A COMPARISON OF HIP AND KNEE KINEMATICS WHEN USING A KNEE ALIGNMENT DEVICE AND DYNAKAD IN NORMAL CHILDREN

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Introduction

Most commercial gait analysis software packages use models that depend on accurate placement of wands and markers on the subject. Since the thigh wand is difficult to properly align, the knee alignment device (KAD) was developed to aid in determining a static offset for an improperly placed thigh wand (Davis, et al., 1996). Baker, et al., (1999) proposed another approach (DynaKAD) that assumes that an improperly placed thigh wand will cause artifact in the knee varus/valgus curve. Previous work has showed no correlation between KAD thigh rotation offsets and DynaKAD thigh rotation offsets (Dorociak, et al., 2000). The purpose of this study is to determine whether there is a difference in hip and knee kinematics when using a KAD thigh rotation offset and a DynaKAD thigh rotation offset.

Statement of Clinical Significance

Improper placement of the markers and wands can propagate errors in kinematic data and may cause errors in clinical decision making.

Methods

Three clinicians with a minimum experience of 3 years performed computerized gait analysis on 59 normal children (mean age 9.5 ± 2.9) using a 6-camera VICON 370 system (Oxford Metrics) with two AMTI force plates. Thirteen reflective markers were placed on the lower extremities in accordance with the model described by Vicon Clinical Manager (VCM). For each subject, a static trial was collected using a KAD (Motion Lab Systems) before the dynamic trials. Static and dynamic data were processed with VCM. For data analysis purposes, one side was randomly chosen and three representative trials for each subject were selected by the clinician. The static KAD thigh rotation offset (KTR) was recorded for each subject. The three dynamic trials were then re-processed with DynaKAD using Bodybuilder (Oxford Metrics). The VCM DynaKAD thigh rotation offset was extracted (DTR).

The three trials were re-processed in VCM using KTR and DTR values. Mean curve values for hip flexion/extension (HFE), hip abduction/adduction (HAA), hip rotation (HR), knee flexion/extension (KFE), knee rotation (KR), knee varus/valgus (KVVmean), and knee varus/valgus minimum (KVVmin) and maximum (KVVmax) were extracted and averaged. An unpaired t-test was performed to determine if a statistically significant difference for KTR and DTR existed between clinicians. A t-test was performed between the KAD and DynaKAD variables, and the difference between the KAD and DynaKAD variables was obtained for each subject.

Results

Since no statistical difference was found between clinicians for KTR and DTR, ($p > 0.116$), all subjects were grouped together. No statistical difference was found for HAA ($p = 0.59$).

	KAD/DynaKAD		KAD/DynaKAD Differences		
	KAD (SD)	DynaKAD (SD)	Difference (SD)	Min	Max
HFE	16.9 (5.2)	18.6 (5.7)	-1.7 (1.4)	-5.2	1.4
HR	5.0 (7.1)	-5.2 (5.4)	10.2 (8.5)	-8.9	29.7
KFE	17.1 (4.3)	20.4 (4.7)	-3.3 (3.0)	-12.7	1.7
KVVmin	-3.2 (2.8)	-5.2 (3.3)	2.0 (2.6)	-6.6	8.3
KVVmax	9.6 (6.2)	2.1 (3.3)	7.5 (6.2)	-5.3	19.5
KVVmean	1.0 (2.9)	-2.1 (2.8)	3.1 (2.7)	-2.8	11.0
KR	-20.5 (11.1)	-8.8 (14.1)	-11.7 (14.1)	-52.3	4.68

Table 1. Significant variables in degrees ($p < 0.0001$) with their mean differences and range. Where + is flexion and - is extension for HFE and KFE, + is internal rotation and - is external rotation for HR and KR, and + is varus and - is valgus for KVVmin, KVVmax, and KVVmean.

Discussion

The sagittal plane variables HFE and KFE have small differences of around 2° and 3° with the DynaKAD variables shifted slightly toward more flexion. The largest difference occurred in the transverse plane variables, HR and KR. Processing hip rotation with static KAD technique produced values that were 10° more internal compared to DynaKAD (maximum difference of 30°). At the knee, the opposite occurred with KAD values 12° more external than DynaKAD (maximum difference of 52°). These results could have significant implications in clinical interpretation when determining whether to perform a rotational osteotomy.

Artifact in the knee varus/valgus curve from an improperly placed thigh wand requires correction in order to obtain true hip rotation values. However, the two commonly used methods to correct this produce significantly different absolute values. The discrepancies in KVV max, KVV mean, and KVV min reflect the differences in each processing algorithm. The inability to determine the “true” rotation makes it difficult to resolve which method is more accurate. Both methods have their inherent sources of error, and further study must be done to determine the most accurate method for thigh rotation offset.

References

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Acknowledgements

The authors wish to thank Richard Baker, all of the subjects that volunteered, and the clinical staff of the Motion Analysis Lab and Clinical Research department.