ELECTRODYNOGRAM FORCE ANALYSIS IN CROSS-COUNTRY SKIING

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Effectiveness of the Langer Electrodynogram (EDG) force analysis system in the cross country ski diagonal stride was tested in a preliminary study. The objective was to utilize the EDG to investigate temporal patterns of the stride performed on level terrain.

EDG SYSTEM

The EDG system is a lightweight portable feild unit. It consists of up to seven (7) individual transducers which are applied directly to each foot. These resistive material transducers produce a voltage, which is transmitted to a data collection waist pack. Data collection is initiated by activation of a button on the waist pack. Upon activation, there is a one-second delay and data then collected from both instrumented feet for five (5) seconds. The waist pack can be easily removed without disturbing the transducers, and data from the pack transferred to the Langer Microprocessor. Output indicates force patterns of each transducer, with reading taken every hundredth (.01) second.

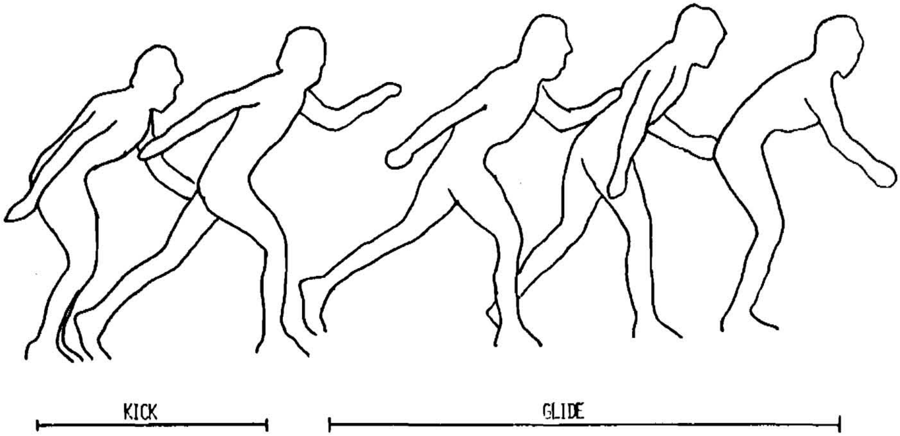
METHOD

An Olympic-caliber Nordic Special skier was the subject for this pilot study. This 28 year old, 148 pound male was prepared with transducers applied to each foot. Previous experimental trials lead us to determine the following transducer locations most effective: 1) first metatarsal 2) third metatarsal 3) fifth metatarsal 4) front lateral heel 5) rear lateral heel 6) front medial heel, and 7) rear medial heel.

After an initial warm-up, the subject performed five (5) trials on level terrain, executing the diagonal stride. An average of three steps per foot were collected from each trial.

FIGURE 1

THE DIAGONAL STRIDE



Following data collection, information from the EDG strip outputs were charted as temporal force patterns of each foot. A minimal threshold of ten percent (10%) body weight was selected as an indicator of whether the transducer was on or off. Because force patterns of the front and rear lateral and medial heel transducers appeared very similar, we decided to treat the front and rear heel transducers as one component (lateral heel) and likewise with the medial heel. For clarity and simplicity, the third metarsal was excluded from the charts, since we were most interested in medial-lateral forefoot and rearfoot movement patterns.

DISCUSSION

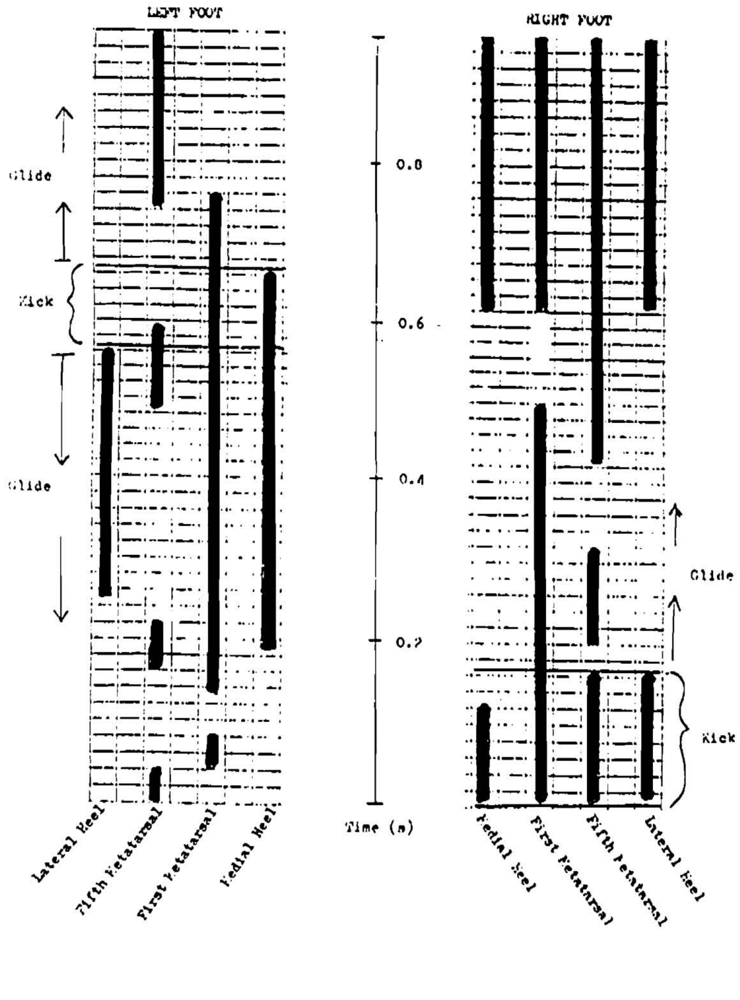
The cross country ski diagonal stride can be divided into two basic phases which are: 1) kick, where the ski is motionless in the track, and 2) glide, where the ski is moving in the track (figure 1). Our initial question was whether the transducers were firing during these phases. A reveiw of the data showed us that they were. This led us to a more detailed examination of patterns within the stride.

Reviewing the charts plotted (an example appears in figure 2) some asymmetrical patterns are revealed. The right foot kick phase illustrated medial and lateral forefoot and heel forces being applied throughout the phase. The left foot, however, showed medial dominance, both forefoot and heel. The glide phase on the right foot illustrated a typical glide phase pattern of forefoot force applied during the free glide with heel force added during the glide while poling phase. The left foot glide does not illustrate this consistent pattern. Although the basic components mentioned in the right glide are apparent, there is a trend toward medial forefoot domination. Also, lateral heel force was minimal in the left foot glide.

It was not the intent of this study to make any definitive statements concerning technique evaluation of this subject on the basis of these results. The assymetry apparent in the stride of this subject can possibly be an indicator of inadequate leg strength in the left leg. With this type of information supplied, the coach and athlete should work together and apply the information to ski technique.

FIGURE 2

TEMPORAL STRIDE PATTERNS



CONCLUSION

This investigation showed the Langer Electrodynogram to be a useful tool in isolating asymmetrical force patterns in the cross country ski diagonal stride. This temporal force profile could be valuable to the coach and athlete.

There do exist some technical problems with this system, however. Initiation of data collection, which is performed through subject activation of a button on the waist pack, is an unnatural cross country ski movement. Perhaps a pole-activated switch would be more applicable. Data output format is another problem. Computerization of the force output, specific to cross country skiing,is necessary.

Feild portability is a positive aspect of this system. Collection of data for five seconds, simultaneously for both feet, is another attractive feature of the EDG.

Future work with this system as applied to cross country skiing could include within subject comparison of terrain, equipment, snow conditions, waxing, and ski technique.

Body position of the skier as it relates to the temporal force patterns is almost essential to a total understanding of the movemnt. Simultaneous high speed film or video records should be collected in the future.