QUANTIFYING THE 'LAW OF DIMINISHING RETURNS' IN MAGNETICALLY CONTROLLED GROWING RODS

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DISCLOSURES

None

■ SPINE

Quantifying the 'law of diminishing returns' in magnetically controlled growing rods

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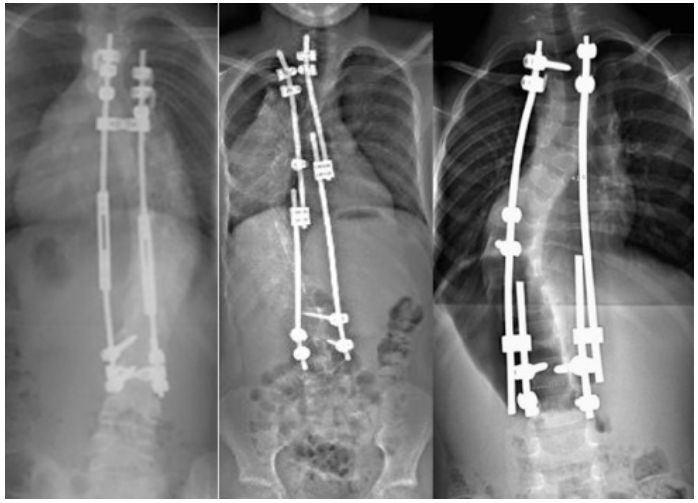
Aims

Magnetically controlled growing rods (MCGRs) allow non-invasive correction of the spinal deformity in the treatment of early-onset scoliosis. Conventional growing rod systems (CGRS) need repeated surgical distractions: these are associated with the effect of the 'law of diminishing returns'.

The primary aim of this study was to quantify this effect in MCGRs over sequential distractions.

INTRODUCTION

- Mainstay of surgical treatment over last decade has been variations of conventional growing rod systems (CGRSs) which require frequent surgical lengthening procedures every 6 months



- It has been shown that repeated operations with conventional growing rods are liable to be subject to the 'law of diminishing returns' because of increased spinal stiffness and spontaneous spinal fusion. To the best of our knowledge no study has associated this phenomenon with MCGRs.

INTRODUCTION

- The magnetically controlled growing rod (MCGR) system has gained worldwide recognition with good early radiological and clinical results for the treatment of Early Onset Scoliosis
- The controversy arises in MCGR relating to issues around the distraction frequency, amount and technique
- To our knowledge there have been no studies which have investigated the 'law of diminishing returns' in MCGRs nor have assessed the impact of physiological variables such as age, BMI (body mass index) or body weight on the efficacy of distraction in the MCGR device.

AIMS

- The primary aim of this study was to quantify radiologically the true amount of remote distraction achieved as a ratio of the intended distraction (T/I ratio) in MCGR, and to assess this trend over a minimum follow-up of two years.

- The secondary aims were to assess the correlation between mean T/I ratio and age, BMI, gender and type of scoliosis at two years follow-up.

METHODS

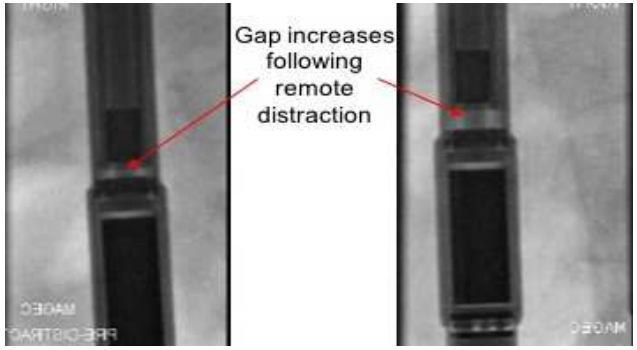
- Patient with EOS aged between 2 and 14 with potential spinal growth
- Prospective observational review of thirty-five patients undergoing insertion of Magnetic Growth Rods by two surgeons (CN, JWM) in one centre. Patients underwent implantation from December 2011 to November 2016
- The senior author (CN) performed controlled distractions using the ERC at three-monthly intervals with the Tail-gating Technique. The intended distraction to be set on the ERC was obtained from Dimeglio's annual growth charts. This method attempts to shadow physiological growth.

METHODS

- 35 pts
- Further distraction measurements stopped after any revision surgery
- Mean FU 30 mnths (6 to 57)
- 4 pts had FU of 6 months / 31 pts had FU of 1 yr or >
- At 2 yr FU 22 pts vs 21 pts in convex/concave rods for calculation of TI ratio

METHODS

- The true distraction was measured from the expansion gap seen within the actuator on the fluoroscopic/radiographic image and calculated using the width of the rod as a conversion factor for magnification. Therefore, the TI (True/Intended distraction) ratio could be calculated for each patient at each specific clinic appointment.



- The intended distraction was a cumulative figure from all previous distractions up to and including the latest clinic appointment.

RESULTS

Follow up (months)	Convex rod mean TI ratio	Concave rod mean TI ratio	Cobb Angle
Pre-operative stage	-	-	52±17° (n=34)
3	0.81±0.58 (n=22)	0.93±0.67 (n=21)	37±17° (n=34)
6	0.85±0.55 (n=26)	0.85±0.64 (n=26)	35±14° (n=34)
12	0.61±0.34 (n=18)	0.53±0.39 (n=18)	36±14° (n=32)
24	0.40±0.27 (n=22)	0.43±0.38 (n=21)	37±14° (n=27)
30	0.27±0.18 (n=11)	0.18±0.12 (n=12)	39±16° (n=35)
51	0.17±0.14 (n=8)	0.18±0.15 (n=6)	-

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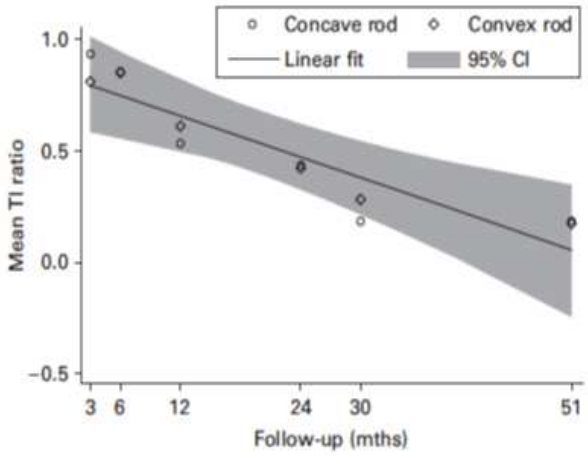


Fig. 1

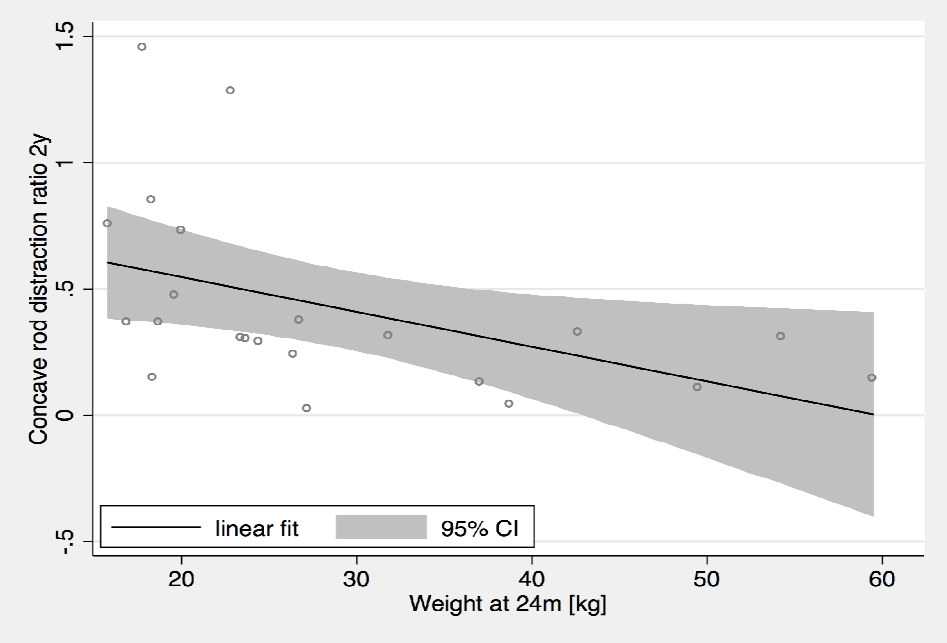
Graph showing the mean T/I ratios plotted for convex and concave rods over the course of treatment with MCGRs at specific time points. The regression line for the overall mean T/I ratios is given with its 95% confidence interval.

RESULTS

Variable	Convex rod mean TI ratio	Concave rod mean TI ratio
Age	r= -0.18, p=0.44, n=22	r= -0.59, p=0.01*, n=22
Weight	r= -0.19, p=0.43, n=22	r= -0.59, p=0.01*, n=22
BMI	r= -0.16, p=0.51, n=22	r= -0.54, p=0.01*, n=22
Gender	t= -0.27, p=0.79, 2-tailed	t= -0.19, p=0.86, 2 tailed
Scoliosis Type	df=3, F=0.12, p=0.95	df=3, F=0.91, p=0.45

Table 2 Correlation between mean TI ratios and different variables at 24-month follow up
***p<0.05 – statistically significant**

RESULTS



The concave rod TI ratios plotted against child weight at 24-month follow up. The regression line is seen with its 95% confidence interval

DISCUSSION

- The distraction ratios for MCGRs are highest in the first year, after which they fall steadily to below 0.5 after two years. This decline continues so that by 2.5 years only around 25% of intended distraction is achieved.
- As the age, weight or BMI of the patient increases, the percentage of intended concave rod distraction reduces significantly at the 2 year follow up time period.
- The older and larger child may have increased risk of distraction failure as the MCGR is unable to impart enough force to allow for lengthening due to increased tissue thickness/bulk.
- No differences in TI ratio between gender
- No differences in TI ratio between types of scoliosis

CONCLUSION

- The 'law of diminishing returns' is a conundrum that also affects MCGR, and of which treating surgeons should be aware.
- Our findings suggest that a case could be made to reduce the frequency of distraction after two years, thereby sparing children regular hospital visits.
- Important to individualise treatment for each patient based on their age, weight and BMI
- BMI calculator for children used which considers age/gender and rapid changes in growth vs Adult BMI calculator

THANK YOU

INTRODUCTION

- Early onset scoliosis (EOS) is defined as a spinal deformity presenting before the age of ten years.
- It can have congenital, neuromuscular, syndromic or idiopathic causes.
- When conservative measures fail and the curve progresses, surgery may be needed.
- The goals of surgery are to stabilise the deformity while allowing spinal growth, thereby enabling sufficient pulmonary development and preventing progression to restrictive lung disease, respiratory failure, and even early death