

## Original Research

# The Generational Differences in Growth-Friendly Treatment Utilization for Early-Onset Scoliosis

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## Abstract

**Background:** The development of new growth-friendly techniques for treating early-onset scoliosis (EOS) has resulted in a rapidly changing landscape of available treatment strategies. There is no literature revealing how a surgeon's years in practice (YIP) is related to the EOS techniques they learned in fellowship and how their YIP influences their decision-making in selecting EOS constructs. The purpose of this study was to assess how a surgeon's fellowship training and their years in practice (YIP) might affect which treatments they use in practice as well as attempt to gain insight into their decision-making process for such treatments.

**Methods:** A 25-question survey was electronically delivered to 144 surgeons who treat EOS, and 87 (60%) responded. Surgeons were divided into two groups: a younger group (YG) with 0-10 YIP and an older group (OG) with >10 YIP. Growth-friendly techniques queried included serial casting, traditional growing rods (TGR), Vertical Expandable Prosthetic Titanium Rib (VEPTR), non-VEPTR rib constructs, Magnetically Controlled Growing Rods (MCGR), and Shilla. A Chi-square analysis was used to determine differences between the YIP groups with regard to which techniques surgeons learned in fellowship and which techniques they use in practice.

**Results:** One hundred percent (38/38) of the YG surgeons were fellowship-trained versus 87.8% (43/49) of the OG surgeons. More YG versus OG surgeons received fellowship training in serial casting (84.2% vs. 38.8%,  $p<0.001$ ), TGR (94.7% vs. 63.3%,  $p<0.001$ ), VEPTR (65.8% vs. 28.6%,  $p<0.001$ ), non-VEPTR rib constructs (55.3% vs. 16.3%,

$p < 0.001$ ), and MCGR (47.4% vs. 2%,  $p < 0.001$ ). OG surgeons were more likely to use TGR in the last 3 years, with 26% of YG versus 6% of OG surgeons never utilizing TGR and 5% of YG versus 31% of OG surgeons performing TGR cases  $> 10$  times ( $p = .004$ ). Regarding treatment preferences, more YG surgeons (84.2% vs. 39.6%,  $p < 0.001$ ) preferred to delay intervention until final fusion rather than use any growth-friendly techniques. Furthermore, YG surgeons see a limited need for growth-friendly constructs other than MCGR.

**Conclusions:** YG surgeons were more likely to learn growth-friendly techniques in fellowship than OG surgeons, though in their practices, the groups use growth-friendly techniques at similar rates. Compared to OG surgeons, YG surgeons prefer performing definitive fusions over utilizing any growth-friendly surgical techniques.

### Key Concepts

- The landscape of treatment options for early-onset scoliosis has changed significantly over the past few decades.
- Aside from younger surgeons' proclivity to use magnetically controlled growing rods at higher rates than older surgeons, the two groups reported using other growth-friendly treatments at similar frequencies.
- Younger surgeons were more likely than older surgeons to prefer waiting to perform a single definitive fusion rather than using a growth-friendly technique to treat early-onset scoliosis.

## Introduction

The treatment of early-onset scoliosis (EOS), defined as scoliosis that develops prior to 10 years of age, has been the subject of increasing study over the past 2 decades.<sup>1-3</sup> Particular attention is paid to EOS due to the high morbidity and mortality associated with the cardiopulmonary compromise that results from curve progression.<sup>4,5</sup> Multiple treatment options exist for EOS, most of which focus on providing curve correction while simultaneously allowing for growth in the sagittal plane.<sup>6</sup> These options include Traditional Growing Rods (TGR), Vertical Expandable Prosthetic Titanium Ribs (VEPTRs), non-VEPTR rib constructs, Magnetic Controlled Growing Rods (MCGR), and Shilla. TGR is a distraction-based method involving vertebral anchors attached to proximal and distal vertebrae. These are connected by two rods which are linked with a connector and then surgically lengthened periodically.<sup>7</sup> VEPTR is a specific rod design that has rings, or "cradles," which are used to attach to ribs proximally and distally; these rods are similarly distracted periodically to allow for growth of the thoracic cavity.<sup>8</sup> Non-VEPTR rib constructs involve using rib anchors for proximal fixation, often

in combination with screw or S-hook fixation distally. MCGR is a newer technique that has seen widespread adoption over the past decade.<sup>9</sup> MCGR utilizes a magnetic actuator inside the rod that allows the rod to be lengthened non-surgically and without anesthesia through the use of an externally applied remote.<sup>10</sup> Lastly, certain techniques, like Shilla growth guidance, allow for spinal growth through the use of sliding screw heads that allow the spine to grow along the implanted rods without the need for active lengthenings.<sup>11-13</sup>

Despite the recent increase in studies related to EOS, there remains little consensus on treatment strategies as well as substantial variability in how spine deformity surgeons choose to treat EOS.<sup>14,15</sup> The purpose of this study was to assess how a surgeon's fellowship training and their years in practice (YIP) might affect which treatments he or she uses in practice. This study also sought to gain insight into the decision-making of surgeons for how they choose a particular EOS treatment modality. We hypothesized that a surgeon's fellowship training and YIP will significantly influence

the treatments they choose when treating EOS, given the rapid progression of this field.

## Materials and Methods

Institutional review board approval was not required for this study. Between October 1st, 2019, and November 30, 2019, a 25-question survey (Appendix) was distributed to 144 surgeons within the Pediatric Spine Study Group (PSSG) and Growing Spine Committee of the Scoliosis Research Society. This survey was generated out of discussions from a 12-person research interest group (RIG) of the PSSG, comprised of EOS surgeons from across the world. The survey was designed to assess how practice patterns differ based on exposure to EOS techniques taught, or not taught, in fellowship training and therefore identify the reasons behind the equipoise that often exists in choosing techniques for EOS patients. Though not validated, the survey went through multiple iterations within the RIG to best ensure face validity and reproducibility. The survey queried respondents' demographics, training experience, techniques used in their current practice, and surgical decision-making when selecting various EOS constructs. For questions that elicited a "true" or "false" response, an answer of "other" was also provided to allow for a free-text explanation (Appendix).

Surgeons were divided into two groups: those with 0-10 YIP were placed in the younger group (YG), and those with >10 YIP were placed in the older group (OG). With MCGRs receiving official approval in the United States in February 2014, the 10-year division point was thought to select for surgeons just learning this technique in fellowship versus those that needed to learn this technique while already in practice. All comparisons between groups, including EOS techniques learned in fellowship training, EOS techniques currently used in practice, and evaluation of responses as to what drives the decision-making for the use of various EOS techniques, were made using Chi-square tests. Post-hoc testing was performed using an analysis of residuals with a Bonferroni correction.<sup>16</sup> P-values < 0.05 were considered statistically significant. SPSS was used for all

statistical analyses (IBM SPSS Statistics for Windows, Version 26.0; IBM Corp., Armonk, NY).

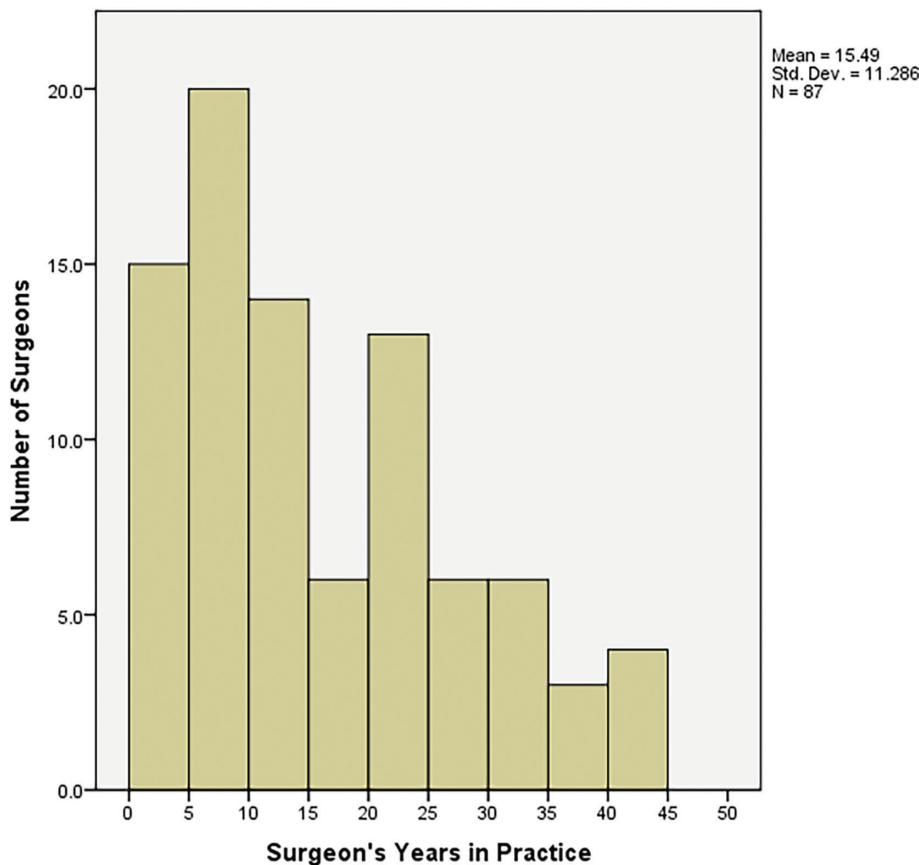
## Results

### *Demographics*

Eighty-seven of 144 surgeons responded to the survey yielding a 60.4% response rate. Thirty-eight respondents (43.7%) were in the YG (Mean YIP:  $5.6 \pm 3.2$  years, Range: 1-10) and 49 (56.3%) were in the OG (Mean YIP:  $23.2 \pm 9.1$  years, Range: 11-43) (Figure 1). Most respondents were male (83.9%) and received fellowship training in only pediatric orthopaedics (71.3%). Respondent surgeons were trained in fellowships distributed evenly across the United States' geographic regions, and 6 (6.9%) of the respondents trained outside the U.S. (Table 1). Surgeons were trained at 25 different fellowship programs. All the surgeons in the YG received fellowship training, while 43/49 (87.8%) of the OG surgeons received fellowship training.

### *Differences in Practice*

All surgeons in the YG received training in at least one of the listed growth-friendly techniques during fellowship (Table 2). YG surgeons received fellowship training in all growth-friendly techniques except for Shilla at significantly higher rates than OG surgeons (Table 2). Despite the differences in fellowship training experience, when evaluating EOS techniques utilized in practice between YG and OG surgeons, only the TGR and MCGR constructs showed significant differences in utilization rates. 30.6% (15) of OG surgeons reported using TGR >10 times in the past 3 years compared to 5.3% (2) of YG surgeons ( $p=0.0031$ , Figure 2). Further, 6.1% (3) of OG surgeons reported never using TGR in the past 3 years as compared to 26.3% (10) of YG surgeons ( $p=0.0088$ , Figure 2). For the MCGR construct, initial Chi-square analysis showed a statistically significant difference in usage rates between the groups across all frequencies ( $p=0.026$ , Figure 3). However, post-hoc testing did not identify a particular frequency where there was a significant difference between the OG and YG surgeons. Of note, 55.1% (27) of OG surgeons reported using MCGR >10 times in the past 3 years compared to



**Figure 1.** Distribution of respondents' years in practice.

42.1% (16) of YG surgeons ( $p=0.23$ ). Further, 16.3% (8) of OG surgeons reported that they never used MCGR in the last 3 years compared to 5.3% (2) of YG surgeons ( $p=0.11$ ). There were no other significant differences seen between YG and OG groups in utilization of serial casting, VEPTRs, non-VEPTR rib constructs, and SHILLA constructs.

### **Differences in Decision-Making**

Multiple differences between YG and OG surgeons were also found in what drives their decision-making when treating EOS (Table 3). A significantly greater percentage of YG surgeons felt that the development of MCGR makes other techniques obsolete ( $p=.004$ ). One YG surgeon wrote in their survey that they use “magnetically controlled if [the patient has] no contraindications,” but they acknowledged that “there are still kids that can’t have MCGR.”

Surgeons who were in the YG were also more likely than surgeons in the OG to report that they do not use TGR because of the associated complication profile ( $p=.012$ ). Still, one participant in the YG group noted that “in very small kids, kids with sagittal plane deformity, and kids who need serial MRI, TGRs are effective.” Lastly, 84.2% of YG surgeons responded that they preferred waiting to do definitive spinal fusions rather than using a growth-friendly technique, if possible, compared to 39.6% of OG surgeons ( $p<.001$ ).

### **Discussion**

This cross-sectional survey-based study sought to determine how surgeons' years in practice influenced their decision-making and utilization of EOS constructs. We found that younger surgeons, who were 0-10 YIP, were more likely to receive fellowship training in growth-friendly techniques, including serial casting, TGRs,

**Table 1. Respondent Demographics**

Demographics		Number of Respondents (% of total respondents)
<i>Sex</i>	<i>Male</i>	73 (83.9%)
	<i>Female</i>	14 (16.1%)
<i>Fellowship training</i>	Yes	81 (93.1%)
	No	6 (6.9%)
<i>Type of fellowship</i>	Pediatric orthopaedics	62 (71.3%)
	Adult spine	1 (1.1%)
	Both	18 (20.7%)
<i>Fellowship region</i>	Northeast, United States	18 (20.7%)
	South, United States	19 (21.8%)
	Midwest, United States	12 (13.8%)
	West, United States	16 (18.4%)
	Outside of the United States	6 (6.9%)
	Fellowship Region not listed	10 (11.5%)
<i>Surgeon Experience</i>	Years in Practice $\pm$ SD	15.49 $\pm$ 11.3 (Range 1-43)
	Age $\pm$ SD	48.82 $\pm$ 11.27 (Range 33-77)

**Table 2. Growth-Friendly Techniques Taught in Fellowship**

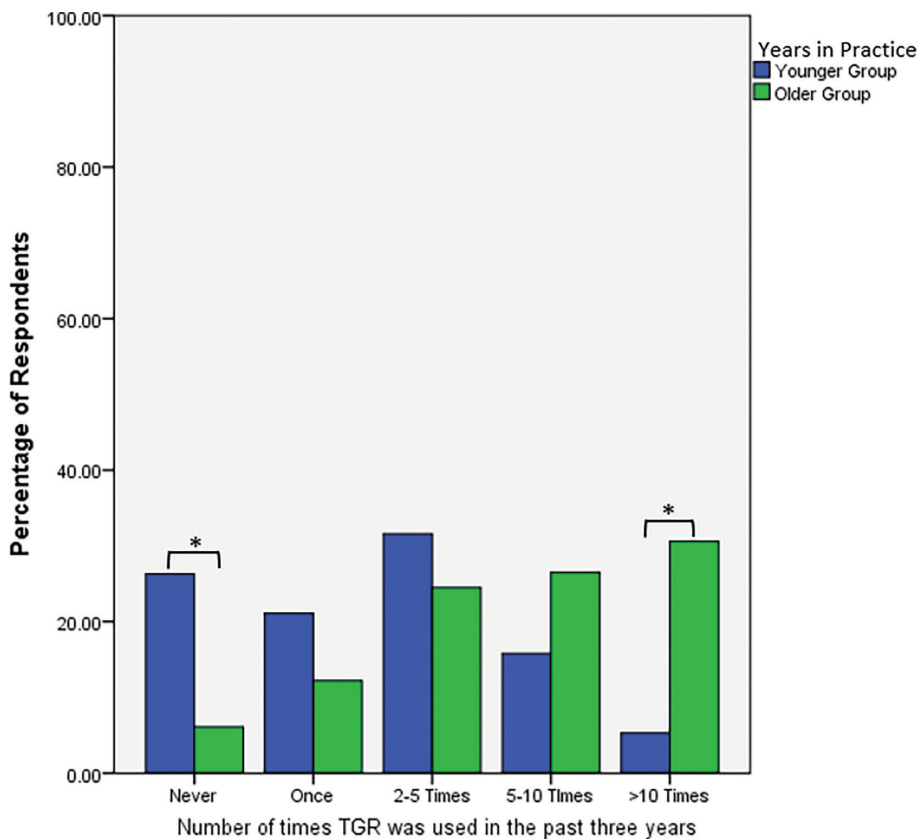
EOS Technique	Younger Group 0-10 YIP (n=38)	Older Group >10 YIP (n=49)	p-value
Serial Casting	32 (84.2%)	19 (38.8%)	<b>&lt;.001</b>
TGR	36 (94.7%)	31 (63.3%)	<b>&lt;.001</b>
VEPTR	25 (65.8%)	14 (28.6%)	<b>&lt;.001</b>
Non-VEPTR rib system	21 (55.3%)	8 (16.3%)	<b>&lt;.001</b>
Shilla	8 (21.1%)	4 (8.2%)	.084
MCGR	18 (47.4%)	1 (2%)	<b>&lt;.001</b>
Other	12 (31.6%)	9 (18.4%)	.153
None	0 (0%)	13 (26.5%)	<b>&lt;.001</b>

*Bold values means a statistically significant result.*

MCGRs, VEPTRs, and non-VEPTR rib constructs. In addition, younger surgeons were both more likely to favor the use of MCGR over other growth-friendly techniques and more likely to dismiss growth-friendly EOS

techniques altogether in favor for waiting and performing a definitive fusion. Compared to OG surgeons, YG surgeons were also more likely to express avoidance of TGR because of its complication profile. This sentiment





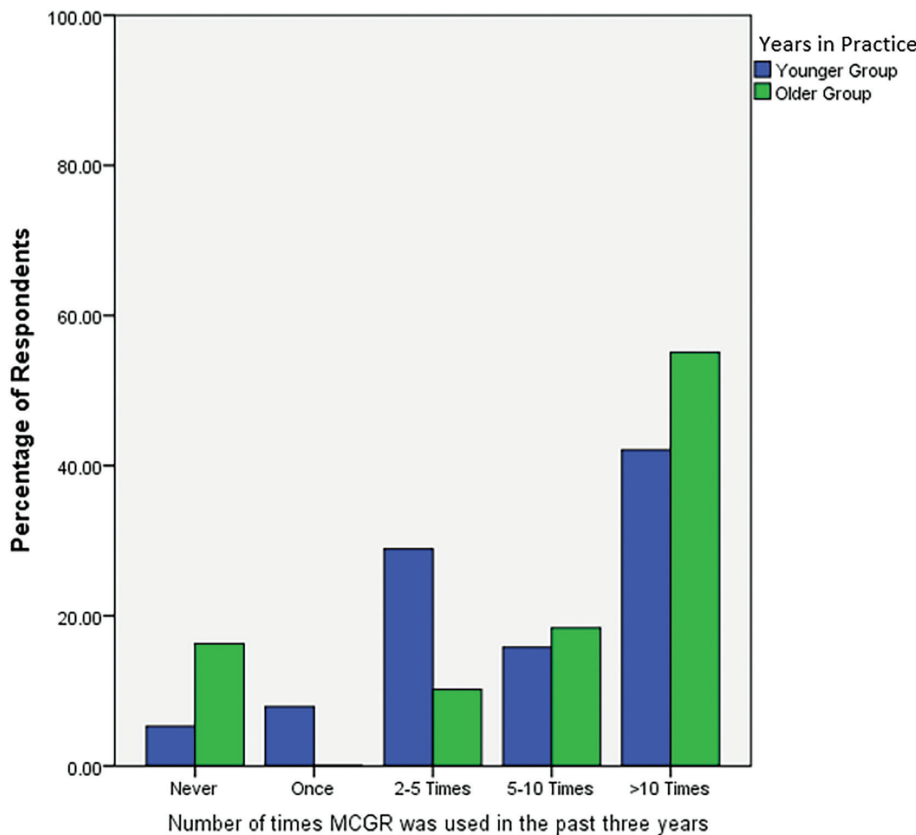
**Figure 2.** Frequency of traditional growing rod usage by surgeon experience.  
\*Indicates statistical significance.

is reflected in surgeons' practice as well, as YG surgeons used TGR at lower rates than OG surgeons.

In our study, younger surgeons reported a preference for delaying surgery on a patient with EOS so that a definitive fusion can be performed rather than intervening with a growth-friendly construct. These results may suggest that YG surgeons are crafting their practice based on the recommendations of recent publications and are choosing definitive fusions to avoid the complication profile associated with growth-friendly instrumentation. In a case-matched study in patients with idiopathic scoliosis aged 9-11 years old, Pawelek et al. found that, when compared to definitive spinal fusion, growth-friendly techniques had lower overall curve correction at final follow-up, required more frequent returns to the operating room, and only resulted in marginally greater T1-S1 height gain.<sup>17</sup> Li et al. found similar results in patients with neuromuscular

EOS when they compared patients treated with single posterior spinal fusion (PSF) to patients that had growth-friendly surgery and definitive fusion (GFDF). Patients that underwent PSF had fewer complications and greater curve correction but less spine growth compared to patients that had GFDF.<sup>4</sup> Notably, the mean age of patients that underwent PSF and GFDF in that study were 10.8 and 8.9, respectively ( $p < .001$ ).<sup>4</sup> Keil et al. found similar results, with patients that underwent GFDF having experienced 2.3 cm greater T1-12 height gain compared to age matched patients that underwent only a PSF.<sup>18</sup> In a study by Mackey et al. that specifically compared MCGR and PSF in patients with EOS, patients that underwent MCGR had less curve correction (27.4% vs. 52.2%) and experienced complications at significantly higher rates (60.8% vs. 14.3%).<sup>19</sup>

Similarly, YG surgeons were more likely than OG surgeons to attest that they avoid using TGR because of



**Figure 3.** Frequency of magnetically controlled growing rod usage by surgeon experience.

the associated complication profile. Though TGRs are effective in managing scoliotic curves, they have been associated with high rates of infection and implant failure.<sup>20</sup> Together with the aforementioned preference for YG surgeons to avoid growth-friendly techniques altogether, YG surgeons' avoidance of TGRs due to their complications may represent an overall greater risk-aversion as compared to OG surgeons. Importantly, the higher rates of complications associated with TGRs may partially be attributed to the fact that TGR has been used in practice for longer than many of the other growth-friendly techniques, allowing for longer follow-up times in which complications can arise. More accurate comparisons will require similar follow-up times for the newer growth-friendly techniques. In an effort to standardize care and determine the effects of the described surgeon preferences, additional research is needed both into potential differences in patient populations between

YG and OG surgeons and the long-term outcomes of the various treatment modalities.

Though many of the surgeons who were in the OG did not learn a variety of growth-friendly techniques in fellowship, they have adopted them into their practices at comparable rates to YG surgeons. Multiple surgeons highlighted the importance of courses or visitations in learning newer techniques. For instance, when asked about VEPTR, one responded said, "I did not learn [to use VEPTR] in fellowship but went to some courses and use this when appropriate." Ninety-eight percent of these surgeons did not learn MCGR in fellowship, but 83.7% of these surgeons have used MCGR in practice in the past 3 years. Nevertheless, a greater percentage of surgeons >10 YIP report never using MCGR in the past 3 years (16.3% vs. 5.3%), which may indicate that there remain additional opportunities for teaching this technique to those that did not learn it in fellowship.

**Table 3. What Drives Decision-Making by Years in Practice**

Drive		True		False		P-value
		0-10 YIP	>10 YIP	0-10 YIP	>10 YIP	
1	With the MCGR now available, I see little reason to use other growing rod constructs.	13 (34.2%)	7 (14.6%)	14 (36.8%)	35 (72.9%)	<b>.004</b>
2	I do not use VEPTR and/or rib-based instrumentation systems because I was not trained to do so.	2 (5.3%)	1 (2.1%)	33 (86.8%)	39 (81.3%)	.373
3	I do not use a SHILLA instrumentation system because I was not trained to do so.	10 (26.3%)	4 (8.3%)	23 (60.5%)	34 (70.8%)	.072
4	I do not use a TGR instrumentation system because I was not trained to do so.	0 (0%)	1 (2.1%)	36 (94.7%)	44 (91.7%)	.654
5	I do not use VEPTR and/or rib-based instrumentation systems because of the complication profile.	14 (36.8%)	12 (25%)	18 (47.4%)	34 (70.8%)	.050
6	I do not use a SHILLA instrumentation system because of the complication profile.	11 (28.9%)	14 (29.2%)	25 (65.8%)	30 (62.5%)	.851
7	I do not use a TGR system because of the complication profile.	10 (26.3%)	2 (4.2%)	27 (71.1%)	45 (93.8%)	<b>.012</b>
8	The patient's sagittal plane and ability to contour a rod plays a role in implant selection.	30 (78.9%)	29 (60.4%)	4 (10.5)	13 (27.1%)	.13
9	While I do not routinely use non-magnetically controlled growing rod systems, I still believe there is a need for these instrumentation systems.	37 (97.4%)	45 (93.8%)	1 (2.6%)	3 (6.3%)	.429
10	I prefer to wait and do a single final fusion, if possible, rather than growing instrumentation.	32 (84.2%)	19 (39.6%)	6 (15.8%)	29 (60.4%)	<b>&lt;.001</b>

*Bold values means a statistically significant result.*

One may ask, “Why make this comparison at all based on years in practice?” At baseline, we know that treating children with EOS is challenging because of the heterogeneity seen in the diagnoses that cause scoliosis as well as the many drawbacks of the instrumentation options available to treat these patients. However, the heterogeneity of the individual surgeons, related to their own fellowship training and their years in practice, was a confounder that we wanted to explore. It is clear from our data that the surgeons 0-10 years in practice have been exposed to more tools to treat patients with EOS (based on their fellowship training), but they report rarely wanting to use any tool other than MCGR or definitive

fusions. The authors argue that as with any learned skill, “if you don’t use it, you lose it.” Therefore, while the complication profiles of non-MCGR growth-friendly (GF) constructs were listed by younger surgeons as their reason for underutilization, it could also be a general discomfort for using a technique that they haven’t performed since fellowship. We believe that this data should make surgeons 0-10 years in training be more introspective and question why they are choosing MCGR more often than more experienced surgeons. If it is a lack of comfort with using a technique that they only did in fellowship, then visiting other centers for site visits may be a way to overcome this concern.



In comparison, EOS surgeons >10 years in practice are more likely to use all of the surgical techniques, or “tools in their toolbox,” to treat these early-onset spine deformities. However, the newest tool, known as MCGRs, appears to be less utilized by these experienced surgeons. In the free text responses, older surgeons listed hyperkyphosis or the need for recurrent MRIs as reasons for underutilization of MCGRs, but there is no explanation given for their underutilization of primary, definitive fusions for their EOS populations as compared to younger surgeons. Does their improved comfort with all of the “tools in their toolbox” lead to a desire to use any type of growth-friendly instrumentation, even when a definitive fusion would work just as well? Or is it that older surgeons are less risk averse, given the high complication rate of GF treatment, as compared to younger surgeons? The results of our survey suggest that utilization of these EOS techniques are not associated with fellowship training of these techniques. Therefore, further work must be done to keep the variety of EOS skillsets current, particularly throughout YG surgeons’ careers.

This study has several limitations. First, given the survey methodology, there is a possibility that recall bias skews the answers provided by respondents. Second, the predefined questions created to understand the decision-making behind why surgeons choose to utilize or avoid certain EOS constructs may not have fully captured all the reasons why surgeons choose a certain EOS technique. For example, the survey did not ask how the etiology of a patient’s EOS might affect the surgeon’s treatment plan. Despite these limitations, this is the first study to show a difference in utilization of EOS techniques based on a surgeon’s years in practice. It is also the first study in the literature to better evaluate the decision-making behind why certain surgeons utilize various EOS techniques. A strength of the study is the relatively high response rate (60.4%) of those surveyed. A systematic review by Meyer et al. found that healthcare professionals’ responsiveness to email surveys is generally around 50%.<sup>21</sup>

In conclusion, older surgeons who were >10 years in practice have readily adopted growth-friendly techniques for EOS despite not learning them during fellowship. Surgeons in practice for 1-10 years disproportionately prefer waiting and performing a definitive spinal fusion as compared to using any growth-friendly technique. However, when YG surgeons do utilize an EOS construct, they prefer to use MCGRs over any other construct. Fellowship training on a certain EOS technique does not result in utilization of these techniques in the practices of younger surgeons early in their practice. This could lead to a loss of these EOS skill sets of younger surgeons become older surgeons if efforts are not extended to relearn these techniques throughout a career. Such practice differences highlight the need for diversity of surgical experience when treating EOS patients. Engaging in discussions with surgeons who may have different fellowship experience, treatment perspectives, and practice habits will allow surgeons to capitalize on this diversity and theoretically better treat their patients.

## Disclaimer

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## Appendix

### Free Text Responses for the Manuscript “The Generational Differences in Growth-Friendly Treatment Utilization for Early Onset Scoliosis”

*With the magnetically controlled growing rods now available, I see little reason to use other growing rod constructs.*

- These are poorly worded questions. I try to use magnetically controlled growing rods as often as possible, but this doesn't imply that I see little reason to use other growing rod constructs. Some patients contour, especially sagittal will not accept a MCGR. Also can be contraindicated in some patients that need high tesla MRIs.
- Most of the time I agree, but syndromes like Juenes requires VEPTR.
- In very small kids, sagittal plane deformity, kids who need serial MRI, traditional growing rods are effective.
- Occasionally kyphosis/rib fusions don't accommodate MCGR.
- MCGR doesn't always work for all.
- I will use it only in appropriately indicated patients. There is still a place for TGRs in the other patients, so I cannot make a blanket statement like this.
- It depends on the relationship cost X benefit.
- They are not indicated in severe kyphosis.
- While currently the best technique available, MCGR have significant design flaws needing improvement particularly with kyphosis.
- There are indications for Trolly system.
- While MCGR are preferred over TGR in most pts, there are a select number of pts (e.g., obese pts, small & kyphotic pts) where TGR may be the preferred construct.
- Fat kids. Kids from other countries.
- Still a role for TGR in very overweight kids or rigid curve.

- Still utilize for older, more obese, kyphosis, stiffer deformities.
- We cannot use MCGR.
- Magnetically controlled if no contraindications, but there are still kids that can't have MCGR.

*I do not use VEPTR and/or rib-based instrumentation systems because I was not trained to do so.*

- I try to stay away from instrumenting the chest wall.
- Only indicated for congenital scoliosis or other conditions with chest wall deformity.
- I did not learn in fellowship but went to some courses and use this when appropriate.
- Because now I have a better indications for use.
- I have removed many of them. I feel spine-based anchors are superior for the majority of cases, with the exception of true TIS with fused or absent ribs and possibly myelomeningocele.
- Just haven't had a patient that needs it last 3 years. Most of my MAGEC rods go to the ribs.
- Indications are rarely seen in my practice.
- Rare indications.
- Not effective for EOS and complication ridden.
- Too bulky.
- I do use this technique.

*I do not use a SHILLA instrumentation system because I was not trained to do so.*

- Appropriate for a small minority of patients.
- Lack of exposure and also not convinced of outcomes.

- I do not believe in the technique due to the metalosis and complications.
- Feel other techniques are more effective.
- I attended a course but choose not to use it.
- Not enough data.
- It is not available in Brazil.
- Because I see a little indications.
- There is a risk of adding-on below the construct.
- Bad idea.
- Did not receive training in Shilla but did a visitation with high volume Shilla surgeon and feel comfortable doing this procedure after learning from this surgeon.
- I have used Shilla; however, I currently do not, as I am concerned about metal debris.
- Don't use cause better options.
- Don't use it because I use other methods. Would not be against using it.
- Too much debris.

***I do not use a traditional growing rod instrumentation system because I was not trained to do so.***

- I try not to use it because of MAGEC but wouldn't say I don't use it.
- I did not learn in fellowship but went to some courses and use this when appropriate.
- Rare indication only if needs MRI.
- Better options.
- When needed, still use TGR.

***I do not use VEPTR and/or rib-based instrumentation systems because of the complication profile.***

- I don't use it in the large majority of cases because I use MAGEC and don't want to instrument the chest wall.

- Only use in the correct situations.
- Very rarely use it with the exception of chest wall deformity.
- I use it in very specific cases.
- Just don't find much use for them.
- VEPTTR and rib-based growing rods are different animals with different complications. Not a good question.
- Have not had a patient who needed this.
- I do use this technique.

***I do not use a SHILLA instrumentation system because of the complication profile.***

- I choose not to use not only because of complication rate but also limited growth with this system.
- A little indications.
- USELESS TECHNIQUE.
- I was not trained to use SHILLA.
- Not trained, no appropriate patient.
- Partially. Concerned about implant prominence and wear debris.

***I do not use a traditional growing rod instrumentation system because of the complication profile.***

- I don't use it in most cases because I prefer MAGEC, but TGR has its indications.
- I do use this technique.

***The patient's sagittal plane and ability to contour a rod plays a role in implant selection.***

***NO RESPONSES***

***While I do not routinely use non-magnetically controlled growing rod systems, I still believe there is a need for these instrumentation systems.***

- I routinely use MAGEC rods, but I still believe other systems should be available for patient's whose body

habitus won't accommodate the unbendable area of the MAGEC rod.

- Routinely use MCGR.
- The premise is false.
- I use them.
- I do routinely use and still believe that there is a need for these systems.

- N/A
- Do use traditional growing rods depending on a number of factors.
- I routinely use.
- Only on critically ill patients that do not tolerate anesthesia well.
- I do use this technique routinely.