FIBER SELECTIVE MUSCLE ATROPHY IN ANKLE ARTHRITIS

[1,2,4] Victor Valderrabano, [1] Vinzenz von Tscharner, [1] Benno M. Nigg, [2] Beat Hintermann, [1,4] Cyril Frank, [3] Beat Göpfert
[1] *Human Performance Laboratory, University of Calgary, Canada*
[2] *Orthopaedic Department, University Hospital of Basel, Switzerland*
[3] *Laboratory of Orthopaedic Biomechanics, University of Basel, Switzerland*
[4] *Orthopaedic Department, University of Calgary, Canada*
email: v.valderrabano@kin.ucalgary.ca, *web:* www.kin.ucalgary.ca/hpl

INTRODUCTION

Recently, the occurrence of ankle arthritis has increased due to an increase of injuries and people's life span [1]. Biomechanical studies of the normal ankle joint complex provided knowledge on range of motion, movement coupling between calcaneus and tibia, gait kinematics and kinetics and functional zones of foot and lower leg [2, 3]. Only a few studies addressed the kinematic characteristics of the disabled ankle in vivo [4]. However, no studies addressed the clinically seen muscle atrophy of the lower leg muscles for subjects with ankle arthritis.

Therefore, the aim of the present study was to analyze the electromyogram and the strength of the lower leg muscles during isometric maximal voluntary dorsi- and plantar-flexion contraction of the arthritic ankle. The results were compared to the contralateral healthy side and a normal population, as well as to clinical orthopaedic and radiological variables.

METHODS

Seven patients and 7 healthy control subjects participated in the study. The patients (3 males and 4 females with an average age of 49 years (range between 43-57 years)) suffered from unilateral posttraumatic end-stage ankle arthritis. The control subjects were age matched with no muscular-skeletal pathologies of the lower extremity.

The clinical variables assessed through an orthopaedic examination included subjective pain score (visual analogue scale 0-10), functional American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score (0-100 points), hindfoot alignment (valgus, varus degree), muscle mass (shank circumference), ankle range of motion, latency time between injury and symptomatic ankle arthritis, and ankle arthritis degree (X-rays). The biomechanical variables included electromyography (EMG; frequency, intensity) and muscle force (ankle joint torque). Muscle activity was quantified using surface EMG during maximal voluntary dorsi- and plantar flexion for the tibialis anterior, gastrocnemius medialis, soleus, and peroneus longus. Electromyograms were analyzed using a wavelet analysis by decomposition the EMG for specified wavelets into an intensity pattern resolving the power of the signal in time and frequency) [5].

RESULTS AND DISCUSSION

The results showed a significant pathology of all clinical variables of patients suffering from ankle arthritis compared to the healthy population. There was a significant decrease of the torque produced by the arthritic joint compared to the torque produced at the contralateral side and the normal population for maximal voluntary dorsi- and plantar flexion. Compared to the contralateral healthy side and the normal population, posttraumatic ankle arthritis also changed the EMG signal of the surrounding muscles (gastrocnemius, tibialis anterior; Figure 1), resulting in a frequency shift towards lower frequency pattern. This phenomenon may be caused by fiber specific changes in the muscle, a hypo-/atrophy of the fast twitched fibers (200-600 Hz). It is speculated that, during maximal contraction, the atrophic muscles attempted to compensate for this shortcoming by increasing the intensity of the remaining pool of slow twitch fibers (Figure 1).

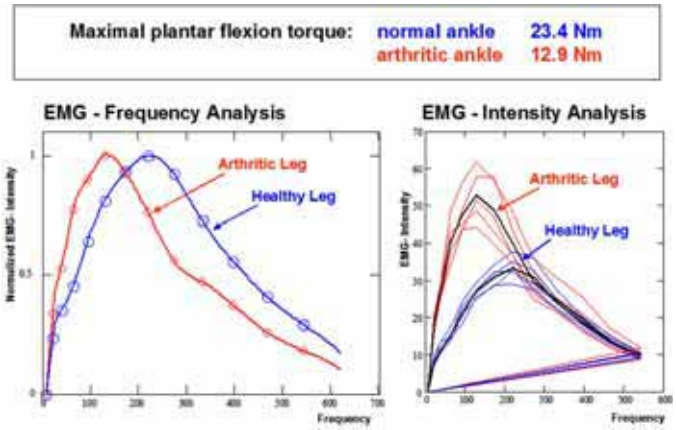

Figure 1: **Gastrocnemius Medialis – Force and EMG of Arthritic and Healthy Leg**. Force, EMG-frequency, and EMG-intensity of the Gastrocnemius medialis during maximal voluntary plantar flexion on the arthritic (red) and the healthy lower leg (blue).

CONCLUSIONS

To the author's knowledge, this is the first study quantifying the effect of posttraumatic ankle arthritis on lower extremity muscle activation, associated with fiber selective muscle degeneration: a fast-twitch fiber hypo-/atrophy. It is proposed that this knowledge may be applied for surgical treatment and rehabilitation programs.

REFERENCES

1. Baumhauer JF, et al.. *Am.J.Sports Med.* 23:564-570, 1995.
2. Hintermann B, Nigg BM. *Foot Ankle Int.* 16:514-518, 1995
3. Valderrabano V, et al. *Foot Ankle Int* 24:888-896, 2003
4. Shih LY, et al. *Foot Ankle Int* 14:97-103, 1993.
5. von Tscharner V. *J.Electromyogr. Kin.* 10:433-445, 2000

ACKNOWLEDGEMENTS

This study was supported by a grant of the Swiss National Science Foundation (SNF).