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THERAPY ARTICLES

The incidence of postoperative flare reaction and tissue complications in Dupuytren's disease using tension-free immobilization

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Abstract
Purpose Open fasciectomy represents a standard treatment of Dupuytren's disease. Although patients are commonly immobilized in extension to prevent postoperative contracture formation, immobilizing the extremity under tension may precipitate a flare reaction and scar-related complications. This study explores the incidence of flare reaction and other complications with postoperative tension-free splinting after fasciectomy for Dupuytren's contracture.
Methods We retrospectively reviewed patients' charts that consisted of 228 procedures in 191 patients who underwent surgery by the senior author between 2000 and 2010. Postoperative notes were reviewed for wound healing problems, scar appearance, flare reaction, and complications. The grading system defined by Evans et al. was used to standardize flare reaction and scar complications.
Results Using tension-free splinting, the incidence of flare reaction was 3.5 % (8/228). The eight patients that had flare reactions had mild involvement, and no severe reaction was observed. Fifteen patients had hypertrophic scars, eight had hypersensitive scars, and six had recurrent contractures.
Conclusions The incidence of flare reaction using tension-free immobilization postoperatively was low in our study. According to our findings, wound healing problems are rare when tensionless splinting is utilized.

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Introduction

Dupuytren's disease is the manifestation of pathologic processes exhibited by perivascular fibroblasts within the palmar fascia of the hand. Secondary involvement often involves the small joints of the hand as a result of chronic soft tissue contracture stretching of the extensor mechanism and concomitant tightness of the oblique retinacular ligament (ORL). This disorder may involve ectopic sites including the plantar fascia (Ledderhosen's disease) and penile shaft (Peyronie's disease). Within the hand, significant limitations in function and quality of life result from palmar fascia disease [9]. Dupuytren's disease is a fibroproliferative disorder that is clinically and pathophysiologically unique and is characterized by normal tissues becoming diseased. While the underlying etiology remains elusive, it has been established that Caucasian males of Northern European descent with a family history of the disease exhibit a high genetic susceptibility [5]. The genetic code, molecular signals, and cellular changes that lead to the fibroblastic disease in Dupuytren's disease, however, are currently being investigated [8, 23]. Cords progressively shorten leading to joint and soft tissue contracture. Palmar disease usually precedes progression into the digits with the metacarpophalangeal joint (MCP) being the most frequently affected joint followed by the proximal interphalangeal joint (PIP). The ring finger is most commonly affected followed by the small, middle, and index fingers and thumb [19, 20].

Surgical intervention is a widely used treatment method for symptomatic Dupuytren's disease. Established indications for surgery are the presence of well-developed cords with MCP flexion contractures greater than 30° and any significant PIP flexion contractures (generally greater than 15°) [22]. Numerous procedures exist and consist of either transecting, removing, or otherwise altering the diseased tissue via percutaneous aponeurectomy, limited-incision fasciotomy/fasciectomy, classic open approaches with extensive fasciectomy, dermofasciectomy, radiation therapy, and more recently collagenase injections. Patients who opt for surgical treatment are often immobilized postoperatively in the form of static splints under the guidance of skilled certified hand therapists or occupational therapists. Postoperative complications include hypertrophic scar formation, sympathetic "flare reaction," joint stiffness/contractures, and recurrent disease [4, 10, 15, 16, 18, 21]. Flare reaction is characterized by a disproportionate degree of reactive erythema, stiffness, and edema in the postoperative period. These symptoms commonly manifest during the third to fourth week after the intervention. Patients usually show normal advancement of healing and improvement of symptoms after the surgery, followed by a decline in exam and symptoms, manifested in increased pain, swelling, and decreased range of motion. Although there is no defined treatment protocol, symptomatic therapy with edema control, anti-inflammatory modalities, neurologic medications, nerve stimulation, and stellate blocks are used. Reported flare reaction rates in the literature range from around 10 % in a study using no tension techniques [9] with some reports of possible incidence as high as 52 % using traditional splinting methods in association with early postoperative transient stiffness [7]. Recurrence rates of Dupuytren's contracture in the operated regions average 30 %, and it is unclear if this is truly disease recurrence versus disease progression [3, 12, 13, 17].

Multiple studies have reviewed surgical technique, postoperative complications, and surgical outcomes with Dupuytren's disease; however, few focus on the role of hand therapy and splinting techniques during the postoperative course. Widely accepted postoperative splinting immobilizes the involved fingers in maximum possible extension (Fig. 1), a position which imparts sustained stress or tension to the healing tissues. The purpose of positioning the fingers in this way is to maintain the improved finger extension obtained at surgery and to prevent recurrent joint contractures during healing. However, studies that have looked at mechanical stress on growth factor release, tissue oxygen supply, and palmar fascia cellularity raise questions as to the effect of tissue tension on scar formation and flare reactions [1, 9, 11]. The purpose of this study is to investigate whether the incidences of flare reaction, scar hypertrophy, and other complications associated with Dupuytren's surgery are lower with postoperative tension-free splinting compared to historical reports as initially suggested by Evans et al. [9].

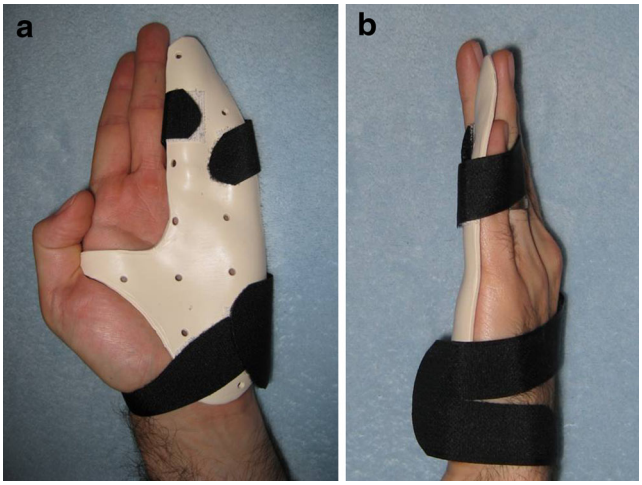

Fig. 1 Traditional splinting

Methods

Study Design

This study represents a retrospective review of 191 consecutive patients that were operatively treated for Dupuytren's disease at a single institution from 2000 to 2010. Patients were identified by searching the billing database for ICD-9 diagnosis codes (International Statistical Classification of Diseases and Related Health Problems, rev. 9) that were associated with Dupuytren's disease. These patient's charts were then reviewed, and patients without evidence of operative treatment of Dupuytren's were then excluded. All patients had follow-up until discharged from care or a minimum of 1 year of follow-up after the initial surgery. All charts were reviewed from the index procedures that were available for all the included patients to capture even late outcome variables. The specific operative modalities selected for inclusion in this study were fasciectomy, open palm Dupuytren's excision, and dermatofasciectomy with full thickness skin grafting.

This yielded 228 operative procedures in the 191 patients included in the study (some patients had undergone bilateral procedures or procedures involving different anatomic sites during a separate procedure).

Operative Intervention

We specifically looked at patients that received fasciectomy, open palm, or skin graft procedures, excluding those that have undergone needle aponeurotomy and fasciotomy without fasciectomy to minimize confounding effects. (For the list of procedures and operated digits, please consult Table 3 in the "Results" section).

Simple tissue closure was employed when no skin grafting was necessary. Incisions were made in accordance with hand

principles using the Brunner pattern to minimize skin contractures. Skin closure mainly consisted of primary closure with infrequent need for rotational flaps such as Z-plasties, VY advancements, or open palm technique. At the end of the operation, the patients were all placed in a forearm-based splint in neutral position (Fig. 2) allowing movement of digits distal to the operated area.

Postoperative Protocol

At the first postoperative visit within 3–5 days after surgery, a dorsal thermoplastic splint was custom fabricated with the MCP joints at 35–45° of flexion and the IP joints in extension according to Evans and colleagues [9] (See Fig. 3). The patients were advised to wear the splint continuously, removing it only for dressing changes and wound care as needed. Gentle active finger flexion exercises with extension to the limit of the dorsal block splint were begun at this first visit. The patients were provided written instructions and illustrations of the exercises for their home exercise program. Home exercise sessions were carried out for three to five intervals daily and as tolerated. Supervised therapy was provided as needed based on the patient's progress and need for assistance with carrying out the exercises and other therapeutic procedures.

The antitension splint was worn until 3 weeks postoperatively. At this time, the splint was remolded to a volar-based position with the involved digits in full comfortable extension. The splint was worn at night to maintain or increase finger extension to neutral. For the more difficult cases with incomplete or unsatisfactory extension, volar finger-based extension splints (for proximal interphalangeal joints) were worn intermittently during the day for the next several weeks until satisfactory extension was obtained (Fig. 4).

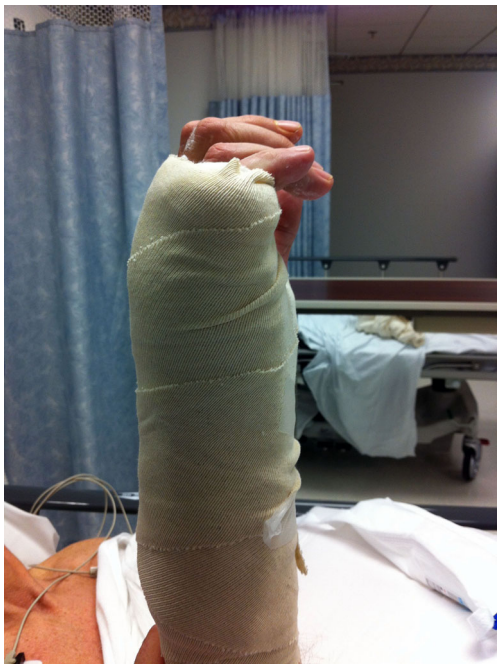

Fig. 2 Tension-free postoperative splint in neutral

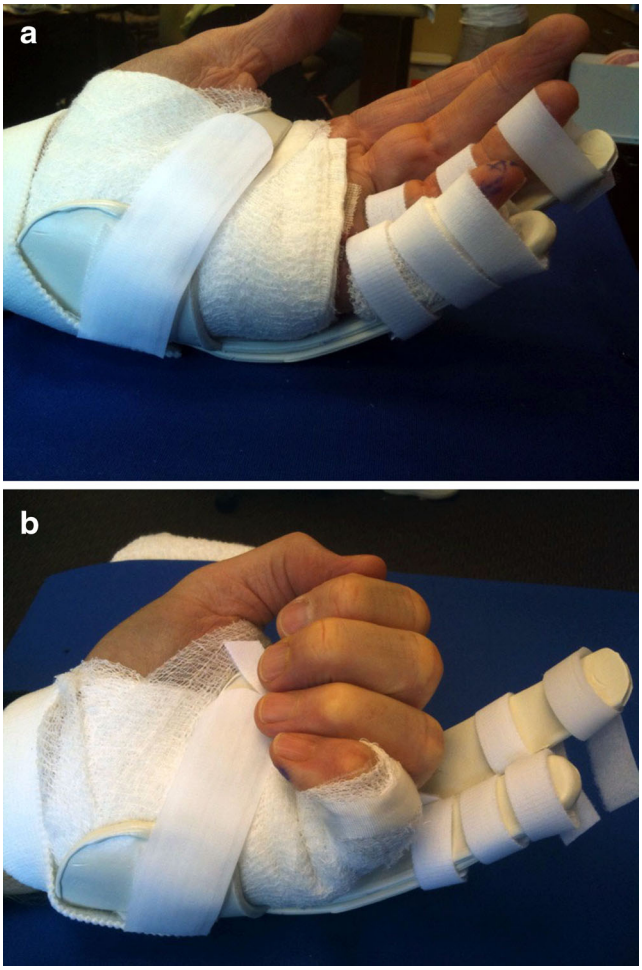

Fig. 3 **a**, **b** Tension-free dorsal extension block splint

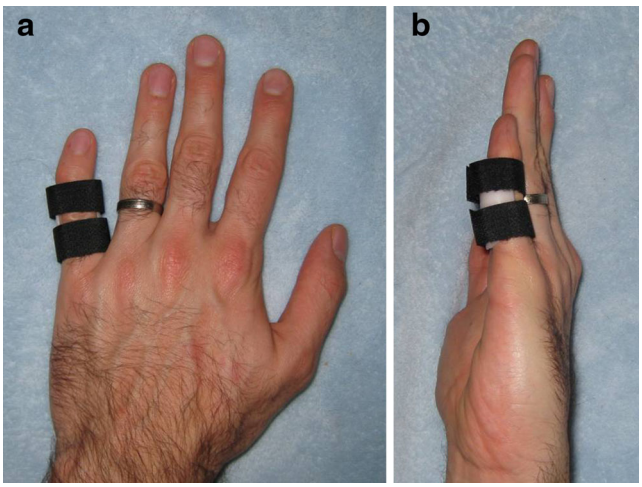

Fig. 4 Removable extension splints (e.g., finger based for proximal interphalangeal joint)

Outcome Measures

The postoperative assessment of patients included evaluation for scarring, wound issues, joint stiffness, or sympathetic flare reaction. Office notes were evaluated by the authors, and the results were tabulated. All cases that had any description of a flare were additionally reviewed by the senior author to confirm the findings (there was 100 % agreement on the presence of flare reaction by the senior author). Scar issues, when present, were classified according to whether they were hypertrophic, were hypersensitive, or resulted in contracture. Flare reactions were graded on a three-level scale initially described by Evans et al. [9] where grade 0 denoted normal wound healing, grade 1 represented a reaction limited to the operated digit, and finally, grade 2 reactions extended beyond the operated digits (Table 1; this grading system has not been validated). When evaluating the outcomes, according to the grading system previously described, a descriptive narrative of the scars was analyzed at all follow-up visits.

In addition to the presence or type of scarring and grading of the flare reaction, each case was analyzed with respect to the type of procedure, the number of weeks postoperatively the flare reaction was documented, and the number of operative sites. We recorded digits involved (by location, dominance, and joint involved when information was available), as well as any incisions made in the palm. We did not exclude patients that required capsulectomy as this was considered part of the required procedure for complete release. These data points were compared using common odds ratio estimates, chi-square tests, and Fisher's exact test to determine the statistical significance of the relationships that were empirically observed using SPSS (IBM, Armonk, NY). When looking at age as a variable, patients were grouped into and "young" and "older" category with a cutoff of 50 years old.

The Institutional Review Board and Office of Human Research at our institution approved this study.

Results

After identifying patients according to the inclusion criteria and excluding two subjects due to incomplete data, we found 191 patients who underwent 228 procedures between 2000 and 2010 (Table 2). Some patients have undergone multiple procedures during this 10-year window, such as contralateral side surgery or additional involved digits.

Table 1 Flare reaction grading according to Evans et al. [9]

Grade	Physical exam findings
0	Normal
1	Redness, stiffness, edema lasting beyond 2–3 weeks at operated sites
2	Symptoms extending beyond operated sites

Table 2 Demographics

Age (years)	
Average	63.3
Minimum	27
Maximum	89
Standard deviation	10.42
Gender	
Male	145
Female	46
Total	191

Table 3 demonstrates the types of procedures performed. Open fasciectomy of the diseased tissue was the most commonly performed procedure. Overall, eight patients had clinical signs that were consistent with postoperative flare reaction. The incidence of this complication in our study population was 3.5 % (8/228, Table 4).

Mild scar complications were observed. Fifteen (6.6 %) patients had hypertrophic scars, and eight (3.5 %) had hypersensitive scars. There were no severe scar complications defined as hypertrophic, inflexible scars with joint limitation, or those that would require surgical scar management by revision surgery, scar excision, or skin grafting. There were no flare reactions and scar or other complications in patients that underwent skin grafting or open palm procedures in our study population.

Looking at other adverse reactions, six patients had recurrent contractures unrelated to flare or scar complications (i.e., non-Dupuytren cord-related contracture such as artrofibrosis). One of these six patients had a mild flare reaction that resolved prior to the contracture formation. In these patients, there was no erythema, swelling, itching, pain, or stiff scar that would point toward contracture due to severe scar-related or flare-related contracture formation. Of the above six patients, one

Table 3 Procedures. Site refers to a digit or palm operated

Type of procedure	No. of operated hands	Distribution
Fasciectomy	216	94.74 %
-One site	112	
-Two sites	80	
-Three sites	20	
-Four sites	4	
Skin graft	10	4.39 %
-One site	5	
-Two sites	3	
-Three sites	2	
Open palm (palm only)	2	0.88 %
Total	228	

Table 4 Outcomes

	n	Incidence
No flare or scar complication	197	86.40 %
Flare	8	3.51 %
Hypertrophic scars	15	6.58 %
Hypersensitive scars	8	3.51 %
Total	228	

patient had later recurrence of Dupuytren's cords, the only instance of recurrence of the disease in the operated area in our study cohort. One patient had a benign wound dehiscence (wound with slight separation that healed with primary intention), and one had pyogenic granuloma formation that was successfully treated short term in the early postoperative period with the use of topical silver nitrate application in the office.

There was no instance of persistent objective neurological or vascular compromise in any case evaluated. Overall complication rate, excluding mild scar reactions that bear no functional limitation, inclusive of flare reactions was approximately 7 %. We did not consider the above mild scar reactions to be complications. However, including these, the scar adverse reactions and the above complication rates combined in our study are 17.6 %.

There incidence of flare reaction was incrementally larger with the extent of surgery or the number of sites operated; however, this relationship was not statistically significant (p=1.000, Fisher's exact test) (See Table 5). Although in our study population, surgery on more than three sites was less common than on fewer sites (one to two sites), a similar trend can be observed that demonstrates the increase of flare reaction with more extensive surgical intervention.

When comparing the outcome variables and their independent relationship with flare reaction, we find that patients with flare reaction have a greater propensity to develop hypertrophic or hypersensitive scars. The association between flare reaction and scar problems is considered to be statistically significant, with p=0.001 (Fisher's exact test).

Further attributes were evaluated to see if other factors are linked to the development of flare reactions. We found no association between flare reaction and the patients' gender in our population (p=0.203, Fisher's exact test). Even though all eight patients that had flare reactions were males, statistical correlation was not found. Similarly, there was no association of statistical significance when looking at age (as categorized) and a flare reaction (p=0.201, Fisher's exact test).

Table 5 Operative sites vs. flare reaction

Operative sites	*n*	Patients with flare	Incidence
	119	3	2.52 %
2	83	3	3.61 %
3	22	1	4.55 %
4	4	1	–[a]
Total	228	8	

[a] Sample size (n) not sufficient to show proportionate correlation

Discussion

Although there is uncertainty about the exact mechanism of contracture formation due to the pathological processes involved in Dupuytren's disease, tremendous advances have been made in the treatment of this progressive disorder. It has been generally accepted practice that once the contracting tissues are released, maintenance of the achieved surgical gains requires splinting in the position that allows for maximal length of the healing areas of the palmar structures. Although postoperative immobilization in this extended position has become the standard of care, some speculation has surrounded the possibility that this may indeed promote reactive processes to become locally aggravated thereby leading to poor outcomes in the early postoperative period.

By releasing tension on the operative bed, we hypothesize that early recurrent contracture and local reactive changes may be diminished. As studies continue to further explore the effect of mechanical stress on in vitro fibroblasts found in Dupuytren's tissues, as well on postoperative wound tension, it is becoming increasingly obvious that mechanical stress may precipitate adverse outcomes [1, 9, 11]. The exact mechanism of how physical tension affects the cellular and molecular pathways promoting cord formation is not clear. It appears that myofibroblasts react to tensile stretch and increase their activity in this state [9].

In our population, tension-free splinting resulted in minimal flare reaction, 3.5 % compared to as high as 52 % in reported literature [7]. Furthermore, the flare reaction that was observed in the eight patients in the study was of the mild form. No patient demonstrated signs or symptoms consistent with severe flare reaction or a grade 2 flare. Similarly, there were no sympathetic symptoms, such as vasomotor changes, dystrophy, or excessive pain, that extend beyond the operated digits or any need for systemic or aggressive local treatment (i.e., nerve blocks, transcutaneous electrical nerve stimulator, systemic neurologics like gabapentin, steroids, stress loading) [9]. The benign form of flare reaction which was observed in our population was manifested by inflammation limited to the operated areas, redness, stiffness, and edema lasting beyond 2–3 weeks and was controlled by local edema control and systemic anti-inflammatories [9]. It is well understood that during open fasciectomy treatment of Dupuytren's disease, the requisite dissection carries significant risks to neurovascular structures. Of the 228 operated extremities, there was no incidence of persistent objective neurologic or vascular compromise

(excluding mild parasthesias that were occasionally observed). Our overall complication rate (7 %) was lower than those published in other studies (3.6–39.1 %), with major complications occurring in as many as 15.7 % of cases in the literature [7]. Although we do not know the exact reason for this discrepancy, we believe that tension-free splinting has a profound effect not only on flare reaction but on other variables as well, possibly including neurovascular complications.

Mechanical stress on vessels may predispose to decreased lumen diameter, which may limit the oxygen delivery to the distal tissues. As clinical or subclinical hypoxia ensues, free radical formation, decreased wound healing, infection, and other local effects may lead to significant surgical complications. Studies show that hypoxia can promote further fibroblast formation [14], thereby contributing to the cycle of continued scaring, contracture formation, and possibly postoperative flare. These local changes may lead to clinical neurovascular changes or deficits. Without tension on these vital structures that previously have not seen much stress due to the contracture, it is possible that some of these adverse events may be avoided.

As demonstrated by this study, the application of tension-free splinting may have contributed to a low incidence and severity of flare reactions and scar formation. As shown in other studies that employ splinting techniques similar to ours [9], the incidence of scar hypertrophy and sensitivity were low.

Flare reaction is thought to correlate with more extensive surgery (fasciectomy at multiple areas) [2]. Although we noted a similar pattern, this was not statistically significant in our study population. It can be debated whether it is the more aggressive or advanced pathological process requiring extensive surgery or the increased tissue trauma caused by greater operation that leads to more frequent flare reactions. It is possible that this finding was not as evident in our patients compared to those of other studies due to the decreased tension on the operative bed using tension-free splinting. When many sites are operated on, the scar tension with traditional splinting may be higher as more scars and more areas are involved. This effect may be minimized in tension-free splinting and may explain this difference.

Some authors advocate eliminating tension by using z-plasty and other skin management tools [6]. It is possible that all these interventions can accomplish the same result that we strive to achieve. We believe that since there is no negative impact of our splinting protocol on range of motion, immobilization techniques are likely the easiest way to achieve stress-free wounds and healing. This technique does not substitute for meticulous surgery and proper technique, but may aid in the potential for improved recovery. In summary, the incidence of flare reaction using tension-free immobilization postoperatively was low and we found no evidence of a severe flare reaction. According to our findings, wound healing problems are rare when tensionless splinting is employed. When wound complications were identified, they were of the mild variety. There were no persistent or clinically significant neurovascular deficits as a result of the surgeries performed among our cohort of patients. Tension-free splinting therefore represents an effective option to potentially decrease complications related to the surgical treatment of Dupuytren's disease.

Although this study did not investigate the relationship between splinting the extremity in a relaxed position and its effect on postoperative short- and long-term range of motion, other studies have demonstrated that there is no detriment to these or other functional outcomes [9].

This study is limited by lack of clear and validated outcome tools used to judge flare reaction, scar healing, and Dupuytren-related surgical complications. There are few studies that detail surgical outcomes in comparable postoperative splinting protocols to ours. Further randomized controlled studies would be beneficial in order to elucidate the more subtle effects of tension-free splinting compared to conventional immobilization. Since we have not yet found the biochemical or cellular basis for Dupuytren's flare reaction, it is possible that certain agents, such as anti-inflammatories or Immunomodulators, when introduced intraoperatively, may also halt the development of these adverse reactions.

Conflict of Interest Michael Rivlin declares that he has no conflict of interest in this article.

Meredith Osterman declares that she has no conflict of interest in this article.

Sidney M. Jacoby declares that he has no conflict of interest in this article.

Terri Skirven declares that she has no conflict of interest in this article.

Uzoma Ukomadu declares that he has no conflict of interest in this article.

A. Lee Osterman declares that he has no conflict of interest in this article.

Declaration (Statement of Informed Consent and Statement of Human and Animal Rights) The above study was performed in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national review board) and with the Helsinki Declaration of 1975, as revised in 2000 and 2008. The study was performed under the guidelines of our institutional review board (Thomas Jefferson University Institutional Review Board); protected patient information was de-identified and has not and would not be used in the publication of this study. Informed consent was not obtained from all patients for being included in the study as the study was determined exempt due to the use of a de-identified radiological database, and no patient identifiers were used in accordance and with the approval of the Institutional Review Board at our institution.

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