



Review Article

Growth modulation for coronal deformity correction by using Eight Plates—Systematic review

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ABSTRACT

Introduction: Coronal deformities are commonly encountered in paediatric orthopaedics and surgical treatment is indicated for severe deformities causing pain, function and cosmetic problems. In a growing bone, major surgical intervention like osteotomy with internal or external fixation can be avoided by growth modulation (hemiepiphysiodesis) using 8-plates. Our aim is to review the published literature on the use of 8-plates for deformity correction.

Methods: We conducted a systematic review on 8-plate growth modulation for coronal deformity correction. We carried out detailed literature search on PubMed, Google Scholar, EMBASE, and Cochrane databases. We analysed selected studies for patient demographics, rate of deformity correction, clinical outcome and complications.

Results: We identified seven studies using 8-plate for deformity correction involving 215 patients (350 Limbs). The mean age was 9.5 years (2–16 years M/F Ratio 1.1:1); underlying aetiology was Idiopathic in 33% and Pathological 67% cases. The deformities were successfully corrected in 196/215 patients (91.2%) and partial/no correction in 19/215 patients (8.8%). The mean time to correction was 15.3 Months (10.3–25) and follows up of 18.9 months (12.4–24). The deformity corrected at 1.28°/month (0.93–1.53), lateral distal femoral angle changed at 0.87°/month (0.65–1.0) and medial proximal tibial angle changed at 0.72 (0.5–1). Complications were reported in 12/215 patients (5.6%) including hardware failure in 5, overcorrection/leg length difference in 5, infection 1 and stiffness 1. The rebound was reported in 8 patients (3.7%).

Conclusion: Growth modulation with 8-plates has high efficacy and low complications for deformity correction; and has been used widely across all paediatric age groups and aetiology. The literature is mostly retrospective and heterogeneous to develop age and aetiology specific recommendations.

1. Introduction

Coronal deformity is most commonly encountered in paediatric orthopaedic practice. The physiological deformities are treated conservatively, but severe deformities causing pain, function and cosmetic concerns, requires surgical intervention. In a growing bone, major surgical intervention with osteotomy and internal or external fixation can be avoided by growth modulation. Manipulation of growing bone by operative or non-operative method is old concept and widely used in paediatric orthopaedic practice for example in Pavlik harness treatment of DDH.¹ Permanent hemiepiphysiodesis with open or percutaneous ablation of the physis for angular correction requires accuracy with timing and close follow up to avoid residual deformity or over-correction.

Temporary hemiepiphysiodesis with instrumentation is an

attractive concept as allows for correction of deformity without above problems. There is ample evidence in literature to suggest that bone remodelling and growth can be modulated by mechanical forces.² The physis works normally under optimum load conditions but lower and higher load leads to stimulation of growth at physis.³ The complex interactions of hormonal and mechanical forces across physis is not fully understood, therefore there are variable results reported to different methods of growth modulation.

The term “guided growth” was first described by Stevens when used a hardware construct with extraperiosteal plate and 2 screws.⁴ Stevens used this plate as tension band restraining the growth of the physis to overcome previous hardware problems of breakage with other constructs. This construct is commonly used for deformity correction by growth modulation of the physis without possibly causing permanent growth arrest. 8-plate appears to have superseded the options of using

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transphyseal screw or staple, due to its simplicity of construct, ease of application and rehabilitation.⁵ The evidence for safety and efficacy of implant is limited to retrospective studies and an experimental study.⁶ According to experimental study, there was statistically significant earlier effect on angle of correction and implant displacement was significantly lower when compared with Blounts staple.⁷

The obvious advantage of 8-plates is reversibility but duration for which these can be applied without losing reversibility remains unclear. There was also concern regarding surgical treatment of pathological physis and younger patients with guided growth due to problems with rebound or risk of permanent growth arrest. There is limited evidence on the use of growth modulation to correct deformities in these conditions.

We carried out a systematic review on growth modulation using 8-plate construct to evaluate demographics, clinical outcome, rate of correction, complication and rebound deformity in the literature. Our aim was to understand and develop the evidence base for the use of this construct. To the best of our knowledge, there is no systematic review in the published literature on this topic.

2. Material and methods

This systematic review was performed in line with PRISMA-P 2015 checklist.⁸ The Pubmed, Google Scholar, EMBASE, and Cochrane database was searched for all relevant articles against search criteria from 2006 to 2016. The keywords used for search are summarised in Table 1.

The author performed literature searches on electronic databases with above keywords and reviewed articles. The abstracts meeting the inclusion criteria were reviewed by both authors. The inclusion criterion was Randomised Controlled Trials; Prospective or retrospective case studies on the Coronal deformity correction by growth modulation using 8-plate. Growth modulation with other methods like percutaneous hemiepiphysiodesis; staple and transphyseal screw was excluded from the study. For studies comparing two different methods; only patient data using 8-plate was included in the analysis. The studies not published in English literature or with incomplete data were excluded from the study.

We collected patient data including number of patients and limbs operated, age, sex of patients, follow up duration. Rate and time taken for deformity correction was documented. We also recorded aetiology of coronal deformity, follow up duration, complications and rebound deformity following removal of plate. We recorded percentage of deformities corrected by this method and successfully avoided the need for osteotomy. The angles for measurement of deformity were as described by Paley et al. and shown in Fig. 1.⁹

Statistical Analysis: SPSS (IBM Statistical Package for the Social Sciences, Version 24) and differences with p-value < 0.05 was considered statistically significant. Patient data was extracted from each article for analysis and summarised using Microsoft excel spreadsheet (Microsoft Corporation USA)

Table 1
Keyword searches for identifying articles.

Keyword and Boolean Searches		
Coronal Deformity	AND	Paediatric
Hemiepiphysiodesis	AND	Eight plate
Hemiepiphysodesis	AND	Children
Guided growth	AND	Coronal deformity
Growth Modulation	AND	Angular deformity
Genu Varum	AND	Deformity correction
Genu Valgum	AND	Deformity correction
Eight Plate	AND	Angular deformity
8-Plate	AND	Deformity correction
Tension Band Plate	AND	Paediatric

2.1. Surgical technique

Surgery was performed as day stay in most studies except one where patients were admitted for inpatient hospital stay. Surgical technique of application of 8- plate was described in publication by Stevens.⁴ It was recommended to place the plate just posterior to sagittal axis under fluoroscopic guidance to avoid risk of developing recurvatum. Two or three cm incision centred over physis to apply plate following meticulous surgical dissection in sub-muscular plane. Damage to periosteum and perichondrial ring should be carefully avoided. The placement of tension band plate should be confirmed under fluoroscopy. Post-operatively patient was mobilised full weight bearing and early return to full activities was recommended. Patient followed with serial radiographs to monitor progress with deformity correction. Screw and plate was removed once deformity was corrected and achieved neutral mechanical axis.

3. Observations and results

The preliminary searches of the literature with the above keywords identified articles as shown in PRISMA flow diagram. Articles were screened against inclusion and exclusion criteria as described in methods (Fig. 2).

We identified seven studies using 8-plate for deformity correction involving 215 patients (350 limbs). The mean age at the time of correction was 9.5 years (range 2–16 years), and male to female ratio approximately 1.1:1 (Male 114, Female 101). The underlying aetiology was documented in six studies (190 patients) as Idiopathic in 33% cases (62/190) and Pathological in 67% (128/190). The pathological conditions included skeletal dysplasia, pseudo-achondroplasia, hereditary osteodystrophy, Blount's disease, rickets, post-traumatic sequelae, other congenital and acquired disorders. The demographic information is provided in Table 2.

3.1. Data analysis

Author's assessment of risk of bias is given in Figs. 3 and 4. There were two prospective studies, two retrospective studies and three case series. There is high risk of selection and performance bias in retrospective studies. There was no randomisation of patient selection in all studies involved in this review.

3.2. Clinical outcome

The mean time to correction was 15.3 Months (10.3–25) and follows up duration 18.9 months (12.4–24). The rate of deformity correction was 1.28°/month (0.93–1.53), lateral distal femoral angle changed at 0.87°/month (0.65–1.3) and medial proximal tibial angle changed at 0.72 (0.5–1). Further details are provided in Table 3.

The deformities were successfully corrected in 91.2% (196/215) cases and partial/no correction in 8.8% (19/215). Table 4 has information on the number of cases.

3.3. Complications

Complications were reported in 12/215 cases treated (5.6%) including hardware problems in 5, overcorrection or leg length difference 5, infection 1 and stiffness in 1. The rebound of deformity was reported in 8/215 cases (3.7%).

4. Discussion

Coronal deformities are commonly presented in children and growth modulation using 8-plate to correct deformity is an attractive concept in skeletally immature patients. This has rapidly gained popularity, but evidence available in literature is limited and many

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