

NORMATIVE DATA FOR TEMPORAL PARAMETERS AND PATTERNS OF FOOT UNROLL DURING BAREFOOT RUNNING

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Summary

To give normative data for temporal aspects and patterns of foot unroll during barefoot running in healthy subjects.

Conclusions

Normative data are given for temporal aspects of barefoot running. As expected, foot-to-ground contact occurs in a lateral-to-medial way, but during final push off the forefoot unrolls over the mid-forefoot (M₂-M₃) instead of over lateral part (M₁).

INTRODUCTION

Dynamic plantar pressure measurements offer a great opportunity to study temporal aspects of foot unroll during running. Earlier Blanc et al (1999)¹ used foot switches on heel, metatarsal I and V and on the hallux to give normative data for temporal parameters and foot unroll during barefoot walking. The purpose of this study was to give normative data for temporal aspects and patterns of foot unroll during barefoot running, based on plantar pressure measurements.

SUBJECTS/MATERIALS/METHODS

Plantar pressure data were collected from 80 healthy undergraduate physical education students. A footscan pressure plate (RsScan nv., 2m x 0.4m, 16384 sensors, 480 Hz, dynamic calibration with AMTI force plate) was mounted in the middle of a 16.5m long running track. The subjects ran barefoot at a speed of 3.3m/s (+/- 0.17 m/s). After testing, one observer identified eight anatomical regions (medial and lateral heel, metatarsal I – V and hallux) on all footprints. Total contact time of the stance phase was measured. Foot unroll was divided into four phases: initial contact (initial contact - first forefoot contact), foot flat (end initial contact - contact of all metatarsals), heel off (end foot flat - heel off) and forefoot push off (end heel off - end of stance phase). Temporal parameters were studied separately for left foot and right foot, according to previous research that showed significant differences for left trials and right trials². The investigation of patterns of foot unroll was based on the sequence of time to first contact and time to end contact of the eight regions for all footprints (left N=249 and right N=247). A more global characterization was performed by a combined sequencing of time to first contact and time to end contact of five regions (heel, metatarsal I, III, V and the hallux).

RESULTS

	<i>Left (s)</i>	<i>Right (s)</i>	
Initial contact	.000 (±.000) to .017 (±.012)	.000 (±.000) to .015 (±.010)	Mean total contacttime was 0.220s (+/- 0.020s) and 0.221s (+/- 0.019s) respectively for left foot and right foot. The most common foot-to-ground pattern was H _{lat} H _{med} M ₅ M ₄ M ₃ M ₂ M ₁ T ₁ , in both left (36%) and right foot contacts (35%). The sequence in which the foot leaves the ground differs between left feet and right feet, although the most common pattern was found to be H _{lat} H _{med} M ₅ M ₄ M ₃ M ₁ M ₂ T ₁ for 24% of left and for 11% of right foot contacts. The more global characterization revealed H M ₅ M ₃ M ₁ T ₁ H M ₅ M ₃ M ₁ T ₁ as the most common pattern for left feet (30%) and H M ₅ H M ₅ M ₃ M ₁ T ₁ H M ₅ M ₁ M ₃ T ₁ for right foot (31%).
Foot flat	.017 (±.012) to .038 (±.013)	.015 (±.010) to .035 (±.010)	
Heel off	.038 (±.013) to .099 (±.019)	.035 (±.010) to .094 (±.020)	
Forefoot push off	.099 (±.019) to .217 (±.020)	.094 (±.020) to .215 (±.023)	

DISCUSSION

The use of eight regions including 5 metatarsal regions and a measuring rate of 480 Hz gives a very good picture of the foot unroll during running. On the other hand, little differences in timing cause a great variability in patterns of foot unroll and explain the small percentage of frequency of some patterns. Making contact with the ground occurs in a lateral-medial way. Forefoot push off was expected to end over the most medial structures (M₁) but, surprisingly, a more central last contact (M₂ and M₃) was found mostly.

REFERENCES

- Blanc Y., Balmer C., Landis T. Vingerhoets F. Temporal parameters and patterns of the foot roll over during walking : normative data for healthy adults. *Gait and Posture* 10 (1999) 97-108
- De Cock A., Willems T., Stal S., De Clercq D. Within-subject variability of plantar pressure patterns in barefoot running. Abstract, IV World Congress of Biomechanics, Calgary, 4-9 August 2002