterilize any septic foci;

b) repair damaged skin areas or necrotic areas by means of grafts or skin transplants;

c) eliminate pseudarthroses;

d) sometimes transplant pieces of bones, often repeatedly.

In the worst cases and in those with the slowest healing there are often many operations done and the skin therefore becomes covered with scars. These scars are often extensive and can be the result both of the original fractures and of the subsequent operations. There are also skin areas oonsisting of distrophic and transplanted tissue.

All these skin lesions are very close together because all the operations use anterior or antero-medial or antero-lateral approaches in order to well expose the tibia, which is the bone that has the most important complications. When there are very serious and extensive skin lesions, the need for further operations on the bone raises serious problems: a correct surgical approach must be chosen so that rapid healing of the skin scar and avoidance of complications are guaranteed. The choice of an incorrect approach can lead to serious skin damage and even to necrosi with subsequent baring of bone. This leads to further delay in healing and above all an increased risk of further septic complications that then necessitate further plastic surgery operations to reconstruct the skin tissues.

At the present time the choice of a surgical approach is based strictly on clinical criteria. The skin zone that is chosen should appear well nourished; possibly not involved by scarring, nor by active inflammatory reaction; and should be outside of the areas having transplanted skin tissue. It is very difficult to recognize the line of demarcation between normal tissue and damaged skin when the lesions are extensive or very close together.

PURPOSE OF THE STUDY

The purpose of this work is to evaluate the possibilities offered by the use of thermography when choosing surgical approaches in the therapy of compound fractures. This possible field of use of thermography is not greatly different from that of certain plastic surgery operations where thermography has clearly shown its usefulness [1, 2].

MATERIALS

Thermography was employed with all the patients (9 cases total, with 12 operations) who were admitted during 1976 to the Verona Orthopedic Clinic because of late complications of compound leg fractures. This series was compared to another done with 25 patients from 1974 and 1975 who had a total of 31 leg operations where the surgical approach was chosen solely on clinical criteria.

All the patients had serious fractures. All had already undergone several operations. The surgical technique was the same in all the patients of both series. The 9 patients who underwent thermography (Tab. I) were between 18 and 43 years of age and averaged 28 years of age. The 12 operations were done between 3 and 32 months after the fractures took place and averaged 19, 3 months later. They included: 2 operations for non-infected pseudarthrosis, 2 for active osteomyelitis, and 8 for pseudarthrosis with bone loss as a result of osteomyelitis (P.B.L.O.). The 25 patients of the control study were between 12 and 67 years of age with an average of 29,4 years. The 31 operations were done at from 2 months to 6 years from the time of the fractures and averaged 13,7 months later. They included: 4 operations for non-infected pseudarthrosis, 12 for active osteomyelitis, 15 for P.B.L.O.

The thermograms were done with the patients staying in a 20°C room for fifteen minutes.

METHOD

Thermographically the possible surgical lines of approach were those where the skin was warm, that is, well vascularized. In fact, good vascularization is indispensable for the healing of the surgical scar.

Since even inflamed areas, granulation tissue areas, and Thiersch or Reverdin skin transplant areas are thermographically warm, the thermographic data must be considered together with the clinical data in order to arrive at the correct evaluation.

Thus the surgical line of approach was in fact determined using both criteria.

In all the cases thermography outlined two or three surgical lines of approach on the anterior regions of the leg.

In 7 operations of the 12, the best thermographic line was also a very valid clinical choice. In these cases there was no difficulty in deciding (Fig. 1). In 4 operations the best thermographic line did not coincide with the best clinical line and one of the second or third choice thermographic lines was chosen.

Tab. I. Cases.

Patient	Age	Complications	Time since the fracture (months)	Evolution of the scare
M. B. F.	23	P. B. L. 0.	30	Favourable
	18	Active osteomyelitis	--	Favourable
A: C:	19	Active osteomyelitis	28	Favourable
		P. B. L. 0.	32	Favourable
-. -.	25	P. E. L. 0.	-.	Favourable
F. A.	42	P. B. L. 0.	20	Favourable
		P. B. L. 0.	26	Favourable
M. G.	38	P. B. L. 0.	12	Skin damage
		P. B. L. 0.	16	Favourable
v. w.	43	Pseudoarthrosis	3	Favourable
C. M.	25	P. B. L. 0.	10	Favourable
G. L.	19	Pseudoarthrosis	5	Favourable

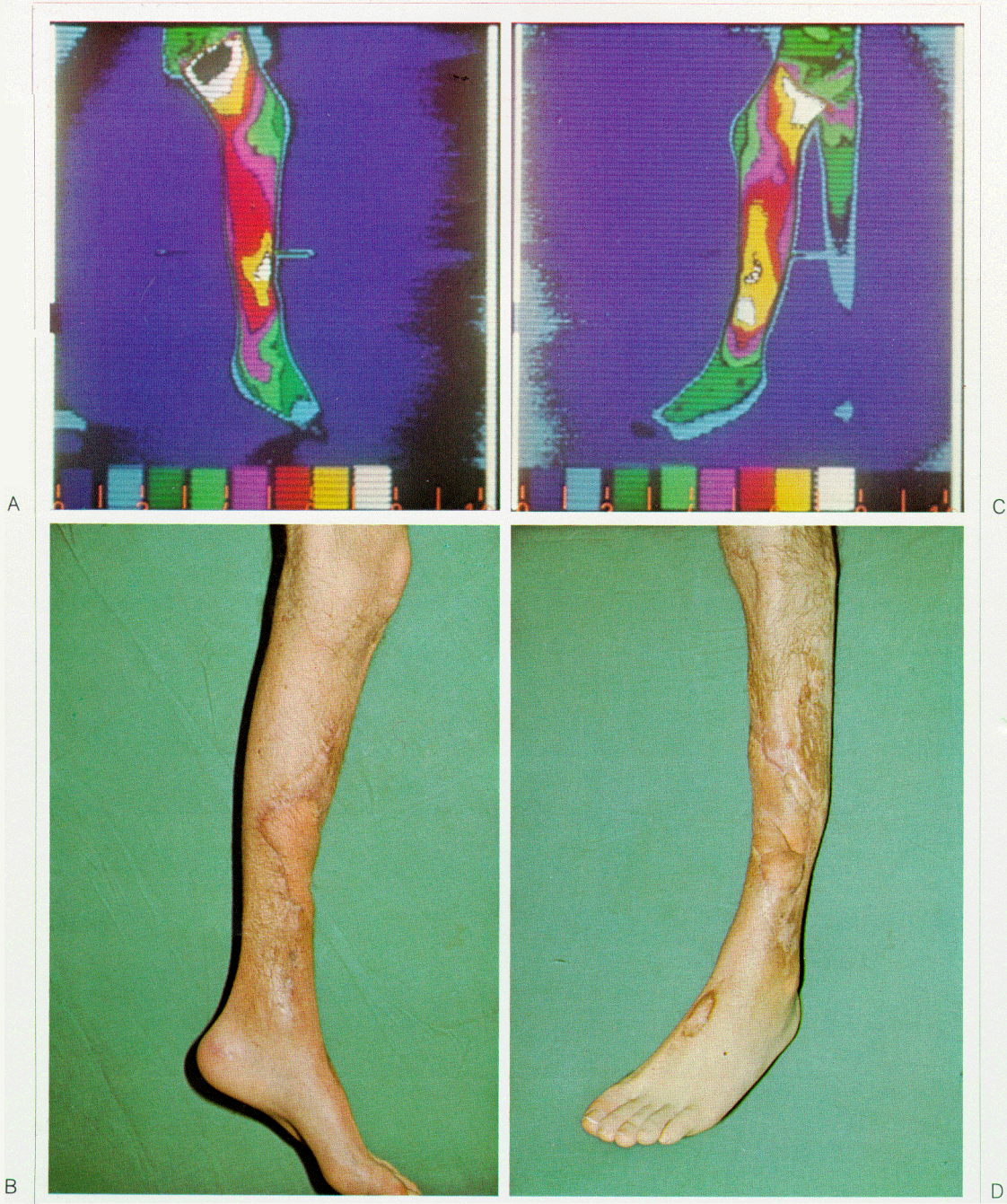


Fig. 1 A-B-C-D. Pseudoarthrosis with bone loss of the left leg; 30 months after fracture. Previous skin transplant for necrosis of the skin after a bone transplant. (A-B) Pre-operative thermography. Medial view of the leg, possible thermographic line of surgical approach at the distal part of the leg, corresponding to the skin transplant. (C-D) Lateral view of the leg, possible thermographic line of surgical approach at the medial-distal part of the leg; this line was preferred.

Fig. 1 E. 12 days after surgery; no skin damage.

In one operation neither of the two thermographic lines coincided with the purely clinical choice and the surgeon placed his trust in the thermographic line even though it passed through a « cross-leg » skin transplant. The healing of the resultant surgical scar was completely normal (Fig. 2).

RESULTS

The use of thermographic data in deciding the choice of a surgical line of approach in compound fractures dramatically reduced subsequent skin damage and necrosis from these operations.

As a result, of 12 operations done on 9 patients, only 1 showed skin damage and this healed spontaneously. More important however: there were no cases of skin necrosis. In all the others there was normal scar healing.

In the 31 operations done on 25 patients of the control series, however, there were 5 cases of skin damage and 12 cases of necrosis. These 12 required further reconstructive plastic surgery. In one case the complicating necrosis led to the relapse of the osteomyelitis and to the amputation of the limb.

Examining separately the types of complications of compound fractures that were treated, it can be seen that (Tab. II):

1. Non-infected pseudarthrosis

No problems in the present series (2 operations) nor in the control series (4 operations).

2. Active osteomyelitis

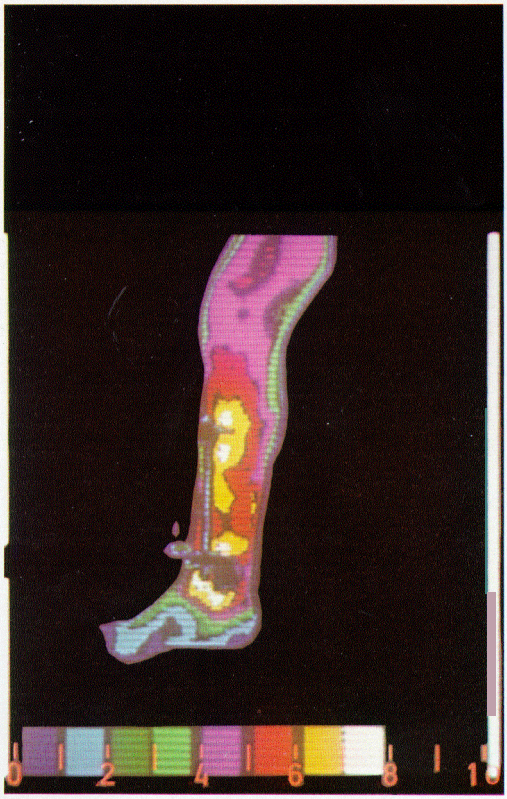
No complications after the 2 operations of this series. But in the 12 operations of the control series there were 3 cases of skin damage that healed spontaneously and 3 cases of skin necrosis.

3. Pseudarthrosis with bone loss as a results of osteomyelitis (P.B.L.O.)

In the 8 operations done after thermography there was only one case of skin damage and

Tab. II. **Results.**

	Thermographic series				Control series			
	Nr. interventions	Normal evolution	Skin damage	Necrosis	Nr. intervention	Normal evolution	Skin damage	Necrosis
No infected pseudoarthrosis	2	2	-		4	4		
Active osteomyelitis	2	2	-		12	6	3	3
P. B. L. 0.	8	7	I	-	15	4	2	9



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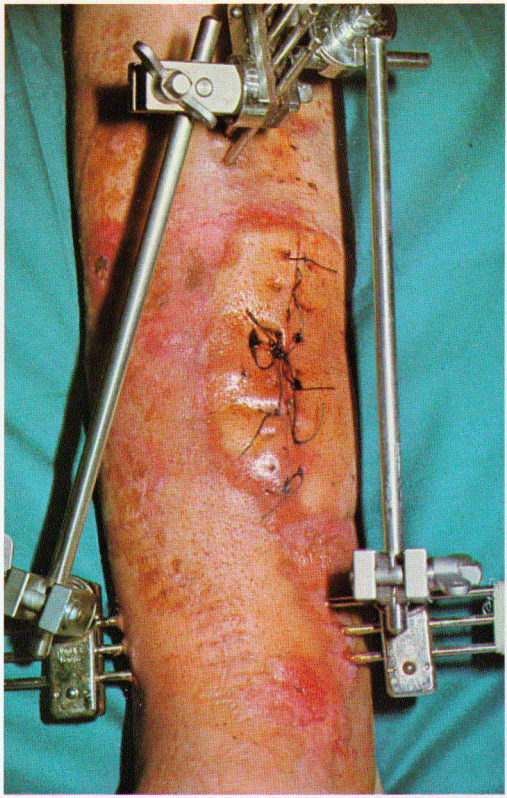

B

Fig. 2 A-B. Pseudoarthrosis with bone loss of the left leg; 10 months after the fracture. Previous skin transplant. (A) Best thermographic line of surgical approach at the antero-medial part of the leg, corresponding to the skin transplant. (B) 10 days after surgery; no skin damage.

it healed spontaneously. There were no cases of skin necrosis.

Much worse results were obtained in the 15 control operations. Infact, there were 2 cases of skin damage and 9 cases of skin necrosis.

CONCLUSIONS

In choosing the surgical line of approach in operations on the complications from compound fractures of the legs, when the thermographic line is comparable with the clinically determined line (11 of 12 in this series), then there is no problem and the line is good.

When there is no comparison possible and thermography clearly shows a good line (1 of 12 in this series), then the thermographic data should be followed because it offers the best guarantee of success.

The sharp reduction in cases of skin damage and the complete elimination of cases with skin necrosis in this series as compared with a control series, shows the usefulness of thermography in this situation.

In the light of the present results, even though based on a limited sample, thermography is the most appropiatc surgical line of approach for operations of complications of compound leg fractures.

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