

THE SENSITIVITY OF PLANTAR WARTS TO ROENTGEN RADIATION

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In two earlier studies Kopp and Reymann (10, 11) reported a very high incidence of radiation injuries after treatment of plantar warts with ultrasoft X-rays and radium. A follow-up study was made of 70 patients who had been treated with X-rays for plantar warts 14 years previously, receiving a single dose of 3000 r (35 kV, 20 mAs, 0.3 mm Al-filter, focus-skin distance 15 cm, HVL 2.4 mm of skin). X-ray cicatrices in the form of atrophy or hyperkeratosis were found in 50 patients (71.4%), 10 of whom had subjective complaints (14.3%). A group treated with radium comprised 49 patients examined 20 years after treatment (11). In the latter material radiation cicatrices were found in 31.7% after one radium treatment, while the corresponding percentage in patients treated twice for the same plantar wart was 87.5%. Only one of the patients receiving a single treatment had subjective complaints while not less than 85.7% of the patients who had received two courses of treatment reported symptoms in the form of tenderness or spontaneous pains.

The consequences of the results obtained by these follow-up studies must indicate that it is absolutely inadvisable to treat plantar warts with X-rays or radium in doses as high as those reported. A review of the literature concerning radiation treatment of plantar warts did not reveal any controlled investigations of the sensitivity of plantar warts to roentgen radiation. The

purpose of the present study was to attempt to assess the possible sensitivity of plantar warts to roentgen radiation by conducting a clinical therapeutic trial—as a rational consequence of the results of treatment described above.

Material and Methods

Patients. Only patients with previously untreated plantar warts were included. Because of occasional shortage of patients, the experiments extended over a period of almost two years. The majority of patients treated had solitary plantar warts. However, one single group of patients with multiple plantar warts was also included.

Method of treatment. In all patients treatment was initiated by loosening the keratotic layer over the wart. For this purpose a keratolytic ointment was used, containing 25% of salicylic acid and 25% of creosote in unguentum cerae (75% of olive oil and 25% of wax). The ointment was placed in the centre of a self-adhesive circular felt pad of a suitable size, so that the wart—surrounded by a border of healthy skin—was freely situated inside the pad. The ointment-filled pad was covered first with a piece of thin plastic and then with a dressing which must be so tightly fitting and so strong that it can remain in place for one week. For such occlusive dressing we used adhesive tape,¹ 5 cm wide. For the

¹ Leukoplast, Beiersdorf.

Table 1. Outcome of treatment of solitary and multiple warts with occlusive dressing and roentgen therapy

Patient group	Diagnosis	Treatment	Total	Patients no. cured	% cured	95 % confidence interval for the true cure rate (%)
I	solitary plantar warts	occlusive dressing, 5 weeks	25	25	100	80.90-100
II	"	occlusive dressing, 2 weeks, 500 r \times 2	25	19	76	54.86-90.65
III	"	occlusive dressing, 1 week, 1000 r \times 1	25	18	72	50.62-87.94
IV	"	occlusive dressing, 5 weeks, 200 r \times 5	25	16	64	42.52-82.03
V	"	occlusive dressing, 1 week, charged blank X-ray tube	25	14	56	34.94-75.59
VI	multiple plantar warts	occlusive dressing, 1 week, 1000 r \times 1	25	7	30	12.06-49.38

dressing of one wart three long pieces of adhesive tape were often used so as to cover the lateral edge of the foot. The dressing was removed after one week. The horny layers, often several mm thick, can then easily be removed by means of a curette.

X-ray treatment was not given until the hyperkeratoses described had been carefully removed. The X-ray quality applied had an HVL of 1.9 mm of skin, which, with the unit² used, was produced with 29 kV, 25 mAs and an 0.3 mm Al-filter.

Results of Treatment

The present study covers a total of 6 groups of patients, each group comprising 25 patients, as outlined in table 1.

Group I comprised solitary plantar warts treated with the occlusive dressing as the only therapeutic measure. The dressings were changed once a week for 5 weeks. The "cure rate" was 100 %.

Group II comprised patients treated with similar occlusive dressing for 2 weeks. At the weekly changing of dressings X-ray

treatment with 500 r was given. The observed cure rate was 76 %.

Group III comprised patients with solitary plantar warts treated with X-rays in a single dose of 1000 r after occlusive dressing for one week. In this group a cure rate of 72 % was found.

Group IV included patients treated in the same way as those in Group III, the X-ray treatment being given in doses of 200 r once weekly for 5 weeks in connexion with occlusive dressing. The cure rate was 64 %.

Group V. The patients in this group were treated with occlusive dressing for one week. The warts were then irradiated applying an uncharged X-ray tube. The observed cure rate was 56 %.

Group VI comprised multiple plantar warts irradiated with X-rays in a single dose of 1000 r after being treated with occlusive dressing for one week. The cure rate was 30 %.

The patients were examined one month after the X-ray treatment, and the follow-up was complete (100 %). Patients who did not appear for examination were examined in their homes.

² Siemens "Dermopan".

Discussion

A characteristic finding in plantar warts is that they are generally covered by a keratotic layer several mm thick. This thickness varies according to the site of the wart and there is also considerable individual variation. It must be a requisite for the completion of the therapeutic experiments described that the keratoses are loosened prior to X-ray treatment. If the warts are just cut, the results will vary greatly whereas the use of the dressing technique described will provide more consistent experimental conditions.

The most difficult feature in the planning of the experiments was to procure exact information about the skin tolerance to X-rays of varying hardness. Roentgen and radium treatment of plantar warts has been used in many parts of the world, and it is characteristic that all imaginable qualities of rays have been applied, from the softest Bucky rays to hard rays with an HVL of several cm of skin. In many departments even contact radiation therapy of a considerable penetrability has been applied. In spite of the widespread application and the great variability in methods a review of the literature did not reveal any reasons for the choice of the different radiation qualities. Moreover, no follow-up studies have apparently been conducted to assess the risk of late roentgen injuries. The sparse literature relating to these problems have been reviewed by Kopp and Reymann (10, 11).

Based on a purely clinical assessment it is evident that even if the keratotic layers covering the plantar warts are removed the penetrability of Bucky rays is not sufficient for therapeutic purposes. In this connexion attention is drawn to studies carried out by Kalz (5, 6) and Miescher (15, 16) who described late injuries after Bucky ray doses between 1000 and 2000 r.

An X-ray quality with an HVL of approximately 2 mm of skin is estimated as being most useful in the present therapeutic experiments. Experience gained from the follow-up studies described in the introduction does not call for the use of

radiation of a higher penetrability, the risk of lasting injuries to the vascularized layers of the corium being too great.

Unfortunately, relevant published literature contains comparatively little information regarding the tolerance of the skin to X-rays of an ultrasoft quality (from 15 to 50 kV). Ebbelhøj (3) studied in particular the conditions relating to the deep effect of ultrasoft X-rays, but he did not state exactly the limits of single or total dosage. However, in a publication from the department of this investigator Amdrup *et al.* (1), studying the treatment of haemangioma state that 1200 r (29 kV) is regarded as the highest permissible single dose. The total dose is supposed to be a magnitude of 3600 r—given as three fractionated doses at intervals of 4 months. In another study from the same department Knudsen *et al.* (9) treated plantar warts with a single dose ranging from 3000 to 4000 r, although of a somewhat lower penetrability of radiation. Kindel *et al.* (7) assumed that the maximum dose in fractionated treatment with ultrasoft X-rays is as low as 1200–1500 r, and Kopp and Reymann (10) observed cicatrices after single doses of 2000 r at a quality of radiation with an HVL of skin of 2.4 mm.

Three publications relating to X-ray treatment of haemangioma, by Klostermann (8), Luger (12), and Münchow *et al.* (17), are of particular interest. These authors followed up independently comprehensive groups of patients treated with X-rays in various doses from 3 to 13 years prior to examination. They found a pronounced individual tolerance variation. But on the whole they observed only slight or no lesions after doses below 1000 r, whereas 1500 to 1700 r represented a critical limit. Above this the number of late injuries increased heavily. The groups of patients in these studies are extremely heterogenous and treatment varies from fractionated to single dose treatment. In a number of cases contact irradiation with roentgen was applied. Hence, an assessment of the results is difficult although a single dose of 1000 r would seem to be within permissible limits.

Only few reports on attempts to treat

plantar warts with ultrasoft X-rays are available. Thus, Auken (2) treated 200 patients with single doses of 3000 r and found a cure rate of 60 %, whereas Knudsen and Amdrup (9), applying a slightly higher dosage, obtained a cure rate of about 91 %. However, these two reports cannot be compared since the cure rate reported in the latter is based on questionnaires distributed to the patients about 2 years after treatment.

The literature contains several warnings against X-ray treatment of plantar warts. By way of example, reports by Nasemann (18) and Pillsbury *et al.* (19) should be mentioned. They emphasize that the amount of the therapeutic dose nearly reaches the dose at which necrosis occurs. A certain number of roentgen cicatrices are therefore unavoidable if such irradiation is used routinely in the treatment of plantar warts. It is characteristic that such statements are based solely on clinical experience, no attempts to clarify the problem experimentally having been made.

The roentgen doses applied in the treatment of plantar warts in the present study were fixed at a maximum of 1000 r, on the basis of the studies reviewed above, and the author's personal clinical experience.

It is extremely difficult to assess the results of the therapeutic experiments described in the present paper. Thus, any definite knowledge as to the spontaneous course of plantar warts is lacking, whereas, as regards hand warts, fairly reliable information in this respect is available. Studies conducted by Massing and Epstein (14), Rulison (21) and van der Werf (22) show concurrently that hand warts disappear spontaneously over a period of two years in 65 to 70 % of the cases. But these results do not give any information as to the conditions relating to plantar warts. The literature contains surprisingly few reports on this subject, although Rasmussen (20) found in a comprehensive patient-material with plantar warts upwards of 3 % in spontaneous remission at the time of the examination. Another study of particular interest is that published by Horwitz and Marker (4). These authors found a cure

rate of 27 % at examination 3 months after treatment, having applied placebo X-ray treatment of solitary plantar warts (i.e. treatment was given by means of an uncharged X-ray tube).

When considering the therapeutic results in our six groups of patients, the high rate of cure in solitary warts is particularly conspicuous. A rate of cure of this order of magnitude was not expected when planning the experiments, although the results show concurrence with clinical experience. This reveals a pronounced effect on solitary warts of occlusive dressings [Marker and Reymann (13)]. However, in the present investigations the cure rates are such that patients with solitary plantar warts must be considered unsuited for being included in the experiments. Because of the lack of knowledge regarding the spontaneous course of various types of solitary warts, the vague information given by the patients as to duration of disease and the difficulty in obtaining sufficiently comprehensive groups of patients, the conclusion as to solitary plantar warts must be restricted. It can be concluded, however, that the effect of ultrasoft X-rays in doses which must be considered to be at the upper limit, although within permissible range, is so slight that X-ray treatment has no practical value as routine therapy in cases of plantar warts.

Also as regards multiple plantar warts the therapeutic results show concurrence with general clinical experience. Although solitary and multiple plantar warts are caused by infection from the same virus, the two types of warts run different courses which cannot be compared directly. As a rule, multiple plantar warts lend themselves less easily to treatment than solitary warts.

In the present study the 25 patients with multiple plantar warts present a very modest cure rate. This strongly contradicts any great effect of roentgen radiation. In particular in adults, but also in children, multiple plantar warts present such a varied course of disease that it will be impracticable to establish a reliable group of controls. Like in solitary plantar warts it must suffice to conclude that X-ray treatment

in the doses applied has such a slight effect that it is without any practical value in the routine treatment of plantar warts.

According to the findings roentgen must be considered quite unsuitable in routine treatment of plantar warts, since satisfactory rates of cure are obtained only with radiation doses which will give rise to late injuries in the form of tender or painful cicatrices.

It would be of great interest to continue the therapeutic experiments with various types of multiple plantar warts. In this case the groups of patients should be classified according to duration of illness, age, and type of wart, but, unfortunately, it is hardly possible to obtain sufficiently large groups of patients.

It is concluded on the basis of a review of the literature available and on the basis of the clinical therapeutic experiments described:

- a) that patients with solitary plantar warts are less suited for therapeutic experiments because of a pronounced effect of the occlusive dressing applied;
- b) that the sensitivity of plantar warts to roentgen radiation—within a dose range which should not give rise to late injuries—is so low that this type of therapy is unsuitable for routine treatment in plantar warts.

SUMMARY

A series of experiments is described in which plantar warts were treated with ultrasoft X-rays in varying doses to determine if the warts were sensitive to roentgen therapy within a dose range which does not give rise to late injuries.

The roentgen doses used were chosen on the basis of a review of the literature and the author's own experience, it being emphasized that available knowledge about the tolerance of the skin to various qualities of roentgen rays is extremely limited.

It is concluded that the sensitivity of plantar warts to roentgen treatment, with

the doses applied, is so low that this form of therapy is unsuitable for routine treatment of plantar warts.

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