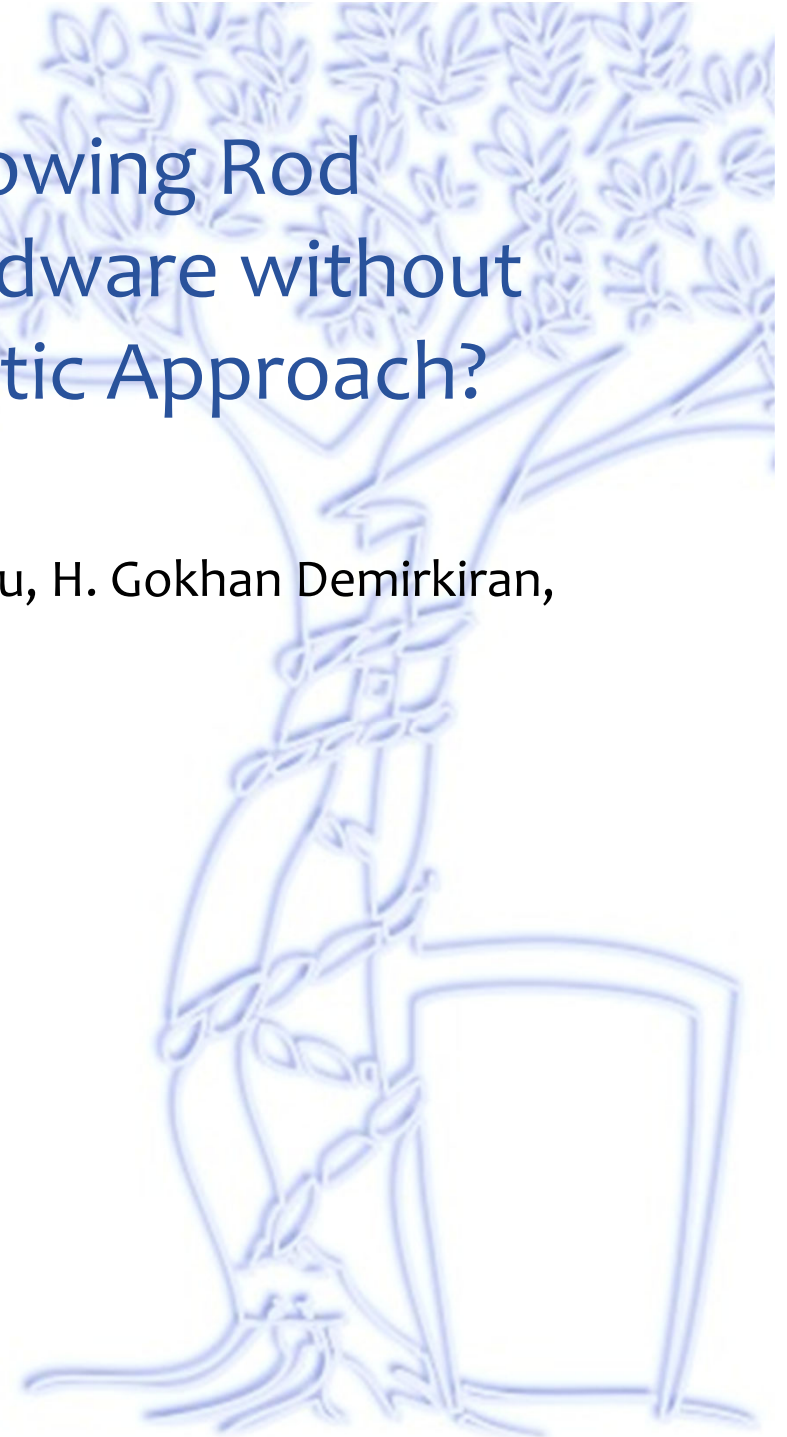


Graduation Protocol After Growing Rod Treatment: Is Removal of Hardware without New Instrumentation a Realistic Approach?

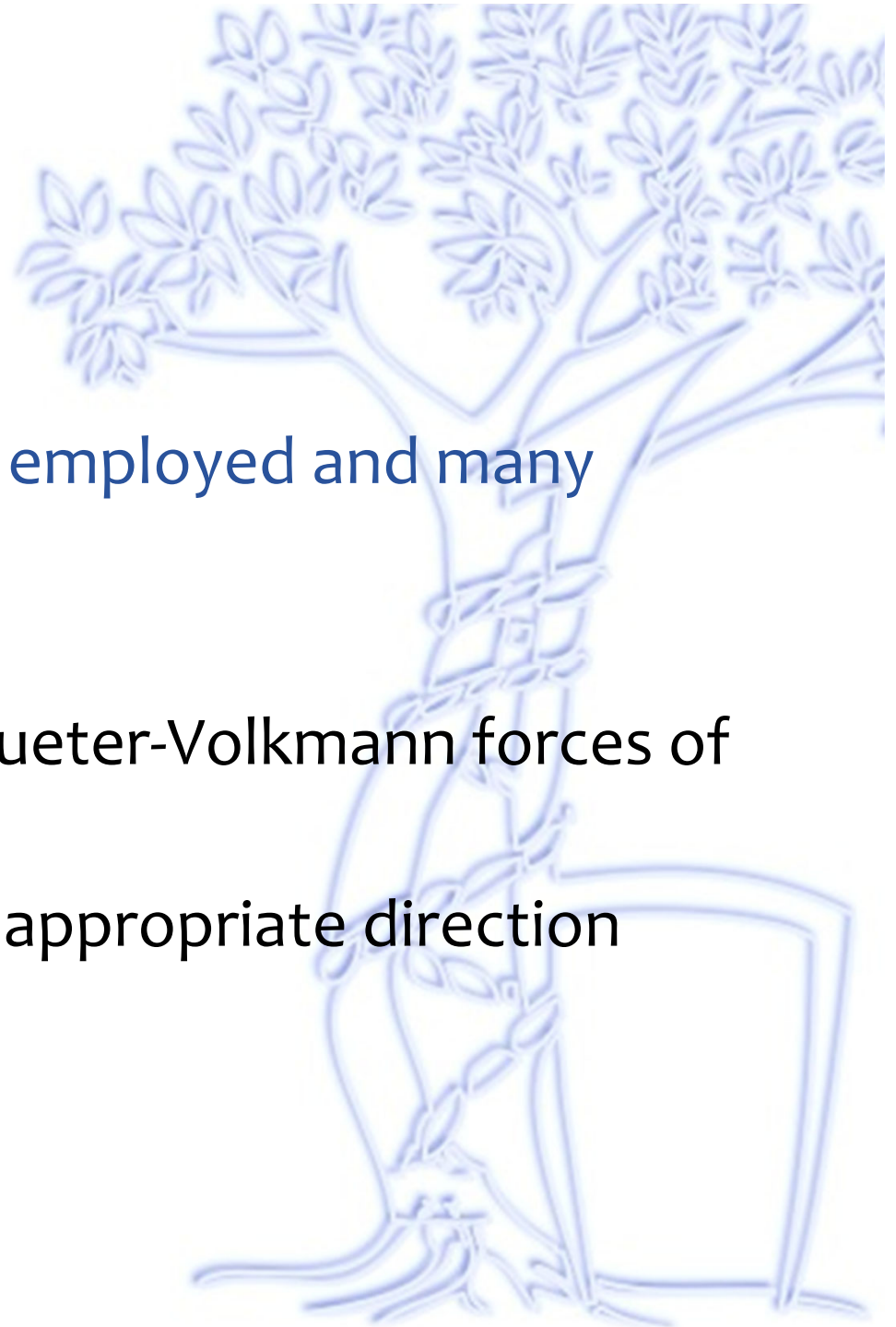
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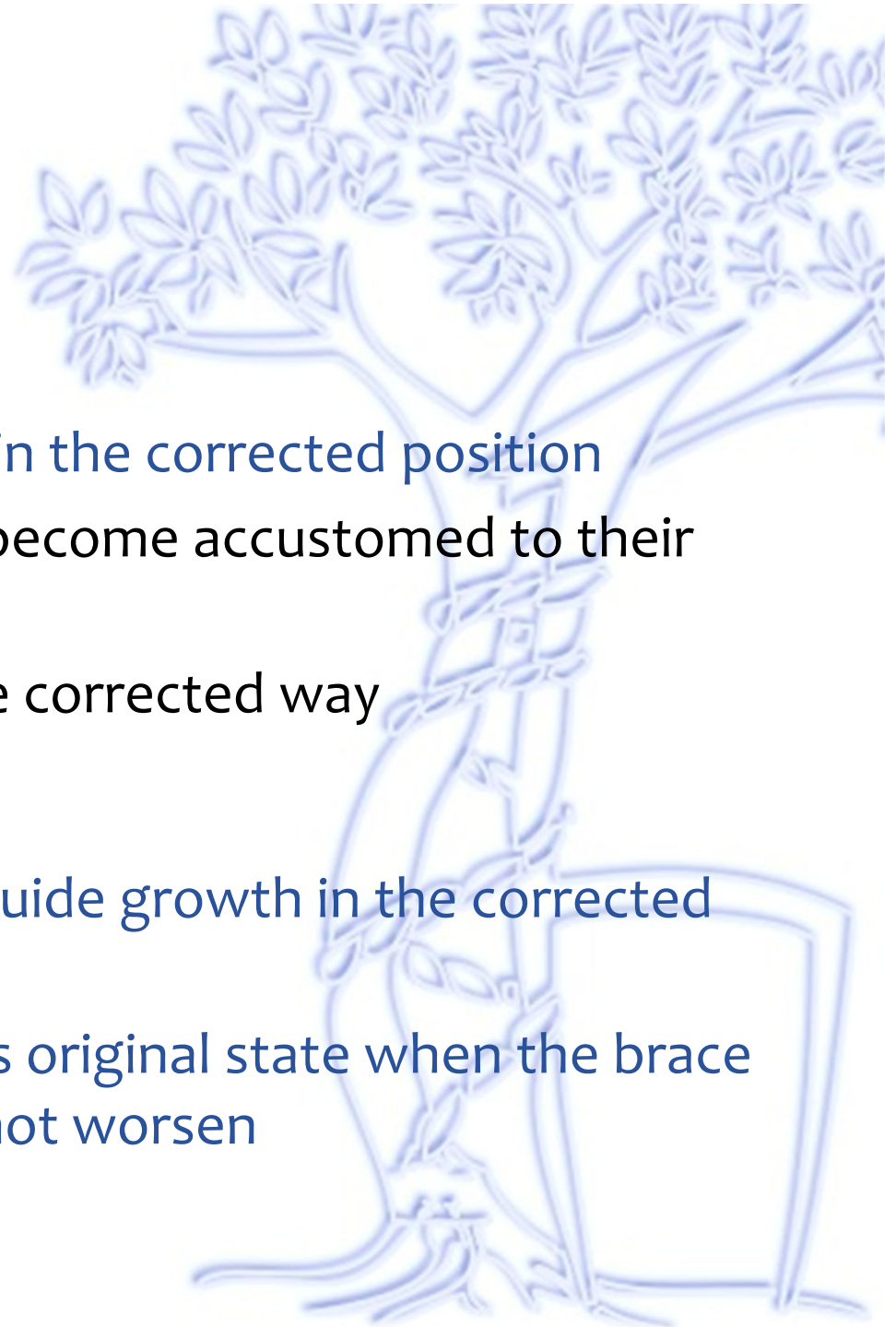
Introduction

- GR
 - With the limited fusion employed and many segments spanned
 - An 'internal brace'
 - Aims to offset the Hueter-Volkman forces of the deformed span
 - Guide growth in the appropriate direction



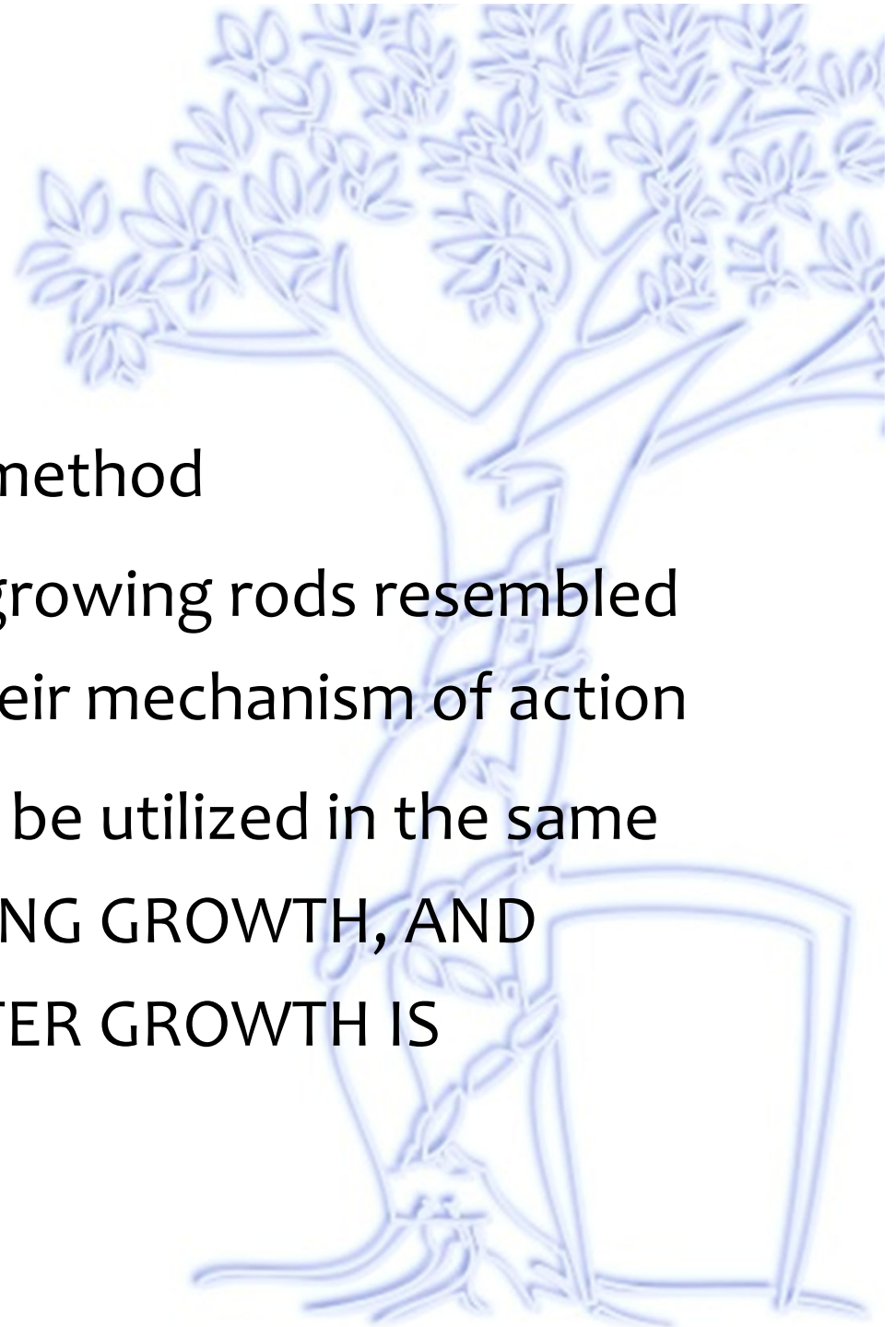
Introduction

- Andre's sapling analogy
 - If growth can be achieved in the corrected position
 - Bones and soft tissues become accustomed to their new arrangement
 - Continue growing in the corrected way
- Brace treatment
 - To correct deformity and guide growth in the corrected position
 - The deformity reverts to its original state when the brace is discontinued, and does not worsen



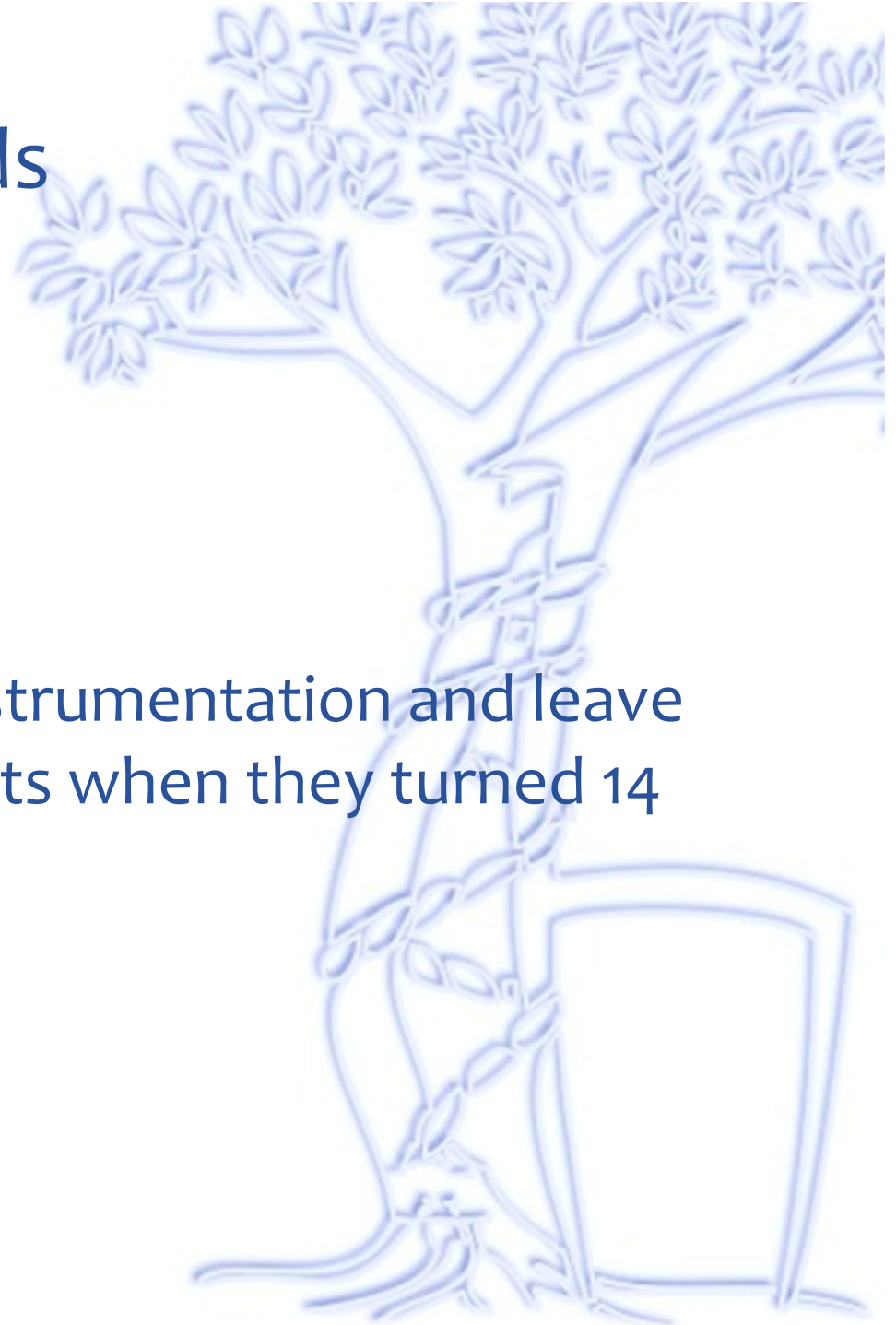
Purpose

- GR
 - As an internal bracing method
 - How much exactly growing rods resembled internal braces in their mechanism of action
 - Whether they could be utilized in the same manner: KEPT DURING GROWTH, AND DISCONTINUED AFTER GROWTH IS COMPLETE!



Materials and Methods

- IRB approval
- 2004
- Prospective study
 - To remove all spinal instrumentation and leave the spine free in patients when they turned 14 years of age



Materials and Methods

- Patients were enrolled consecutively
 - 1) Chronological age less than 10 years at index surgery
 - 2) No previous surgery
- At the time of the submitting of this abstract, further inclusion criteria
 - 3) Completeness of records and radiographs at final FU
 - 4) Regular lengthenings during GR every 6-9 months
 - 5) No major complications requiring unplanned surgery
- Patients that met the above criteria were re-evaluated during their first visit after turning 14

Materials and Methods

1) Group 1 (Initial intention)

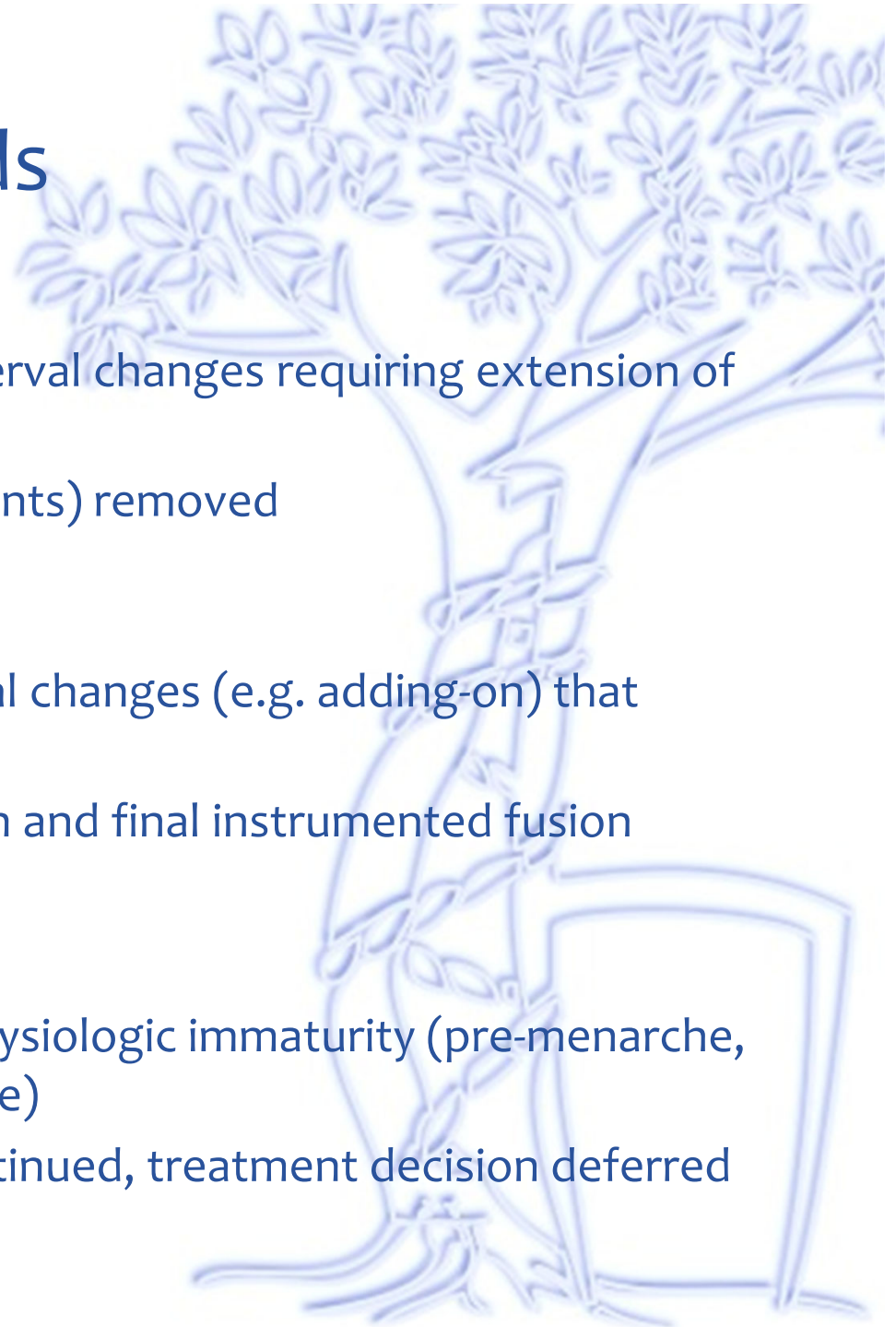
- Adequate correction and no interval changes requiring extension of instrumentation
- Growing rods (vertical components) removed

2) Group 2 (Final fusion)

- Inadequate correction or interval changes (e.g. adding-on) that require extension of fusion
- Removal of TGR instrumentation and final instrumented fusion procedure

3) Group 3 (Continued TGR)

- Risser sign 0 or other sign of physiologic immaturity (pre-menarche, short stature, low Tanner grade)
- Regular lengthenings were continued, treatment decision deferred



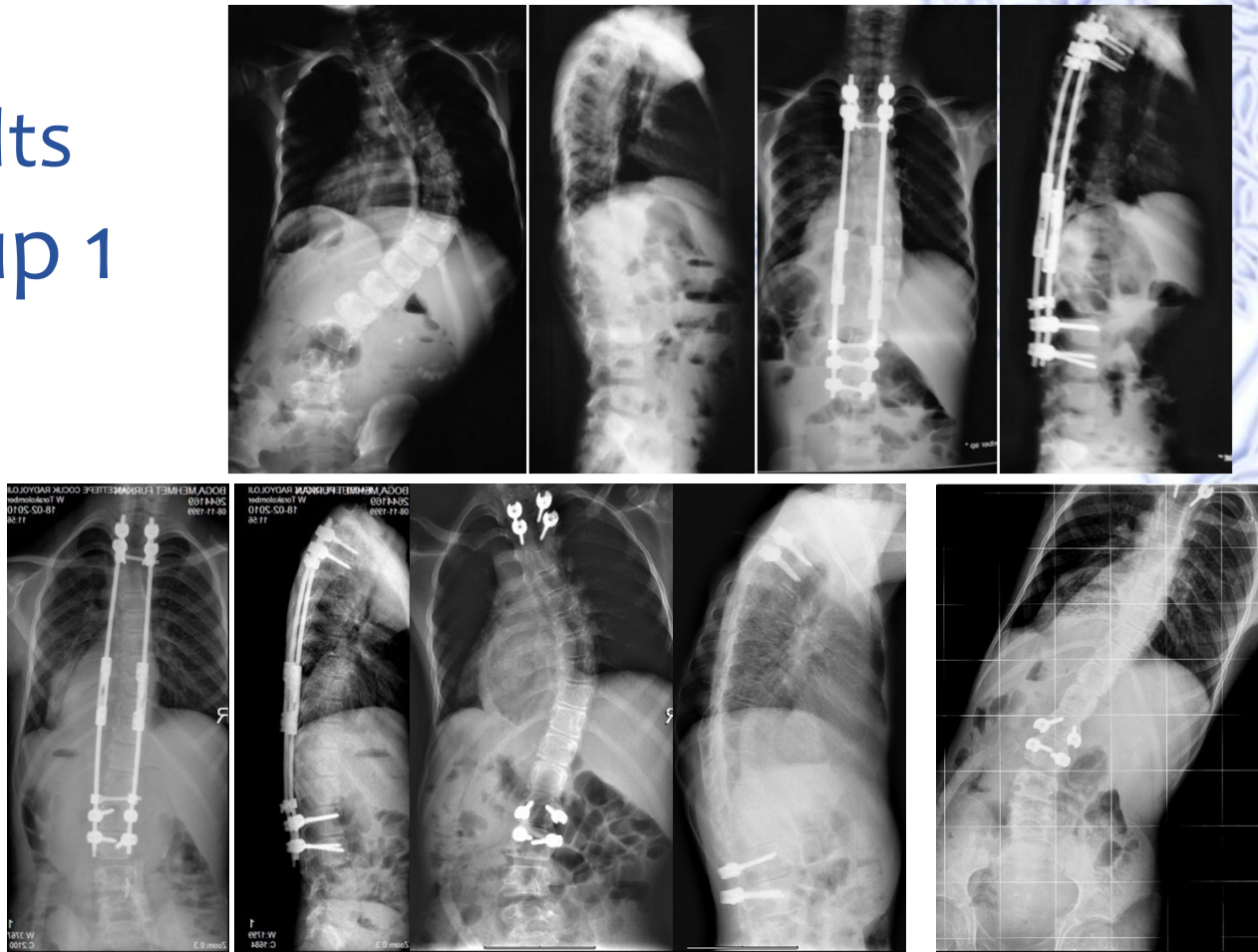
Results

Group 1

- After removal, patients were followed in 6 month intervals
- Failure of treatment was defined as an increase of $>10^{\circ}$ Cobb

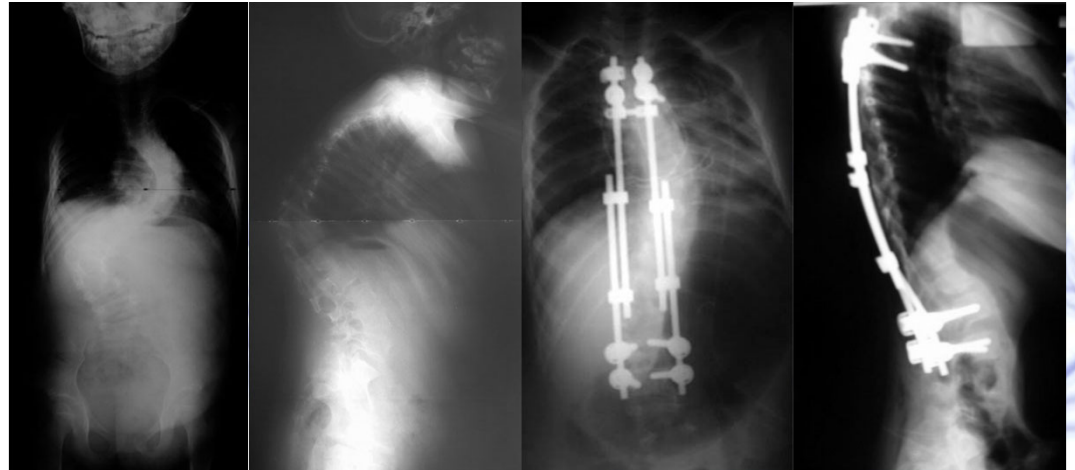
Group	Age @ index surgery(mo)	# lengthenings	FU (mo)	Pre-index Cobb	Post-index Cobb(°)	Pre-graduation Cobb(°)	Post-graduation Cobb(°)	Pre-definitive surgery Cobb(°)	Post-definitive surgery Cobb(°)	Latest FU Cobb(°)
1	82	12	83/19	61	25	37	43	53	36	35

Results Group 1



During FU after removal of hardware, 90% of these patients' deformities continued to worsen, eventually requiring another procedure to instrument and fuse the spine, and the protocol was abandoned due to ethical considerations !

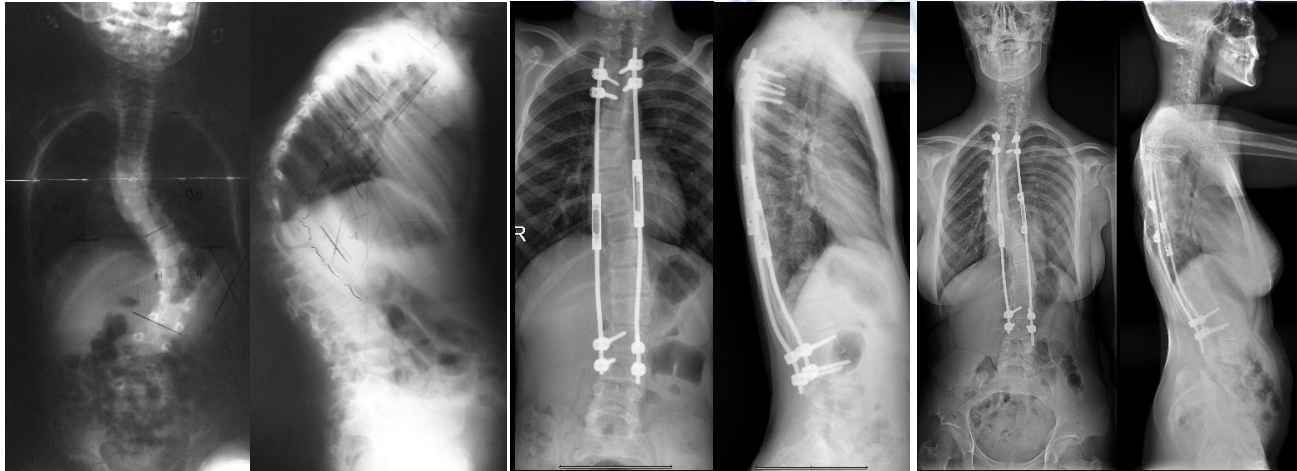
Results Group 2



Group	Age @ index surgery(mo)	# lengthenings	FU (mo)	Pre-index Cobb	Post-index Cobb(°)	Pre-graduation Cobb(°)	Post-graduation Cobb(°)	Pre-definitive surgery Cobb(°)	Post-definitive surgery Cobb(°)	Latest FU Cobb(°)
2	79	12	78/44	60	30			43	31	33

Results

Group 3



Group	Age @ index surgery(mo)	# lengthenings	FU (mo)	Pre-index Cobb	Post-index Cobb(°)	Pre-graduation Cobb(°)	Post-graduation Cobb(°)	Pre-definitive surgery Cobb(°)	Post-definitive surgery Cobb(°)	Latest FU Cobb(°)
3	87		93	51	23					35

Conclusion

- Removal of growing rod hardware after a measure of skeletal maturity has been achieved is not an acceptable end point for growing rod treatment
- Retaining hardware if curve features are acceptable
 - Needs FU evaluation
 - Risk for further implant problems?

