

Does growing rod cause degeneration and secondary deformity in the adjacent segment?

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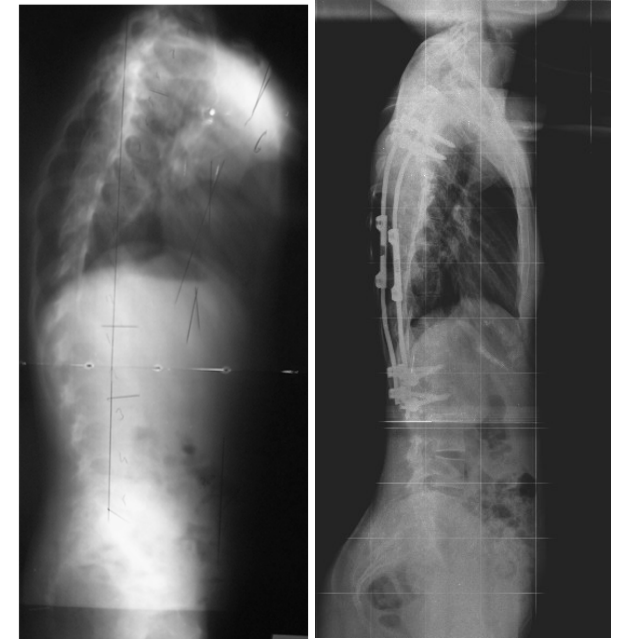
Ankara, TURKEY

Disclosure

- Caglar Yilgor No disclosure
- Serdar Aritan No disclosure
- Gokhan Demirkiran No disclosure
- Kenan Daglioglu No disclosure
- Kemal Kosemehmetoglu No disclosure
- Muharrem Yazici K2M (b), DePuy (c)

Background

- Observations and reports
 - PJK after GR applications
- Possible reasons
 - Repeated distractive forces
 - Soft tissue damage at index surgery (ligaments & capsules)
 - Stress concentration on the junction
 - GR can decrease stressors to the junctional area by preserving mobility of the spine in some manner



Aim

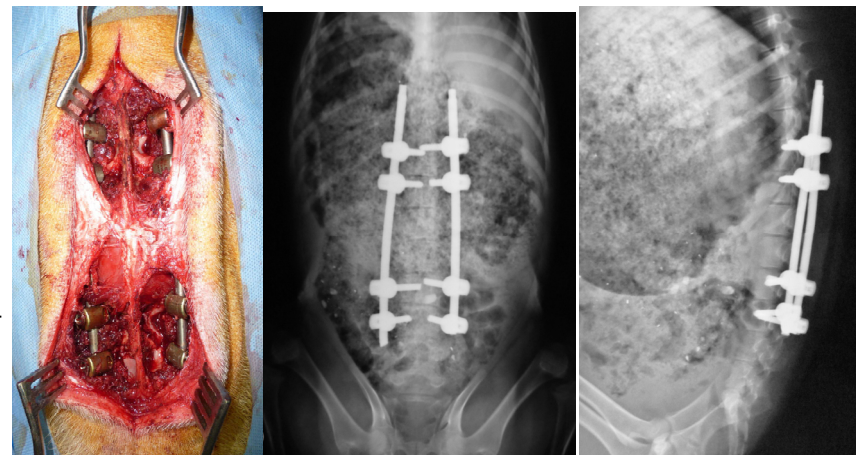
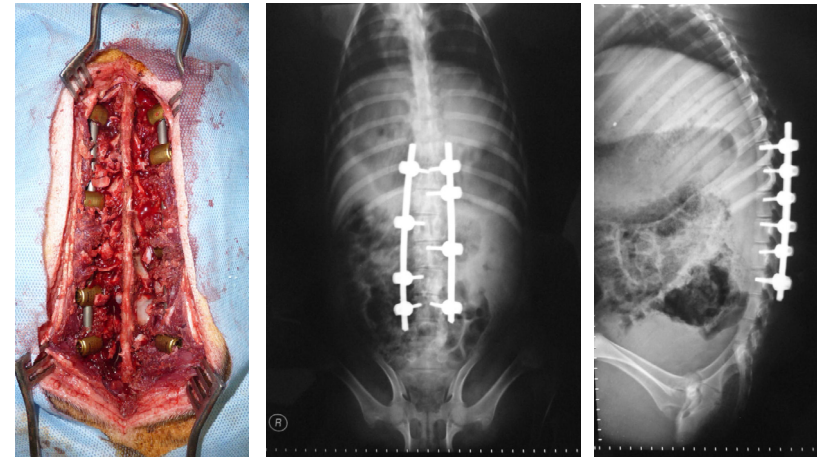
- Stress concentration on the junction after GR ??
 - Transition segment motion capability
 - MRI changes of the adjacent discs
 - Histological analysis of the adjacent discs and facet joints
- Comparison between 3 groups
 - Control group (CG)
 - GR
 - Instrumented fusion (IF)

Material & Methods

- IRB approved
- Study granted by
 - The Scientific and Technological Research Council of Turkey
 - Hacettepe University Scientific Research and Development Office
- 13 piglets (7 GR, 3 IF, 3 CG)
- 10-14 weeks of age

Technique

- CG
 - Age matched healthy animal
- IF
 - 6 levels fusion at TL spine with pedicle screws and local bone
 - 4 months of follow-up
- GR
 - After index surgery monthly lengthening of 5 mm monthly for 3 months
 - Same levels used with 2 spanned intermediate segments



Material & Methods

- MRI evaluation
 - Adjacent segment discs
 - Grading system → Yoon et. al., *J Neurosurg Spine*, 2008
- Motion capability analysis
 - Proximal and distal adjacent segments
 - “The Mechanical Spine Test System”
 - “HUBAG Biomechanical Toolbox”
- Histological evaluation
 - Adjacent discs and facet joints
 - Grading system → Gries et. al., *Eur Spine J.*, 2000

Table 1 Grading system of histologic changes in lower lumbar discs (*BEP* bony end-plate, *CEP* cartilaginous end-plate)

Grade	Annulus fibrosus	Nucleus pulposus	Cartilage end-plate	Margins/subchondral bone
1	Intact lamellae Narrow inter-lamellar matrix Intact annulus attachment Vessels only in outer 1/3	Homogeneity Absence of clefting	Uniform thickness Intact attachment to bone Uniform calcification < 1/5 of depth Uniform cell distribution	Even thickness of BEP Lamellar bone only Distinct junction with CEP Few vascular intrusions into CEP
2	Minor lamellar splitting and disorganization Minor widening of matrix Minor disorganization of attachment Rim lesion without reparative reaction	Minor clefting Minor cell necrosis Minor posterior displacement of annulus Minor chondrone formation	Minor cartilage thinning Small transverse fissures Irregular thickening of calcified zone Few invading vascular channels Small chondrones	Slightly uneven BEP Schmorl's nodes Minimal remodelling of BEP Small marginal osteophytes
3	Moderate lamellar disorganization Moderate widening of matrix Moderate fissuring of attachment Radiating tears, not involving outer 1/3 Minimal chondroid metaplasia Cystic degeneration Vessels in outer and middle 1/3 Rim lesion with minor reparative reaction	Moderate clefting Moderate cell necrosis Cystic degeneration Posterior displacement within annulus Centripetal extension of collagen Moderate chondrone formation	Marked cartilage thinning Marked thickening of calcified zone Many transverse fissures Many vascular channels Many chondrones	Moderately uneven BEP Vascularized Schmorl's nodes Moderate trabecular thickening Defect in bone lamellae Minimal fibrosis tissue in marrow spaces Medium-sized osteophytes
4	Extensive lamellar disorganization Radiating tears extending into outer 1/3 Extensive chondroid metaplasia Vessels in all zones Rim lesion with marked reparative reaction	Complete loss of nucleus Loose body formation Marked chondrone formation	Total loss of cartilage Calcification of residual cartilage Widespread fissuring	Marked uneven BEP Ossified Schmorl's nodes Large osteophytes Marked trabecular thickening Marked fibrosis of marrow spaces Cartilage formation

Table 2 Grading system of histologic changes in lower lumbar facet joints

Grade	Cartilage	Osteochondral junction	Subchondral bone	Margins
1	Smooth intact surface Orderly chondrocyte distribution Orderly collagen framework	Uniform tidemark Calcification < 1/5 cartilage thickness	Uniform lamellar subchondral bone plate Uniform vascular budding into cartilage	Smooth articular margin Normal synovium Normal capsule
2	Tangential surface flaking Minimal chondrocyte death Few chondrones	Minimal irregularity of tidemark Calcification 1/5–1/4 cartilage	Minor thickening of trabeculae Small fissures at bone-cartilage junction Occasional fibrous tissue formation	Small osteophytes Minimal capsular fibrosis
3	Fissures < 1/2 total depth Loss of cartilage < 1/2 depth Moderate chondrocyte death Many chondrones	Marked irregularity of tidemark Calcification 1/4–1/2 cartilage	Moderate trabecular thickening Woven bone formation Moderate fibrous tissue formation	Moderate osteophytes Minimal-moderate appositional new bone Fibrocartilage formation Moderate capsular fibrosis Minimal-moderate synovial thickening
4	Deep fissures Areas of total cartilage loss Extensive chondrocyte death	Calcification > 1/2 cartilage	Eburnation of exposed bone Bone sclerosis Cysts Extensive fibrosis	Extensive and large osteophytes Marked appositional new bone Marked capsular thickening Marked synovial thickening

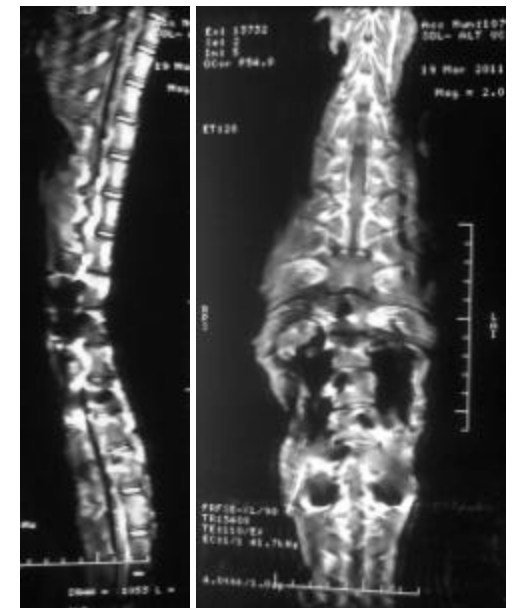
Results

MRI

- Distal adjacent segment
 - signal intensities and water contents of the discs were normal & were grade 1
 - in both GR and IF
- Proximal adjacent segment
 - degeneration to some degree in both groups
 - statistical analysis did not reveal a significant difference ($p=0.903$)

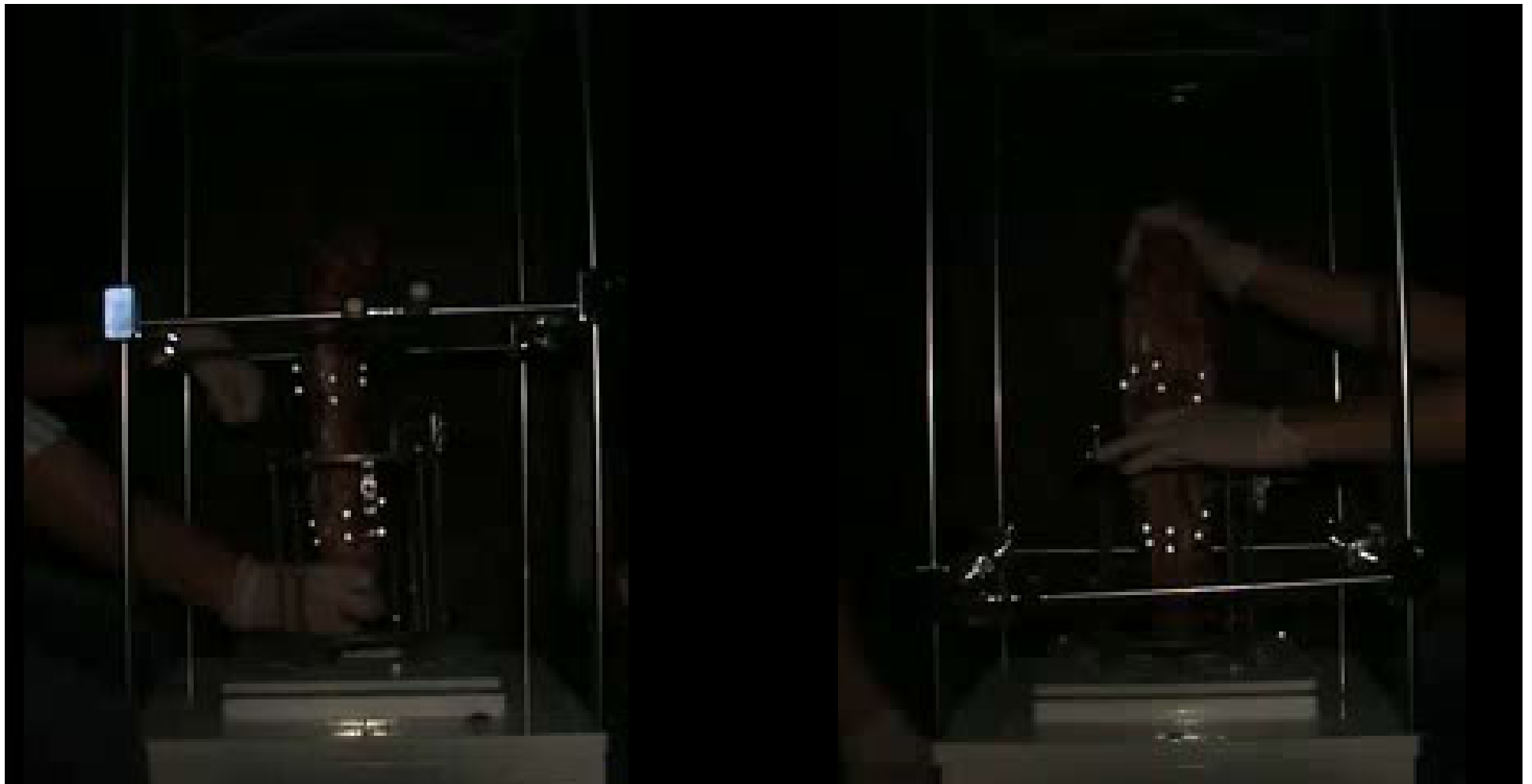


GR group – Grade II and III



IF group – Grade V

Motion Capability Analysis



Results

Motion capability

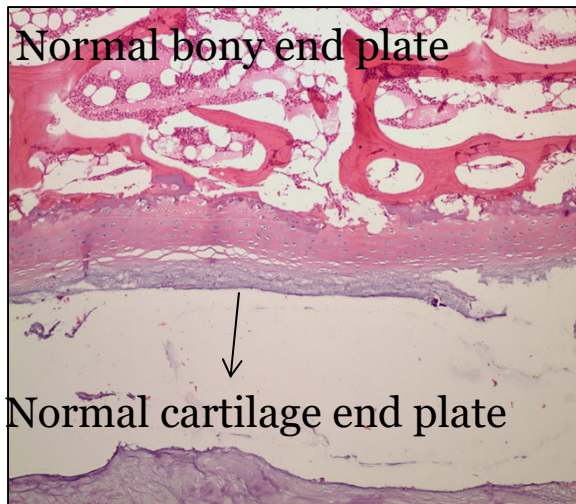
Biomechanical Evaluation*		CG (°)	GR (°)	IF (°)	χ^2	p
Thoracic	Lateral	3.2988	1.6106	0.6417	11.47	0.003
	Flexion	5.1650	2.2414	0.5700	8.84	0.01
	Extension	2.7250	1.5200	0.8300	2.9	0.2
Lumbar	Lateral	2.0300	1.7686	0.5817	10.28	0.005
	Flexion	3.2367	1.3529	0.4800	8.69	0.01
	Extension	3.2600	1.2171	0.6233	7.51	0.02

*Interobserver and intraobserver reliabilities : 0.984

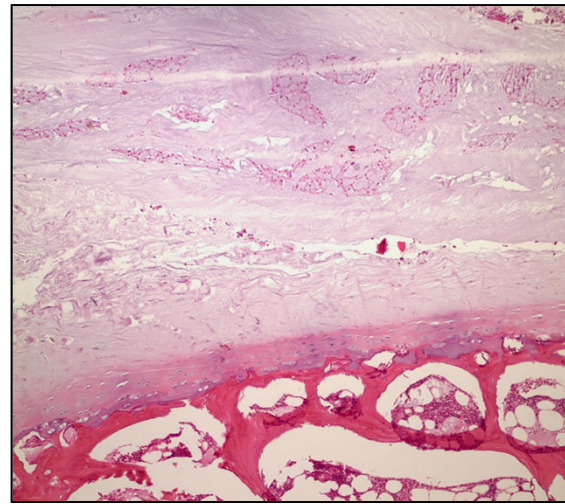
Results

Histology

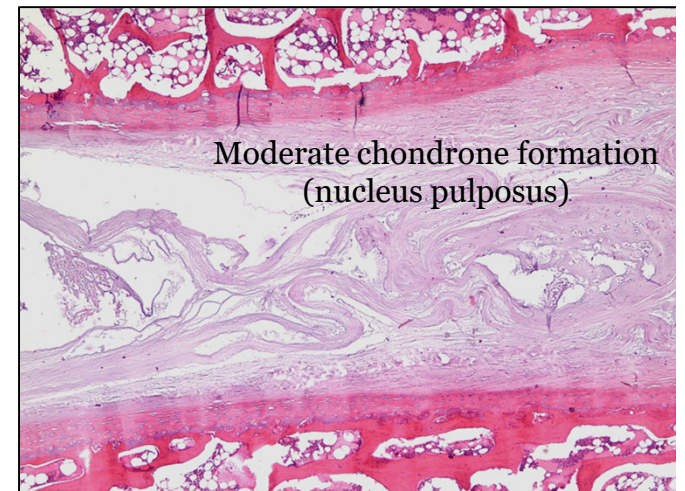
Histological Evaluation		CG mean	GR mean	IF mean	χ^2	p
Proximal	Adj. Disc	1.1333	2.2963	3.1538	22.39	0.00
	Adj. Facet	1.1250	1.4722	2.9412	25.74	0.00
Distal	Adj. Disc	1.1333	1.8214	2.7692	24.40	0.00
	Adj. Facet	1.1250	1.3684	3.1875	31.50	0.00



Normal disc



Near normal disc

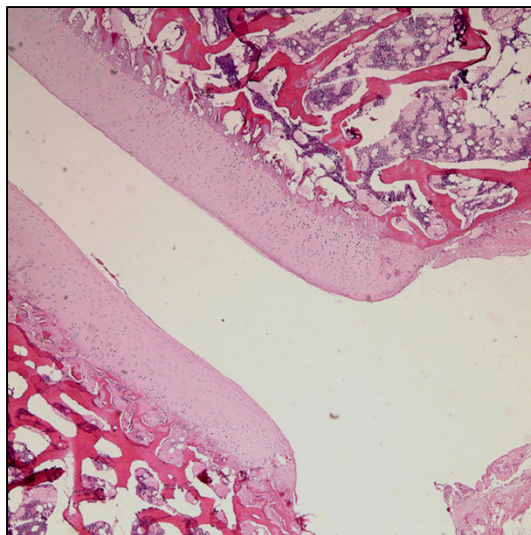


Degenerated disc

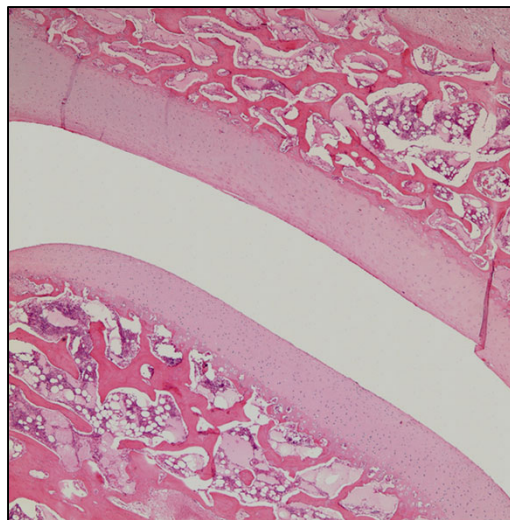
Results

Histology

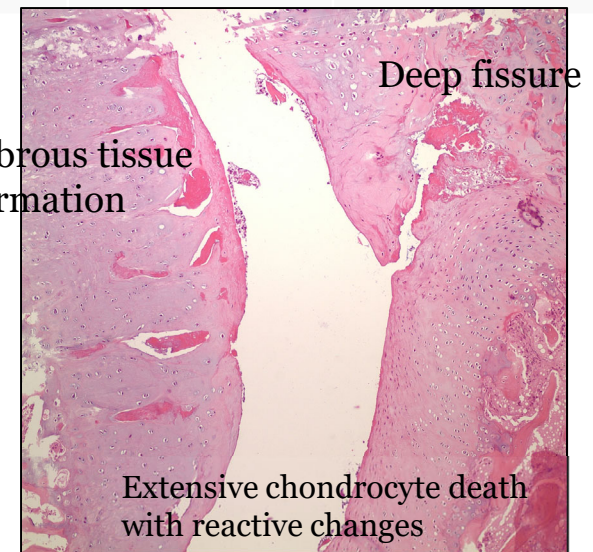
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Normal facet



Near normal facet



Degenerated facet

Conclusions

- Although some degeneration occurs with GR in the adjacent segment discs and facet joints and motion capability decreases to some degree
- It is significantly lower than the changes caused by IF
- GR is closer to normal physiology even after several lengthening procedures