



ISB 2013
BRAZIL

XXIV CONGRESS OF THE INTERNATIONAL
SOCIETY OF BIOMECHANICS

XV BRAZILIAN CONGRESS
OF BIOMECHANICS

EFFECTS OF THREE RUNNING TECHNIQUES ON LOWER LIMB KINEMATICS IN HEALTHY RUNNERS: A CASE SERIES

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SUMMARY

This study aimed to compare the immediate effects of three running technique modifications on the hip and knee kinematics and on the subjective assessment of comfort in three healthy runners. The runners performed usual running (USRUN) plus three running techniques at a random order on a treadmill: 1) landing with the forefoot (FFOOT); 2) increasing 10% of the step rate and (10% SR); 3) increasing trunk flexion (TFLEX). Three-dimensional hip and knee kinematics were evaluated using a motion analysis system (Qualysis Medical AB, Sweden). During FFOOT technique, all runners demonstrated reductions in hip flexion (87% less than USRUN), and two runners presented less hip adduction (91% less than USRUN) and hip internal rotation (70% less than USRUN). The average knee flexion showed 34% reduction during FFOOT and 34% increase during 10% SR. Small changes were observed on knee abduction. All runners considered FFOOT the most comfortable technique. Future studies with larger sample size are needed to identify lower limb biomechanics during different running techniques in order to develop more effective injury prevention and treatment programs.

INTRODUCTION

The exponential growth of the number of runners is observed all over the world. It is estimated that over 30 million of North Americans practice running [1]. However, this practice has a potential risk for injury [2]. Approximately 56% of recreational runners and more than 90% of runners present some injury every year [3]. More than 40% of injuries involve the knee joint. In order to improve injury prevention and rehabilitation programs, it is important to investigate the effect of different running techniques on lower limb biomechanics.

Recently, it has been hypothesized that three running technique modifications has the potential to produce beneficial effects on the lower limb biomechanics reducing the demand on the knee joint, for example: 1) landing with the forefoot (FFOOT)[4,5], 2) increasing 10% of the step rate (10% SR)[6] and 3) increasing the trunk flexion (TFLEX)[7]. Therefore, the purpose of this study was to investigate the effects of three running technique modifications on hip and knee kinematics and on the subjective assessment of comfort.

METHODS

Three young healthy runners (1 female, 2 males) participated in the present study (Table 1). All subjects ran a minimum of 20 km/week for at least 3 months and presented a rearfoot strike pattern during running [4,6]. Each subject completed a familiarization session (maximum 3 days before data collection) when it was determined the preferred speed (9.66 ± 0.57 km/h) and step rate (169.33 ± 4.61 steps per minute). All techniques were analyzed using the comfortable speed chosen during the familiarization session.

Three-dimensional trunk and lower limb kinematics were collected at 240 Hz, using a six-camera system (Qualysis Medical AB, Sweden) on a treadmill. Twenty passive reflective anatomical markers and five tracking markers were positioned on the participant. The order of running techniques was randomized for each subject. The data was recorded during 10 s for each technique. The variables of interest were peak knee flexion, knee abduction, hip flexion, hip adduction and hip internal rotation. All variables were averaged across 10-foot contacts from the dominant lower limb. Kinematics variables were analyzed during the initial foot contact, determined by the minimum vertical position of the distal heel marker for USRUN, 10% SR and TFLEX, and using the hallux marker for FFOOT.

The confirmation of the FFOOT technique was obtained by analyzing the real time plantar pressure distribution with insole sensors (Pedar-X System, Novel GMBH, Munich, Germany). For the 10% SR technique, the runners were monitored using a metronome. The TFLEX technique was visually confirmed. The Visual 3D software (C-Motion, Rockville, MD) was used to quantify the movements of the hip, knee and foot. The subjective assessment of comfort during the running techniques was evaluated using a 10-cm visual analogue scale (0: uncomfortable and 10: very comfortable).

RESULTS AND DISCUSSION

The values of hip and knee kinematics on the sagittal plane: flexion (+) /extension (-); frontal plane: abduction (+) /adduction (-); and transversal plane: medial (+) /lateral (-) are shown in Figure 1 for each condition. Our results indicated that running technique modifications could alter lower limb kinematics. The average knee flexion from all runners showed mixed results. When compared to USRUN, runners performed less knee flexion during FFOOT (34%

reduction) and more knee flexion during 10% SR (34% increase). There were small differences in the average knee abduction among running techniques (USRUN: -0.68; FFOOT: 0.72; 10% SR: 0.69; TFLEX: -0.06).

The FFOOT technique demonstrated the greatest difference on hip kinematics. All runners demonstrated reductions in hip flexion during the FFOOT (87% less than USRUN). Also, runners 2 and 3 demonstrated less hip adduction (91% less than USRUN) and internal rotation (70% less than USRUN) during the FFOOT. Additionally, all runners considered the FFOOT the most comfortable technique (8.86 ± 0.75), followed by 10% SR (6.26 ± 2.95), and TFLEX (4.93 ± 3.98).

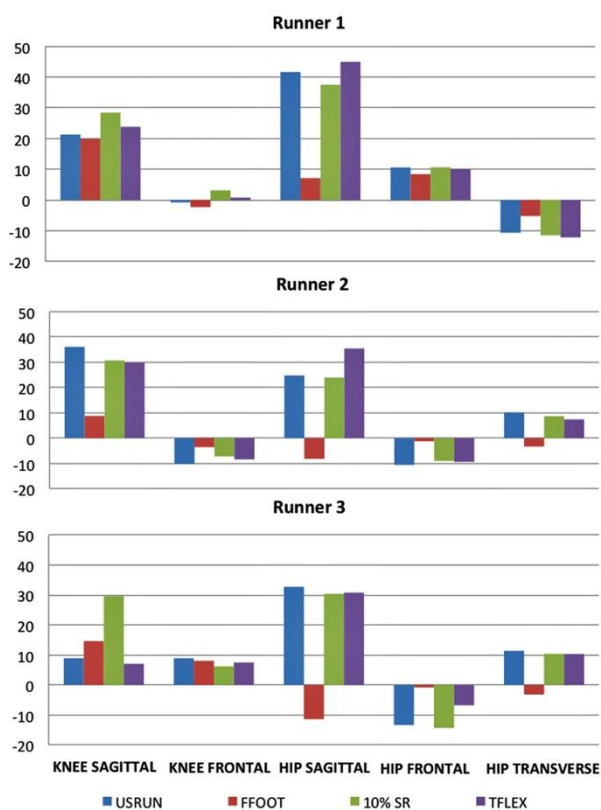


Figure 1: The effect of running technique modifications on the hip and knee kinematics during the initial contact of the stance phase of running.

Table 1: Baseline demographic characteristics of the population studied.

Characteristics	Runner 1	Runner 2	Runner 3
Age (years)	21	23	19
Height (m)	1.89	1.67	1.61
Mass (kg)	80	55	62
Body Mass Index (kg/m ²)	22.39	19.72	23.91
Running Experience (years)	3	3	1
Running Distance (km/week)	40	25	20
Dominant Limb	Left	Right	Right

Overall, runners demonstrated similar hip and knee kinematics during 10% SR, TFLEX and USRUN. Unlikely previous study, our results did not show reduced knee flexion and hip adduction during 10% SR [6]. Teng et al. [7] demonstrated decreased patellofemoral joint stress during TFLEX. Corroborating with the cited study, we did not find difference in knee kinematics during TFLEX. Contrary to previous study, runners demonstrated decreased hip and knee flexion during FFOOT [5]. Frontal plane hip and knee kinematics findings during FFOOT may contribute to lower risk of injury [4].

CONCLUSIONS

This was the first study to compare USRUN with FFOOT, 10% SR and TFLEX running techniques. Our results suggest that all running techniques showed the potential to alter lower limb kinematics, but the FFOOT technique demonstrated the greatest differences on the hip and knee kinematics. In addition, subjective assessment of comfort revealed that all runners considered FFOOT technique the most comfortable one. Future studies with greater sample size are necessary to confirm these results in order to assist in developing preventive and rehabilitation programs.

ACKNOWLEDGEMENTS

The authors are grateful for the financial support obtained from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

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