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Secondary Effects of Radiation Therapy to the Hand for Benign Conditions

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Abstract

Background: Emerging literature introduces radiation therapy for benign hand conditions. However, hand surgeons are wary recommending radiation therapy for nonmalignant conditions. In our practice, we have used radiation therapy for patients who present with infiltrative or recurrent giant cell tumor of the tendon sheath (GCTTS) since 1998. The purpose of this study is to examine the secondary effects of radiation to the hand through the critical lens of a hand surgeon. **Methods:** A case series of patients who received radiation therapy for GCTTS were reviewed. The Radiation Oncology/Toxicity Grading Late Radiation Morbidity Scoring Schema was used, and patients were questioned about symptoms and examined for physical findings involving their irradiated digits. **Results:** A total of 8 patients with GCTTS presented for follow-up. The average patient age was 59.1 years, and the average time since radiation therapy was 5.4 years. Patients had an average of 2.3 surgeries on the affected digit prior to receiving radiation therapy. The average Disabilities of the Arm, Shoulder, and Hand score was 8.1. The most common sign of radiation was nail changes. All patients complained of sensibility changes, although only 2 of the 8 patients had abnormal moving 2-point discrimination tests. There were no confirmed recurrences of GCTTS and no skin cancers. **Conclusions:** Patients who received radiation therapy to the hand report high levels of satisfaction with the therapy. Radiation therapy is tolerated well by these patients and has a low level of morbidity in our population.

Keywords: Dupuytren disease, giant cell tumor of the tendon sheath, benign hand lesions, radiotherapy, radiation therapy

Background

There is increased interest in the use of radiation for benign hand conditions. Emerging literature introduces radiation therapy for recurrent giant cell tumor of the tendon sheath (GCTTS) and Dupuytren contracture.[1-6] Despite promising early literature, hand surgeons are wary recommending radiation therapy for nonmalignant conditions.

Although other authors have described using radiation therapy to the hand, no authors have investigated the long-term effects of radiation therapy to the hand through the critical lens of a hand surgeon. Other authors have examined the early effects of radiation,[1,3-6] although this treatment is considered an unproven treatment due to scarce evidence and unknown long-term adverse effects.[7]

GCTTS may have multiple recurrences in some patients. Although benign, GCTTS may have a recurrence rate as high as 27%.[8] Patients with a history of recurrent GCTTS have a 42% chance of suffering an additional recurrence.[8] Recurrent benign pathology may pose a surgical problem as multiple excisions result in worsening morbidity. This may ultimately result in loss of motion, sensation, and amputation.[9,10] As a result, the use of radiation therapy may be an important treatment option for cases of infiltrative GCTTS.

In our practice, we have used radiation therapy for patients with multiple GCTTS recurrences or infiltrative GCTTS since 1998. We have previously shown that radia-

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tion therapy for benign hand conditions can be effective in the prevention of recurrent GCTTS.[2] These practices have created a population of patients who have received radiation that we now have used to evaluate its effects over time. This follow-up study aims to examine the secondary effects of radiation therapy to the hand from the detailed perspective of a hand surgeon.

Methods

All procedures followed were in accordance with the ethical standards of responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. Informed consent was obtained from all patients for being included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in the article.

Research ethics board (REB) approval was obtained (REB #16-5196.0) to conduct a retrospective chart review at a single institution based on billing codes for GCTTS from January 1, 1998, to March 30, 2017.

There were a total of 90 patients associated with the respective billing code. Patients were excluded from the study if they did not receive radiation therapy as part of their GCTTS treatment. Patients were included in the study if they did receive radiation therapy for GCTTS. Of these 90 patients, 15 underwent surgical excision of infiltrative GCTTS and radiation therapy and were included in the study. Infiltrative GCTTS included lesions that were found intraoperatively to have local infiltration of the soft tissue (tendon or ligament) and bone or joint involvement.[2]

These 15 patients were invited to participate in the study, and 8 agreed to follow up for clinical evaluation and hand photographs. Informed consent was obtained from all individual participants included in the study. Signed consent was obtained at the follow-up visit, and the patients were compensated with a small gift card. These patients were reviewed in clinic with special attention to subsequent radiation effects on the hand. The patients were questioned on the Disabilities of the Hand, Shoulder, and Arm (DASH). In addition, patients were questioned about symptoms and examined for physical findings involving their irradiated digits. Finally, the Radiation Oncology/Toxicity Grading (ROTG) Late Radiation Morbidity Scoring Schema was measured, and photographs of the hands were taken for each patient.

Results

A total of 8 patients with GCTTS (3 men and 5 women) with a history of adjuvant external beam radiation therapy to the hand (48 Gy in 24 fractions) presented for follow-up to examine for secondary effects of radiation. All patients received the same radiation therapy protocol.

Seven patients provided high overall satisfaction ratings of the radiation therapy results (10/10), and 1 patient rated his or her satisfaction at 8/10 due to proximal interphalangeal joint stiffness, which was documented prior to receiving radiation therapy.

Demographics

The average patient age was 59.1 years (range, 42-74 years). None of the patients had a family history of GCTTS. The average time since radiation therapy was 5.4 years (range, 9 months to 11 years 1 month). Patients had an average of 2.3 surgeries (range, 1-4) on the affected digit prior to receiving radiation therapy. Five of the 8 patients had disease involvement of an interphalangeal joint, and 6 patients were believed to have incomplete resection of diseased tissue at the time of surgery. All patients were offered hand therapy immediately following their definitive surgeries.

Disabilities of the Arm, Shoulder, and Hand

The DASH[11] is a standardized tool used as an outcome measure for patients with upper extremity musculoskeletal conditions. The DASH score is marked from 0 to 100, where 100 is the most disabling score possible with this tool. The average DASH score was 8.1 (range, 0-28) at the time of follow-up. Within the DASH questionnaire, 5 patients reported they had no pain, 2 complained of mild pain, and 1 patient had severe pain.

Physical Examination

All patients complained of sensory changes (Figure 1), although only 2 of the 8 patients had abnormal moving 2-point discrimination tests of more than 6 mm (Figure 2). Neither of the patients required resection of digital nerves during their surgeries. The most common sign of radiation was nail changes, such as ridging and discoloration, which occurred in 7 of 8 patients. Other common signs of radiation included skin dryness, erythema, and subcutaneous atrophy (Figure 1). There were no confirmed recurrences of GCTTS on physical examination and no evidence of skin cancers. One patient had a mass at the previous GCTTS excision and was being investigated for a possible recurrence at the time of publication.

The active range of motion for the affected digits revealed a range of 10° to 90° of joint flexion. Most patients were able to achieve extension to a neutral position, although 3 patients had 10° to 30° of extension loss (Figure 3). The average difference in grip strength from the nonradiated side to the radiated side was 2.5 kg (Figure 4a). The average difference in key pinch strength

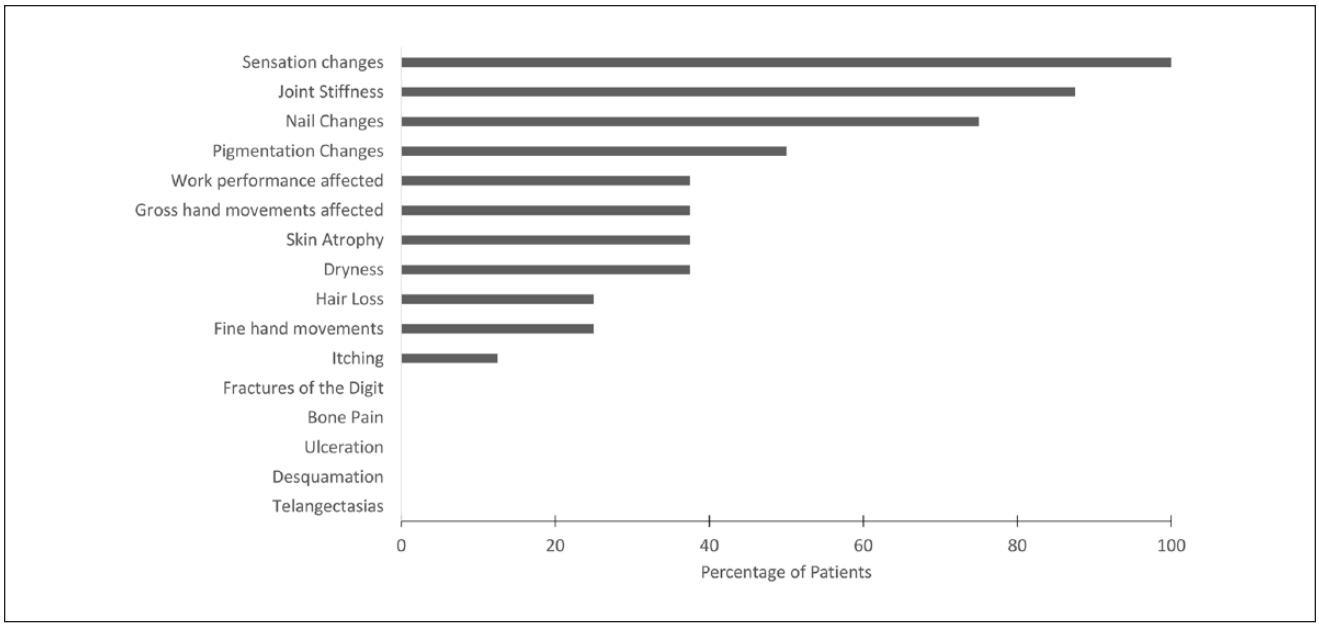

Figure 1. Patient-perceived signs and symptoms.
Reflects the patient-perceived signs and symptoms from radiation therapy.

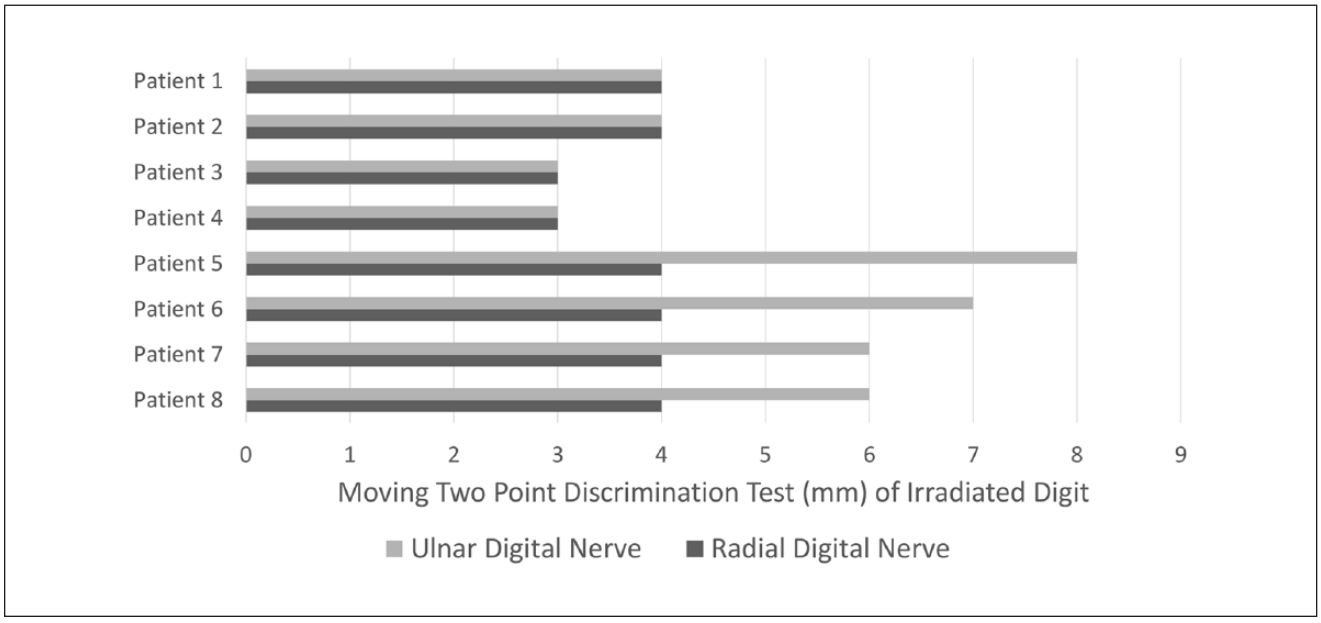

Figure 2. Moving 2-point discrimination.
Results of moving 2-point discrimination test on the affected irradiated digit at follow-up examination.

from the nonradiated side to the radiated side was 0.93 kg (Figure 4b).

Patients tended to perceive fewer signs of radiation changes to their hand compared with the evaluating physician (Figure 5).

Radiation Oncology/Toxicity Grading

The ROTG Late Radiation Morbidity Scoring Schema is a standardized method of assessing late toxicity of radiation. The scale ranges from 0 to 5, where 5 represents

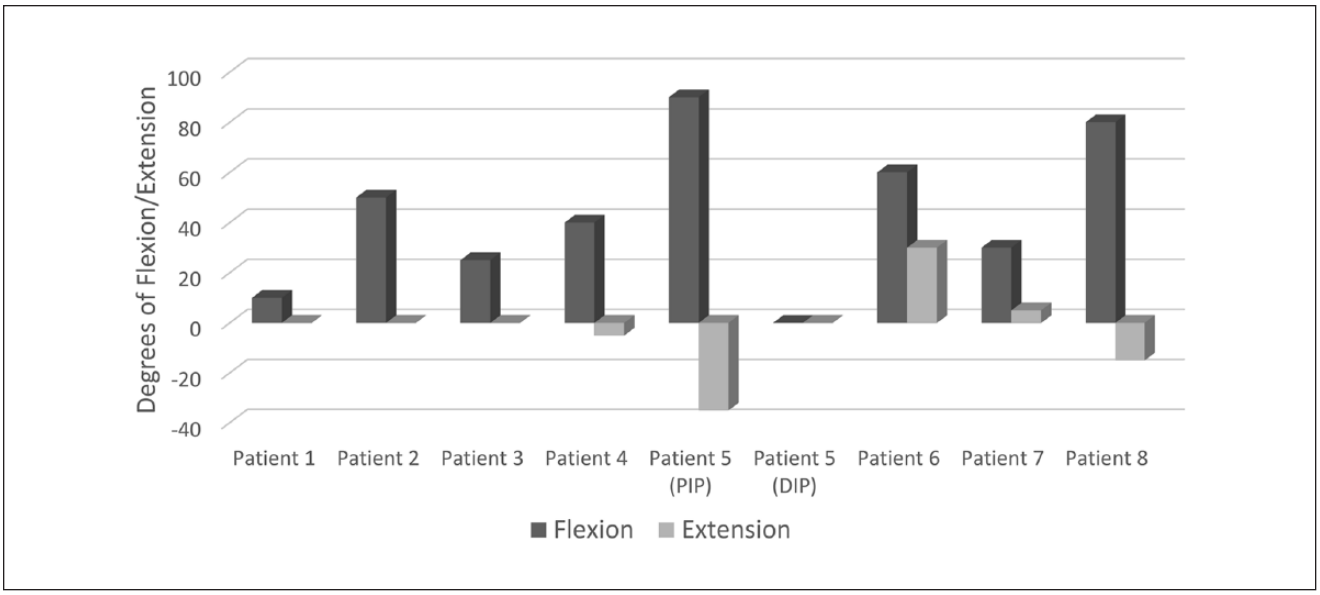

Figure 3. Range of motion of affected joint.
Demonstrates the degrees of active flexion and extension of the affected joint. Patient 5 had 2 involved joints, the PIP and the DIP, which are each included in the data set.
Note. PIP = proximal interphalangeal joint; DIP = distal phalangeal joint.

death directly related to radiation late effects.[12] The ROTG Late Radiation Morbidity Scoring Schema was used to grade the severity of radiation changes to the skin, subcutaneous tissue, bone, and joint on physical examination (Figure 6).

Patients presented with an average of 4.1 signs and symptoms of radiation therapy, although only an average of 3.5 of those are documented as new since their radiation therapy. New radiation signs showed a nonsignificant negative trend over time (Figure 7). Representative photos of participants are seen in Supplementary Figure 1.

Discussion

The study reveals that radiation therapy to the hand for GCTTS was well tolerated in our study population. Patients reported functional use of their hands with a low average DASH score, and mild radiation damage was reflected by the low ROTG grades. The narrow difference in hand strength demonstrates that radiation did not significantly affect hand strength. All patients noted sensation changes in the radiated digit, although 2-point discrimination was well maintained in 6 of the 8 patients.

Radiation therapy is gaining a role in the management of benign pathologies of the hand. Radiation therapy to the hand has been previously described for GCTTS,[2,13] pigmented villonodular tenosynovitis,[10,14] keloid scars,[15] and early-stage Dupuytren contracture.[1,3-6]

Despite literature on the use of radiation to the hand for benign hand conditions, few articles[1,3-6] have examined its secondary effects, and none have been written from the hand surgeon's perspective. Many of these articles have focused on radiation therapy for early Dupuytren contracture, and a recent systematic review on the topic found that this modality is considered an unproven treatment due to scarce evidence and unknown long-term adverse effects.[7]

We have previously shown that radiation therapy for benign hand conditions can be effective in the prevention of recurrent GCTTS,[2] and this study reveals radiation is well tolerated and associated with low morbidity. We advocate the use of radiation therapy in patients with specific benign pathology of the hand, including infiltrative and recurrent GCTTS. In severe cases, surgical excisions of infiltrative or recurrent benign hand conditions may lead to loss of motion, sensation, and even amputation.[9,10] We hope that radiation therapy may allow amputation to become an obsolete option for this patient population. We believe that radiation therapy in patients with severe benign pathology of the hand may prevent morbid operations, decrease the number of surgeries required, and better preserve hand function.

Although the patients tolerated the radiation therapy well overall, almost all patients noted joint stiffness since their radiation treatment. Due to the retrospective nature of this study, it is difficult to discern whether the decreased range of motion is truly related to radiation changes, intra-

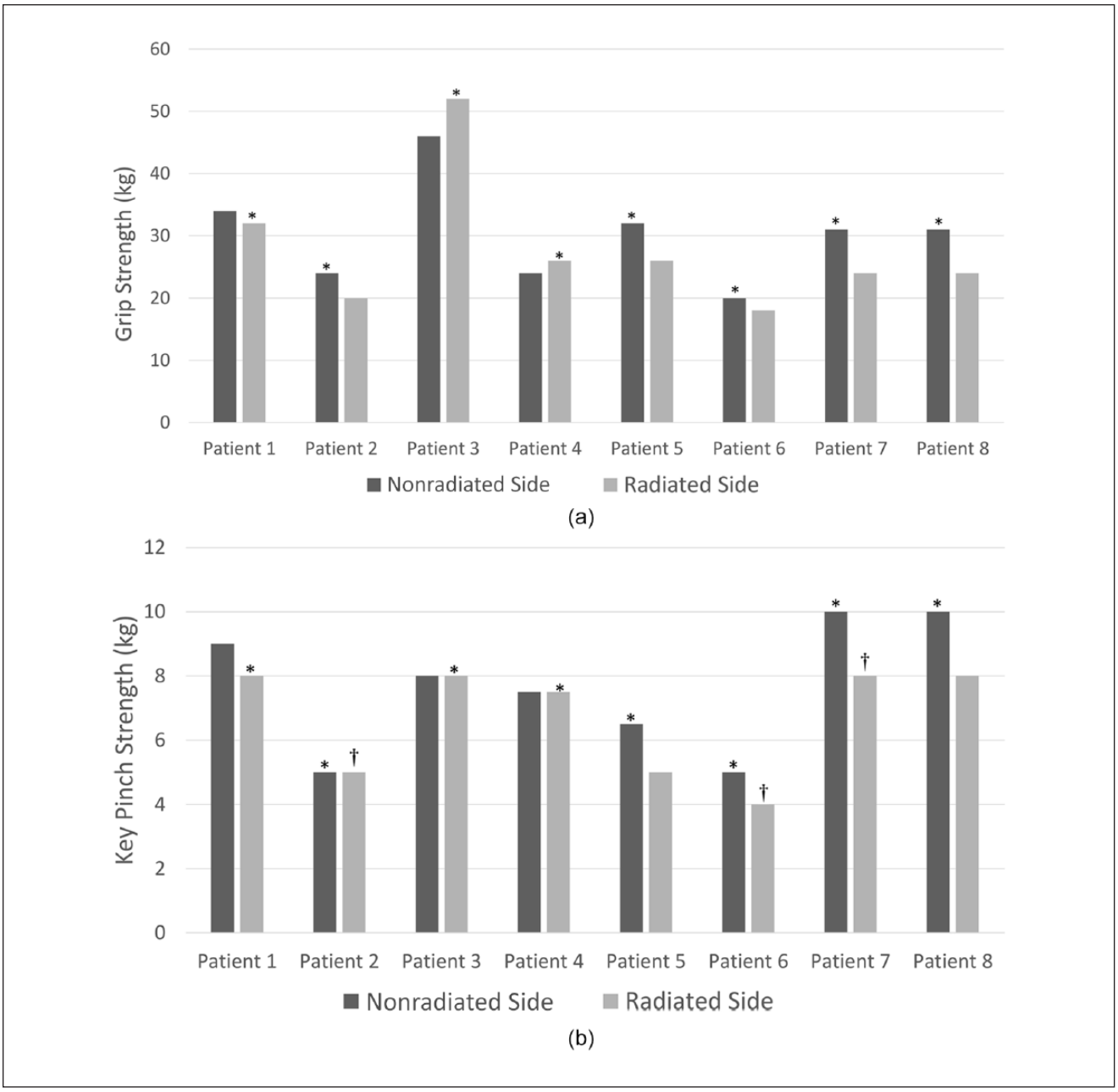

Figure 4. (a) Grip strength and (b) key pinch strength.
(a) Demonstrates the grip strength of the nonradiated and radiated hand in kilograms. Measurements were taken using a handheld dynamometer. Asterisk (*) indicates the self-reported dominant handedness of the patient. (b) Demonstrates the key pinch strength of the nonradiated and radiated hand in kilograms. Measurements were taken using a handheld pinch gauge. Asterisk (*) indicates the self-reported dominant handedness of the patient, and dagger (†) indicates that the patient's thumb received surgery and radiation for giant cell tumor of the tendon sheath.

operative resection of structures, postoperative fibrosis, or possible underlying osteoarthritis.

Only 8 of the 15 patients were available for follow-up, which may have resulted in selection bias. Although the study has a small sample, no other studies in the literature have evaluated the secondary effects of radiation to the hand in this population. A longer follow-up will be required to examine whether these problems worsen with further time. We attempted to separate the effects of surgery and radiation, and we believe that our observations specifically related to radiation are valid.

Radiation therapy to the hand was well tolerated in our population and was associated with a low level of

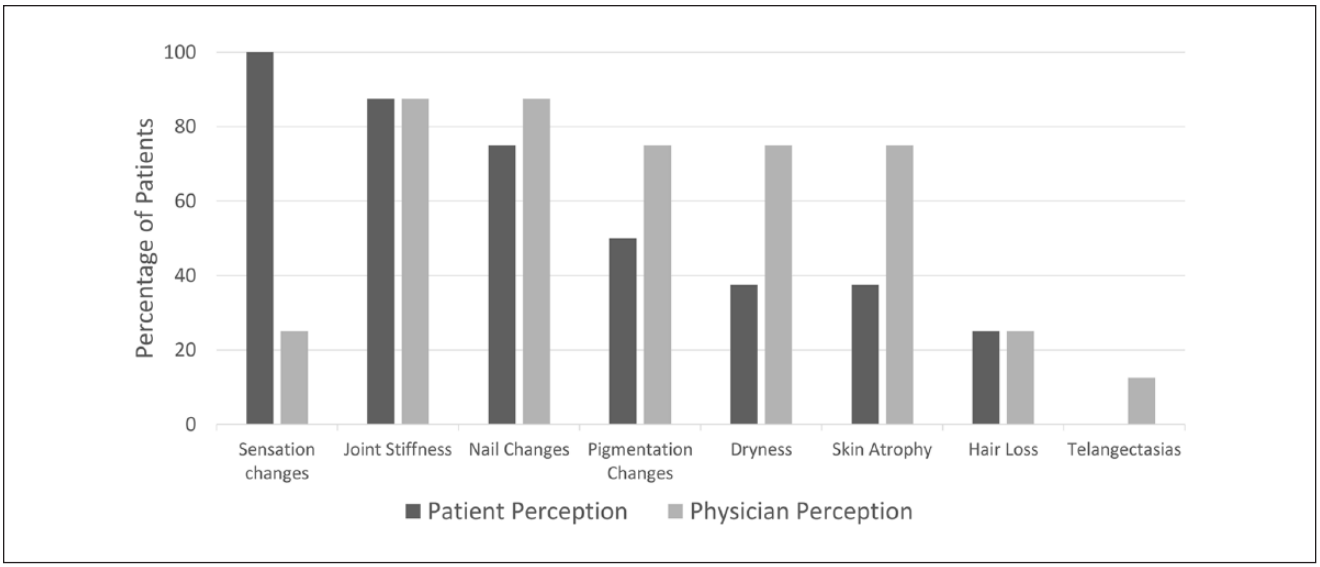

Figure 5. Patient- versus physician-perceived signs.
Compares the patient-perceived signs of radiation therapy compared with physician evaluation.

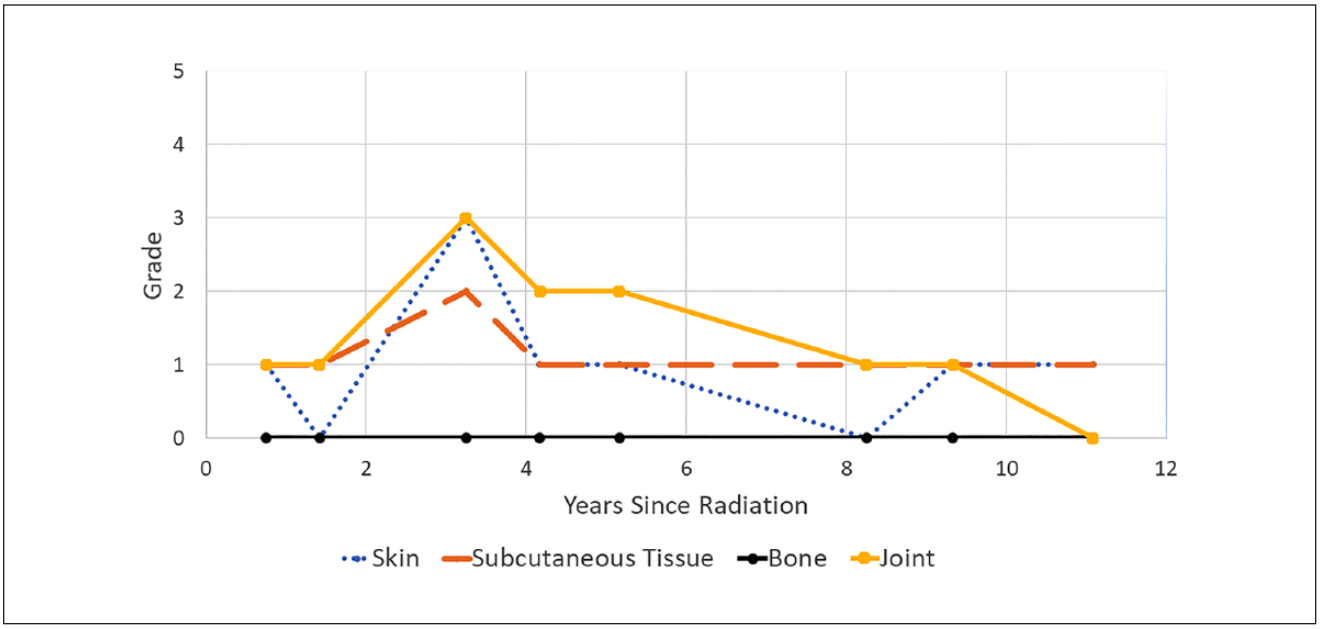

Figure 6. Late radiation morbidity scoring schema over time.
Demonstrates the Radiation Oncology/Toxicity Grading Scale Late Radiation Morbidity Scoring Schema for skin, subcutaneous tissue, joint, and bone for each patient as a function of time since radiation.

morbidity. We believe that radiation therapy in patients with severe benign pathology of the hand may prevent morbid operations, decrease the number of surgeries required, and better preserve hand function. No studies have yet investigated the use of radiation therapy in strong Dupuytren diathesis, and we next hope to examine the efficacy of radiation therapy in the treatment of Dupuytren diathesis.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

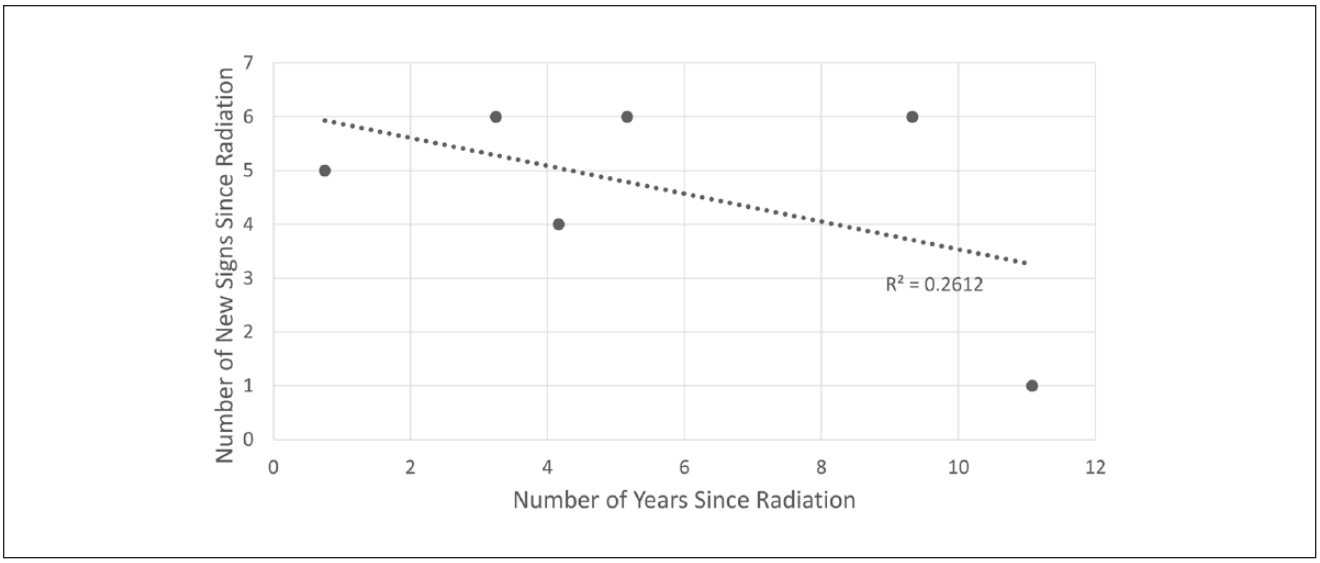

Figure 7. New radiation signs.
Demonstrates the number of new radiation signs found on examination compared with preradiation physical examination documentation. The nonsignificant inverse linear trend is also displayed.

Statement of Informed Consent

Informed consent was obtained from all patients for being included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in the article.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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