Foot and Ankle Surgery 20 (2014) 61–66

Contents lists available at ScienceDirect

Foot and Ankle Surgery

journal homepage: www.elsevier.com/locate/fas

Effect of radiofrequency microtenotomy on degeneration of tendons: An experimental study on rabbits

Taner Gunes MD[a,*], Erkal Bilgic MD[a], Mehmet Erdem MD[b], Bora Bostan MD[a], Resit Dogan Koseoglu MD[c], Seyyid Ahmet Sahin MD[d], Cengiz Sen MD[e]

[a] Gaziosmanpasa University School of Medicine, Department of Orthopaedics and Traumatology, Tokat, Turkey
[b] Sakarya University School of Medicine, Department of Orthopaedics and Traumatology, Sakarya, Turkey
[c] Gaziosmanpasa University School of Medicine, Department of Pathology, Tokat, Turkey
[d] Erbaa State Hospital, Clinic of Orthopaedics and Traumatology, Erbaa, Tokat, Turkey
[e] Istanbul University, Istanbul Medical School, Department of Orthopaedics and Traumatology, Istanbul, Turkey

ARTICLE INFO

Article history:
Received 25 July 2013
Received in revised form 9 October 2013
Accepted 4 November 2013

Keywords:
Microtenotomy
Radiofrequency
Tendon
Degeneration

ABSTRACT

Introduction: Radiofrequency microtenotomy is used to enhance healing by increasing vascularity in the degenerated tendon. In the present study, the effect of radiofrequency microtenotomy (Rf-mt) treatment on tendon degeneration was investigated.

Materials and methods: A total of 32 New Zealand rabbits were enrolled in the current study. Experimental degeneration was performed by injecting prostaglandin E1 (PGE1) into the bilateral Achilles tendons of rabbits. After excluding 4 rabbits with an infection on the injection site, 4 other rabbits were sacrificed to define the histopathologic changes in the tendons. The remaining 24 rabbits were divided into 2 groups: the control group and the Rf-mt group. In the control group, the Rf-mt device was only applied to the Achilles tendon without running the device. In the Rf-mt group, the Rf-mt device was applied bilaterally at the fourth energy level for 500 ms to an area within 2 cm proximal to the insertion site at 0.5 cm intervals in order to form a grid. Six rabbits from each group were sacrificed at 6 and 12 weeks. The Achilles tendons were evaluated histopathologically by a modified Movin scale and by immunohistopathologic staining for vascular endothelial growth factor and type 4 collagen.

Results: After the PGE1 injection, findings similar to chronic degenerative tendinopathy were observed. The Rf-mt group showed significant improvement in vascularity in the histopathological and immunohistochemical examination ($P < 0.05$). However, there was no significant difference in healing between the control and Rf-mt groups ($P > 0.05$).

Conclusions: Rf-mt treatment increases vascularity in degenerated tendons but does not create difference to facilitate the healing process comparing control group.

1. Introduction

The treatment of chronic degenerative tendinopathy (CDT) is still controversial [1]. Although several treatment alternatives are available, none is suitable for all patients [1,2]. Nonsteroidal anti-inflammatory drugs, stretching exercises, injections (e.g., steroids, polidocanol, and blood), extracorporeal shock wave therapy, and surgical procedures are among the current treatment modalities [1,3,4].

Radiofrequency microtenotomy (Rf-mt) is a new treatment method for CDT that has recently been introduced [5]. It has been postulated that angiogenesis stimulated by several mediators released from the debridement area triggers a healing response [5]. Currently, Rf-mt is used in areas of electrophysiological cardiology, otolaryngology, cosmetic surgery, and wound healing [6–10]. In several studies on tendon degeneration, pain control in the early period and a pain-free period up to 18 months have been reported [9,11–13]. In contrast to these findings, no beneficial effect was observed in an experimental study on the delayed repair of acute supraspinatus tears in rats [14].

Neovascularization is believed to be the main factor underlying the effects of Rf-mt [5]. Vascular endothelial growth factor (VEGF) and type 4 collagen are markers of neovascularization. VEGF is a potent mediator of new vessel formation, and its presence in tissues indicates that new vessel formation will begin [15]. Type 4 collagen is the main component of the basal membrane [1]. It accumulates in the subendothelial layer in the early period of neovascularization. By detecting the presence of type 4 collagen, one can show neovascularization.

* Corresponding author at: Gaziosmanpasa University School of Medicine, Department of Orthopaedics and Traumatology Muhittin Fusunoglu Cad., Kaleardi Mah., 60100 Tokat, Turkey. Tel.: +90 356 212 95 00x1282; fax: +90 356 213 31 79.
E-mail address: drtgunes@gmail.com (T. Gunes).

1268-7731/$ – see front matter © 2013 European Foot and Ankle Society. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.fas.2013.11.003

Although several studies have evaluated the effects of Rf-mt on pain, to the best of our knowledge, no studies have evaluated its effects on tendon degeneration. In the present study, the effect of Rf-mt treatment on the healing process following tendon degeneration was investigated. We hypothesized that Rf-mt would enhance the healing response in a degenerative tendon with increased vascularity.

2. Materials and methods

2.1. Experimental methods

This study was performed on 32 rabbits (mature male New Zealand white rabbits weighing 2.5–3 kg). After receiving ethical committee approval, according to the experimental tendon degeneration model of Sullo et al. [16], 1600 ng of PGE1 was bilaterally percutaneously injected 1 cm proximal to the Achilles insertion intratendinously once per week for 4 weeks. PGE1 was diluted from a stock solution (0.2 mg/mL Na_2CO_3) to a final concentration of 1600 ng/mL. To dissolve PGE1, the information provided by Sigma (product number P5515) was used. During the injection period, infection developed in 4 rabbits at the injection site, and as a result, the study was completed with 28 rabbits.

One week after the last injection, 4 rabbits were sacrificed to define the histopathologic changes in the tendons. The amounts of VEGF and type 4 collagen were also investigated by semiquantitative immunohistochemical methods. The results obtained from the 8 Achilles tendons of these 4 rabbits were used for the degeneration model (DM) group to verify the changes that occurred in the control and Rf-mt groups over time. The remaining 24 rabbits were randomly divided into 2 groups: control and Rf-mt. The 24 rabbits in these 2 groups were treated surgically one week after the last injection.

2.2. Surgical technique

Ketamine (30–40 mg/kg) and xylazine (3–5 mg/kg) were intramuscularly injected for anesthesia. A single dose of cefazolin sodium (50 mg/kg) was administered for prophylaxis. Longitudinal skin incisions were made on the 2 legs after shaving and preparing the skin with an antiseptic solution. The Achilles tendon was exposed by opening the paratenon longitudinally. In the control group, the Rf-mt device was touched to the Achilles tendon without running the device. Microtenotomy was performed in the Rf-mt group as described by Tasto et al. [5] (Fig. 1). The Rf-mt device (TOPAZ MicroDebrider, ArthroCare Inc., USA) was applied bilaterally at the fourth energy level for 500 ms to an area within 2 cm proximal to the insertion site at 0.5 cm intervals in such a way that it would form a grid at the end of the procedure. After irrigating the tendon with saline solution, the incision was closed with 6/0 prolene (Ethicon, San Angelo, TX, USA) for the paratenon and 4/0 prolene (Ethicon, San Angelo, TX, USA) for the skin. Acetaminophen (1–2 mg/kg) was added to each 100 mL of drinking water for analgesia. The rabbits were housed with unrestricted cage activity and given standard rabbit chow and tap water ad libitum.

2.3. Evaluation

Six rabbits from each group were sacrificed at 6 and 12 weeks after the operation, and each pair of Achilles tendons was examined for histopathologic and immunohistochemical parameters. After separating the Achilles tendon from the muscle at the musculotendinous junctions, it was resected with a small piece of bone block. All samples were fixed in 10% buffered formalin for 24 h and embedded in paraffin. Longitudinal sections (5 μm thick) were cut and stained with hematoxylin and eosin. Five slices of each tendon were interpreted by a pathologist who was blinded to the group design using the semiquantitative grading scale first described by Movin et al. [17] and later modified by Sullo et al. [16] Fiber structure, fiber arrangement, nuclei rounding, regional variations of cellularity, decreased collagen staining, hyalinization, and the presence of acute inflammatory characteristics were included in the scale. Each slice was given a score between 0 and 3. In this scoring system, the values are assigned as follows: 0, normal; 1, slightly abnormal; 2, abnormal and 3, markedly abnormal. As the degeneration progressed, the score increased.

VEGF and type 4 collagen were investigated using the streptavidin-biotin-peroxidase enzyme reaction method for immunohistochemical staining. A pathologist who was blinded to the group design evaluated 5 slices for each tendon using a new semiquantitative scoring system developed by our group and described below. The arithmetic mean of these 5 scores was taken

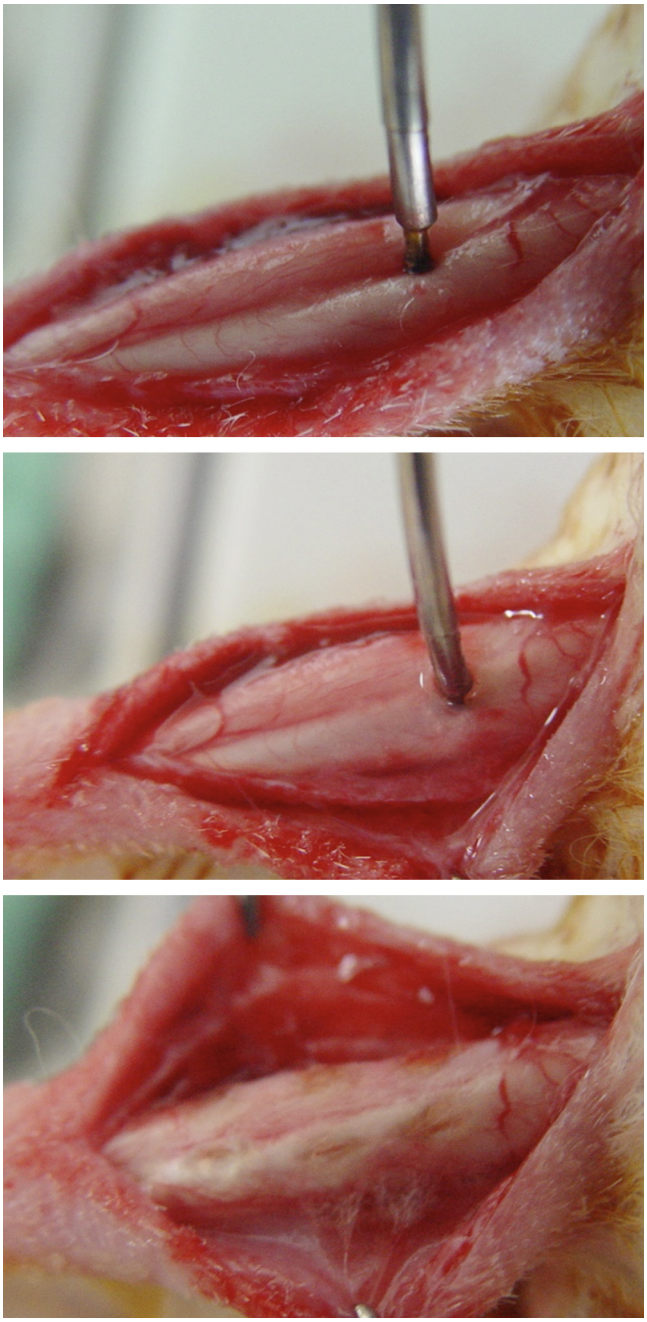

Fig. 1. Performing microtenotomy, as described by Tasto et al.