Gait & Posture 42 (2015) 394–397

Contents lists available at ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Short Communication

# Correction of static axial alignment in children with knee varus or valgus deformities through guided growth: Does it also correct dynamic frontal plane moments during walking?

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ARTICLE INFO

*Article history:*
Received 5 February 2015
Received in revised form 20 May 2015
Accepted 20 June 2015

*Keywords:*
Varus
Valgus
Knee
Guided growth
Gait

ABSTRACT

Malaligned knees are predisposed to the development and progression of unicompartmental degenerations because of the excessive load placed on one side of the knee. Therefore, guided growth in skeletally immature patients is recommended. Indication for correction of varus/valgus deformities are based on static weight bearing radiographs. However, the dynamic knee abduction moment during walking showed only a weak correlation to malalignment determined by static radiographs. Therefore, the aim of the study was to measure the effects of guided growth on the normalization of frontal plane knee joint moments during walking.

15 legs of 8 patients (11–15 years) with idiopathic axial varus or valgus malalignment were analyzed. 16 typically developed peers served as controls. Instrumented gait analysis and clinical assessment were performed the day before implantation and explantation of eight-plates. Correlation between static mechanical tibiofemoral axis angle (MAA) and dynamic frontal plane knee joint moments and their change by guided growth were performed.

The changes in dynamic knee moment in the frontal plane following guided growth showed high and significant correlation to the changes in static MAA ($R = 0.97$, $p < 0.001$). Contrary to the correlation of the changes, there was no correlation between static and dynamic measures in both sessions. In consequence two patients that had a natural knee moment before treatment showed a more pathological one after treatment.

In conclusion, the changes in the dynamic load situation during walking can be predicted from the changes in static alignment. If pre-surgical gait analysis reveals a natural load situation, despite a static varus or valgus deformity, the intervention must be critically discussed.



## 1. Introduction

Lower extremity angular deformities are among the most common nontraumatic conditions in children being referred to pediatric orthopedist [1]. In particular malaligned knees are predisposed to the development and progression of unicompartmental degenerations because of higher loads placed on one compartment, or side, of the knee [2–4]. Therefore, guided growth in skeletally immature patients is a standard procedure, since it requires only minimally invasive surgical techniques compared to corrective osteotomies in adulthood. In addition, early restoration of the mechanical axis during childhood is recommended, to avoid permanent abnormality of the adjacent joint surfaces [1]. Today, the eight-plate, a minimally invasive, secure and effective implant [5–9] has become the gold standard in guiding growth [5]. The device is a two hole pre-contoured plate, fixed with non-locking screws. It acts as a tension band across the medial or lateral epiphysis of the knee resulting in asymmetric growth into knee varus or valgus respectively. Indication is based on static weight bearing full length radiographs. However, the internal knee abduction moment, a valid marker of mechanical loading of the knee joint during walking [2,4], showed only a weak correlation with the malalignment determined by static radiographs

*Abbreviations:* MAA, mechanical tibiofemoral axis angle; TD, typically developed controls.

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http://dx.doi.org/10.1016/j.gaitpost.2015.06.186
0966-6362/

**Table 1**
Patients individual anthropometrics and interventions.

| No. | Knee malalignment | R/L legs no. | Body height [cm] | Body weight [kg] | Gender | Age at implantation [years] | Duration of implantation [months] | Increase in body height during implantation [cm] | Implantation site | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Femur medial | Tibia medial | Femur lateral | Tibia lateral |
| 1 | Valgus | 1, 2 | 165 | 60 | m | 15 | 9 | 5 | x | | | |
| 2 | Valgus | 3, 4 | 180 | 71 | m | 14 | 11 | 8 | x | | | |
| 3 | Valgus | 5, 6 | 173 | 69 | m | 15 | 17 | 6 | x | | | |
| 4 | Valgus | 7, 8 | 155 | 45 | f | 12 | 8 | 7.5 | x | x | | |
| 5 | Valgus | 9, 10 | 156.5 | 40 | f | 11 | 9 | 8 | | x | | |
| 6 | Varus | 11, 12 | 149 | 35 | f | 12 | 13 | 1.5 | | | | x |
| 7 | Varus | 13, 14 | 153 | 48 | f | 13 | 15 | 3 | | | | x |
| 8 | Varus | 15, – | 164 | 57 | m | 14 | 21 | 4.5 | | | x | x |

[10,11]. Possible explanations might be associated rotational deviations in the transverse plane [12,13] as well as ipsilateral trunk lean [14]. To our best knowledge only one of the numerous studies about guided growth reported the effect on the dynamic loading situation during walking using the former stapling technique [15]. This is astonishing since the procedure aims to prevent excessive unilateral loads.

Therefore, the aim of this study was to measure the effects of guided growth on the desired normalization of frontal plane knee joint moments during walking. The hypothesis was that the change in dynamic moments and change in static alignment are closely related.

## 2. Methodology

A consecutive sample of 8 children with idiopathic genu valgum or varum that received eight-plates in 2013 was analyzed. Indication for surgery was based on axial deviations in frontal plane standing radiographs assessed by one experienced surgeon. Participants provided written consent, as approved by the local

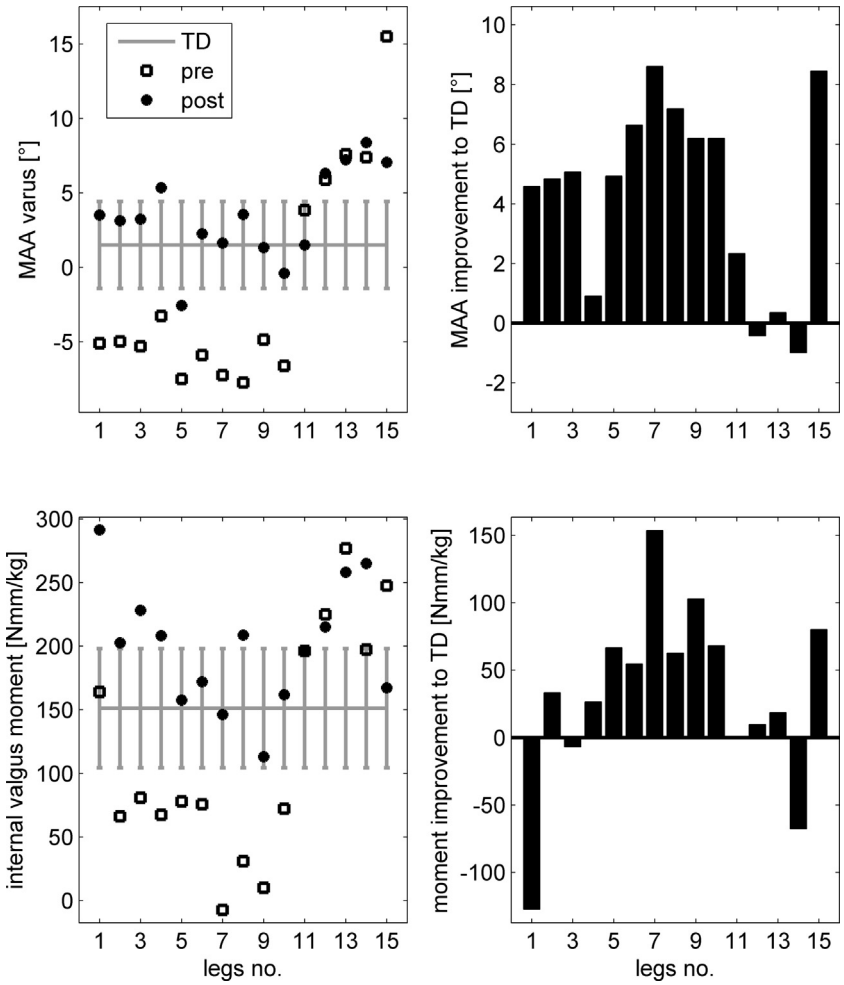


**Fig. 1.** Static mechanical tibiofemoral axis angle (MAA) and dynamic mean knee joint moments during stance phase of walking. Both, pre and post guided growth and with respect to typically developed (TD) peers.