Correlations between thermography and morphology of primary cutaneous malignant melanomas

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SUMMARY. Of 30 malignant melanomas 27 (90%) had positive thermal gradients, varying from + 1°C to 4°C. These thermal gradients do not correlate with the histogenetic type, nor the cell type, nor the mitotic activity, nor the lymphocytic infiltrate (neither at the in situ portion nor at the invasive portion), nor, finally, with the level of invasion, even if all the neoplasias at the 5th level show a thermal gradient of 3°C. However there is clear correlation with the TNM clinical stage.

Key words: thermography; cutaneous malignant melanoma; anatomo-clinical comparison.

Introduction

The prognosis for cutaneous malignant melanoma seems to be related to its histologic characteristics ([12]), and to the cellular, humoral, and specific antitumoral immunity of the patient ([10, 15]).

Melanoma is a biologically complex and unpredictable neoplasia as can be seen from the documented spontaneous regression ([13]), its great ability to metastasize early, and the long periods of remission even in cases in advanced clinical stages.

The success of antimelanoma therapy appears to depend on early clinical and histological diagnosis, but this is made difftcult, because of the existence of lesions that are morphologically and histologically similar to melanomas. Thermography of pigmented tumors is a useful, easy to use, and innocuous diagnostic method.

In the majority of cases malignant melanomas present as warm areas. This warmth may be directly proportional to invasiveness of the neoplasia ([9]).

The purpose of this work is to analyse the thermographic data of 30 malignant cutaneous melanomas in a comparison with their respective morphologic characteristics, and to search for possible significant correlations.

Material and methods

The thermograms were taken with a Bofors I R Mark 3 camera. The thermal gradient was evaluated by comparing the increased warmth of the lesion with the 'warmth of the surrounding skin. It was recorded in degrees Centigrade (+1°C +2°C, +3°C, and +4°C). The thermograms were taken in black and white and in color. With ulcerated lesions, the cold area corrisponding to the ulcer was not considered and only the surrounding thermal gradient was evaluated. The age and sex of each patient was considered. With each neoplasia we recorded its clinical appearance, its TNM grade ([5]), the possible pre-existence of a nevus, and the duration and description of the presenting complaints (bleeding, changes in color, enlargement or ulceration of the lesion, and pain).

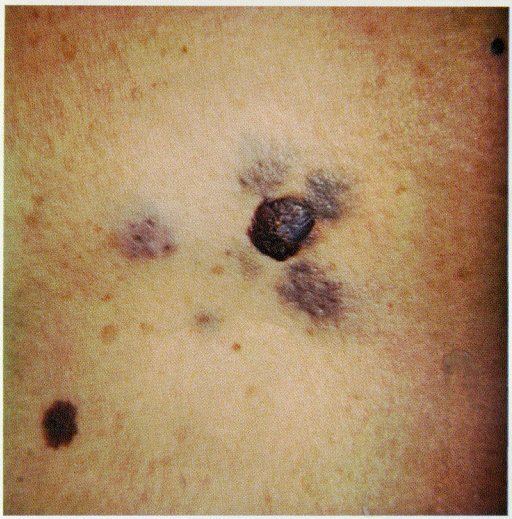
The specimens were fixed in buffered formalin and the sections were stained with hematoxylin-eosin, Alcian blue-PAS, and Weigert-Van Gieson.

Analysis for melanin was done with the

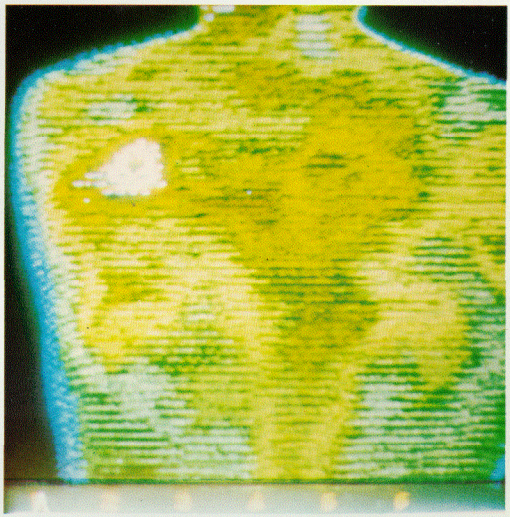
A

B

Fig. 1. Case 3. A) Right foot: nodular melanoma. B) Thermogram: cold area (ulcer) surrounded by intense (+3°C) hyperthermic halo.



A



B

Fig. 2. Case 13. A) Back: invasive melanoma with adjacent intra-epidcrmal component of superficial spreading type; subcutaneous metastases. B) Thermogram: very warm (+3°C) white area.

method of Fontana-Masson. It was always differentiated from hemosiderin by Tumbull's Blue method.

In one case. excision of the tumor was done at autopsy because when the patient was first seen, the neoplasia had 50 highly metastasized that excision was considered deferrable. Therefore in this case the mitotic activity was not considered.

The malignant melanomas were classified according to the terminology recommended by McGovern et al. ([14]).

In each case we examined:

1) the site;
2) the overlying epidermis;
3) the level of invasion, described according to the criteria reported by Clark et al. ([3,4]);
4) the cell type of the malignant melanocyte, distinguishing between epithelioid, spindle, and anaplastic;
5) the mitotic activity, evaluated according to the grades (1,2,3) reported by McGovern et al. ([14]);
6) the lymphocytic infiltrate at the level of the invasion and its eventual adjacent intra-epidermal component was evaluated as:
   a) absent;
   b) slight: characterized by sparse accumulation of lymphocytes and plasmocytes usually localised at the margins of the lesion;
   c) moderate: the immune reaction is observed as a broken barrier usually peripheral to the lesion;
   d) intense: a complete barrier of lymphocytic infiltrate entirely surrounds the melanoma.

Results

In this series of cases there was a prevalence of females (60%) over males. Incidence was highest (23,3%) between 50 and 59 years of age. The most common sites were on the limbs (53,3%), usually the lower (75%) rather then the upper limbs. Eighteen patients (60%) had case histories of a nevus from the time of birth. In four patients the nevi appeared in later years. The symptoms varied in duration from 7 years to 15 days, with the highest incidence from 1 to 6 months (56.6%). The classification of the melanomas, is this series, in clinical stages according to the TNM system, showed a slight prevalence of the T2's (40%) over T3's (33,3%). There were 2 cases that had already metastasized at the time of diagnosis: one to regional lymph nodes, another diffusively.

The epidermis overlying the lesion ap-

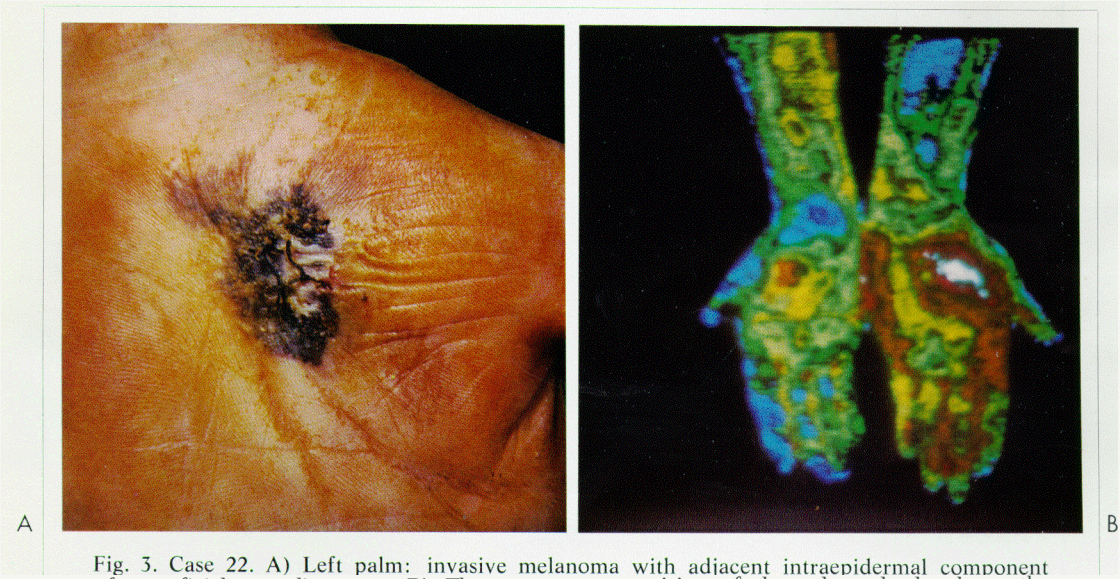


Fig. 3. Case 22. A) Left palm: invasive melanoma with adjacent intraepidermal component of superficial spreading type. B) Thermogram: comparision of the palms clearly shows the hyperthermic area (+2°C) on the left.

Table I.

N°	Name	Biopsy N°	Age	Sex	Site	Pre existent nevus	Duration of symptoms in months	Over lying epider-mis	Clinical stage TNM	Histogenetic type	Level invasion	Cell type	Mitotic activity	Lymphocytic infiltrate: In situ compo-nent	Lymphocytic infiltrate: Inva-sive compo-nent	Ther-ma1 gradient
1	C.M.	46604	70	M	Abdomen	B	3	LJ	T 2	IM+SSM	3	S	3	M	A	1°C
2	G.P.	30534	49	F	R. Face	B	1	A	T 1	SSM In situ	1		1	I		1°C
3	B.A.	30299	43	F	R. Foot		24	U	T3	N M	5	S	2		A	3°C
4	M.A.	16604	59	M	Back	B	3	A	T2	IM+SSM	3	S	3	I	S	3°C
5	F.O.	21469	67	F	R. Thumb		3	U	T3	NM	5	E	1		A	3°C
6	F.M.	32269	33	M	Face Chin	B	1	H	T 1	IM+SSM	2	E	3		S	1°C
7	c s .	21581	59	F	L. Foot		84	H	T3	NM	2	E	1	I	I	3°C
8	P.F.	36859	63	F	Face	B	5	U	T3	NM	3	E	1		M	3°C
9	F.C.	15315	37	M	Face	B	4	H	T2	IM+SSM	3	E	3	S	A	3°C
10	V.R.	36896	89	F	Face	B	12	U	T3	NM	5	E	3		A	3°C
11	B.P.	33050	74	F	Face	B	2	A	T 1Nlb	IM+SSM	2	E	1	I	I	3°C
12	C.T.	37371	56	F	R. Foot	B	1	U	T2	NM	3	E	2		A	1°C
13	Z.D.	1001	50	M	Back	B	2	u	T3M1	IM+SSM	4	E		S	A	3°C
14	F.M.	12638	19	F	R. Forearm	B	8	U	T2	IM+SSM	3	E	2	I	A	3°C
15	C . I .	18305	49	F	R. Thigh	B	24	U	T2	IM+SSM	3	E	1	S	A	3°C
16	M.D.	44598	20	F	Neck	B	7	A	T 1	SSM In situ	1		1	I		1°C
17	R.C.	17385	50	F	R. Leg	B	6	A	T3	NM	5	A	1		A	3°C
18	O.L.	40358	65	M	R. Palm		24	U	T3	NM	3	A	2		A	4°C
19	M.C.	45751	52	F	L. Leg	3Yrs	2	A	T 1	IM+SSM	2	E	1	I	A	0
20	B.C.	43172	47	F	L. Leg	B	7	H	T2	IM+SSM	3	E	1	S	A	0
21	A.C.	42498	47	F	L. Leg	1Yrs	6	H	T3	NM	4	E	2		A	3°C
22	C.S.	42058	54	M	L. Palm	5Yrs	1/2	H	T2	IM+SSM	3	E	3	I	A	2°C
23	R.B.	26759	68	M	Face		4	U	T2	NM	4	E	3		M	2°C

24	G.C.	36889	71	M	Face		6	A	T 1	HMF	1		1	I		2°C
25	R.A.	37055	70	M	L. Foot	B	2	H	T 2	NM	4	A	3		A	O
26	R.A.	38418	77	M	L. Foot		36	U	T 3	IM+SSM	4	E	3	S	A	3°C
27	N.M.	47950	64	M	Abdomen	B	2	A	T 2	IM+SSM	3	E	3	I	S	1°C
28	D.L.	47951	36	F	R. Leg	B		H	T 1	NM	2	E	1		M	1°C
29	P.C.	24703	72	F	Face L.		1	A	T 2	IM+HMF	4	S	1	I	A	3°C
30	P.A.	26871	37	F	L. Leg	9Yrs	48	U	T 1	NM	3	S	2		S	1°C

B = nevus from Birth
Yrs = nevus from Years

U = Ulcerated
A = Atrophic
H = Hyperkeratosis

SSM = superficial spreading melanoma
IM+SSM = invasive melanoma superficial spreading Type
NM = nodular melanoma
HMF = Hutchinson's melanotic freckle
IM+HMF = invasive melanoma Hutchinson's melanotic freckle Type

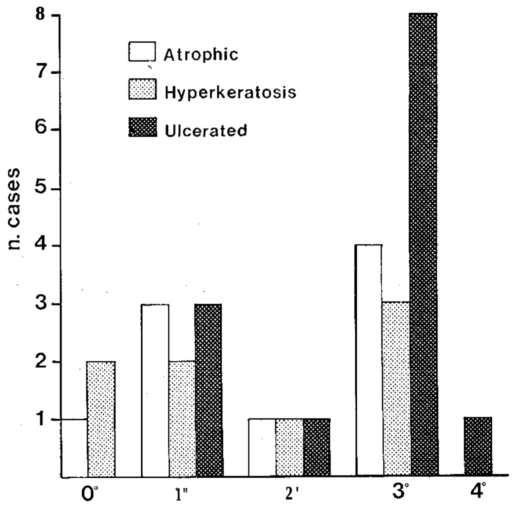
S = Spindle
A = Anaplastic
E = Epithelioid

I = Intense
S = Slight

A = Absent
M = Moderate

peared ulcerated in 13 cases (43,3%). It was atrophic [7] in 9 (30%), and hyperkeratosic in 8 cases (26,7%).

The histogenetic types that were most highly represented were the nodular melanoma'and the invasive melanoma with adjacent intra-epidermal component of superficial spreading type (43,3%).



Graph. 1. Correlation between thermal gradient and overlying epidermis.

The most common level of invasion was the third (40%), where the most prevalent type was the invasive superficial spreading melanoma. The nodular type (30,7%) invaded to the 5th and 3rd levels with an equal incidence (40%).

The rare' in situ types (1 Hutchinson's melanotic freckle, 2 superficial spreading noninvasive melanomas) all showed intense lymphocytic infiltrate, but these infiltrates diminished in direct relationship to the level to which the tumor invaded. In fact, indipendently of the histogenetic type, the infiltrates were always absent in forms that reached level 4 or 5.

For invasive melanomas with adjacent intra-epidermal component, the lymphocytic infiltrate adjacent to the in situ portion was greater in comparison to that found adjacent to the invasive portion.

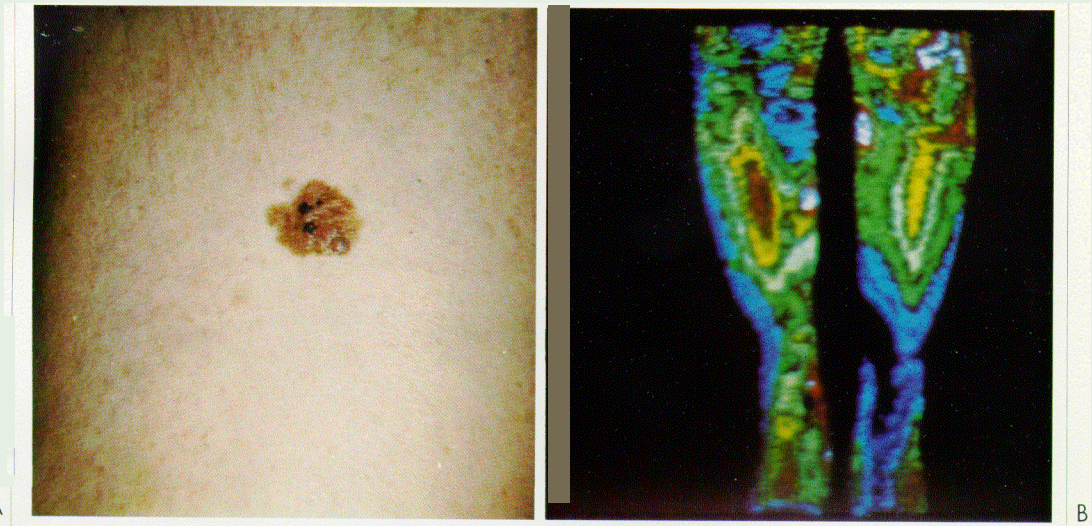
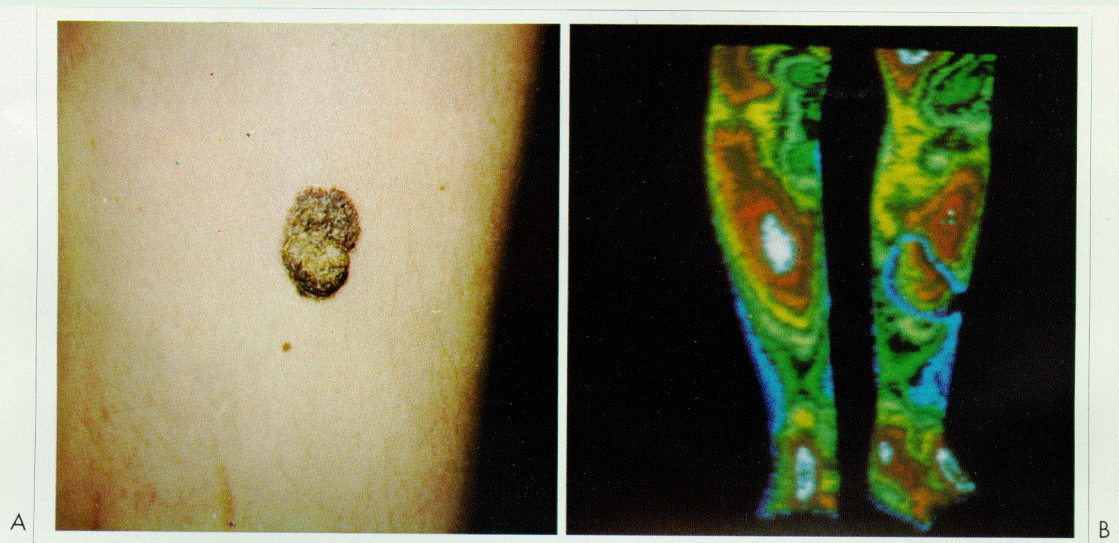


Fig. 4. Case 28. A) Right leg: nodular melanoma picked up at physical exam. The patient had a nevus from the time of birth and was without symptoms. B) Thermogram: the red area on the right leg shows a slight hyperthermia (+1°C).



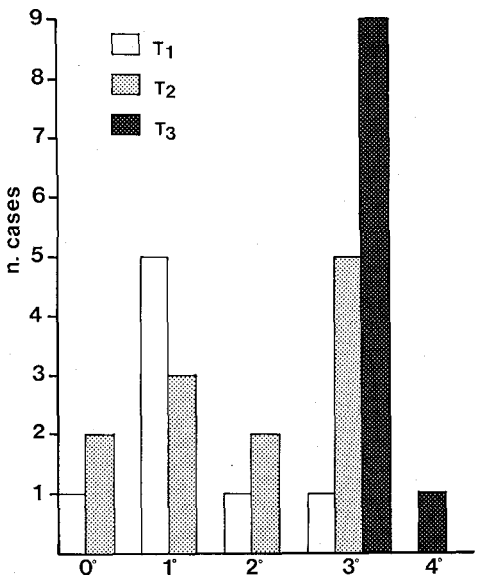
[1]Fig. 5. Case 20. A) Left leg: invesive melanoma with adjacent intra-epidermal component of superficial spreading type. B) Thermogram: comparision between the two limbs reveals paradoxical thermal differences despite the presence of the melanoma (« false negative »).

The most frequent cell type was the epithelioid (63,3%). Grade 1 mitotic activity had a slight, little significant prevalence over grade 3 (43,3% vs 33,3%). Neither cell type nor grade of mitotic activity appear to have any correlation with either the histogenetic type or the level of invasion.

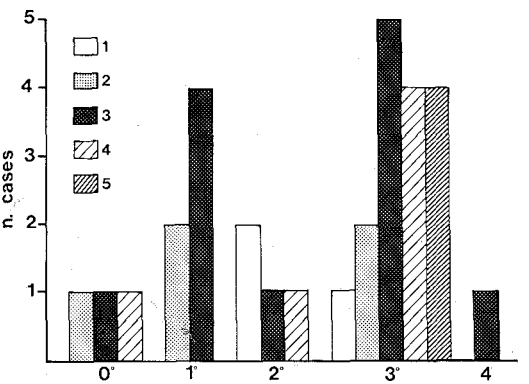
At thermography 27 melanomas (90% of the cases) showed an increase in temperature. This was 3°C in 15 cases (55,5%),

1°C in 3 cases (29,6%), 2°C in 3 cases (1l,l%), and 4°C in 1 case (3,7%).

The correlations between the thermograms and certain data (overlying epidermis, TNM clinical stages, levels of invasion, and mitotic activity) are shown in graphs 1, **2,3,4.**



Graph. 2. Correlation between thermal gradient and clinical stage TNM.



Graph. 3. Correlation between thermal gradient and level of invasion (Clark et al.).

Other data can be compared from table I, but appear to correlate less significantly.

Discussion

Thermography is a useful diagnostic method in the study of neoplasias, especially those of the breast, thyroid, and pigmented skin.

Primary cutaneous malignant melanomas are the most frequent exothermic tumors ([1,2,6,8,16,17]).

Eighty per cent of them are « warm », in contrast to pigmented nevi which are 80 to 90% «cool».

Thermograms can hint at the nature, benign or malignant, of the pigmented neoplasia. According to some studies repeated thermograms can be used to evaluate the invasiveness of the Hutchinson's melanotic freckle.

In the present series, 90% of the malignant melanomas were warmer than the surrounding skin by amounts varying from 1" to 4°C. The remaining 10% were cool, were all localized on the legs, always presented a portion that invaded various levels, and never had lymphocytic infiltrates. These cool melanomas had an overlying epidermis that was usually associated with hyperkeratosis, and never ulcerated. Their symptomatology was short, they were found in a pre-existent nevus, and they were of different histogenetic types. Nevertheless, the low number of cool melanoma cases does not permit us to draw definitive conclusions that would explain the negativity of their thermograms.

Comparing the degree of hyperthermia with the various clinical and histologic characteristics of melanomas, it, is evident that the increase in temperature of the neoplasia is not directly proportional to the level of invasion as measured according to Clark et al. ([3,4]) criteria; nor is it proportional to the mitotic activity.

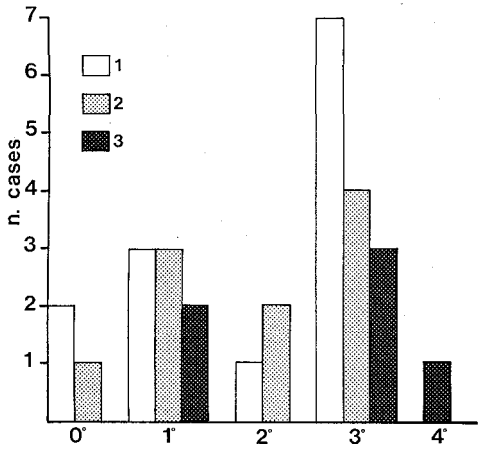
Consequently the use of thermography to chart the invasiveness of the in situ types

of melanoma, particularly the Hutchison's melanotic freckle, appears not to be supported by these data.

Moreover the thermal gradient of the neoplasia does not reveal its level of invasion; and it is this level which acts as the criteria in judging the correct size for surgical excision of the lesion or excision of the regional, usually anergic, lymph nodes ([15]).

Nevertheless all the neoplasias that invade to level 5 show a thermal gradient of 3" C.

The thermal gradient also appears to be



Graph. 4. Correlation between thermal gradient and mitotic activity.

unaffected by the age of the patient, or by the histogenetic pattern, the cellular type, or the site of the lesion.

Stage T3 represents the intense proliferative activity of the melanoma that results in lesions that are more than 5 cm. in size and/ or deeply invading the derma. This stage is always found in « hot » melanomas, those with a thermal gradient of 3" or 4°C.

The skin adjacent to a cool ulcerated area, in most cases, had high thermal gradients, usually 3°C. Consequently, it seems that the results of thermograms are greatly influenced by the overlying epidermis. In fact the negative thermograms were mostly associated with intense hyperkeratosis. A high thermal gradient in a pigmented neoplasia should lead to a diagnosis of malignancy without being pathonomonic of malignancy.

It appears to be directly proportional to the clinical grade of diffusion of the lesion. (TNM).

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