JRGOS 2025 Abstract

Title: Novel Targeted Model of Congenital Scoliosis using the Application of an Electric Current in the Developing Chicken Embryo

Introduction: Congenital scoliosis (CS) results from vertebral malformation during embryogenesis, which causes progressive spinal deformity present at birth. Abnormalities of the spine are generally classified in terms of failures of formation or failures of segmentation. There is an unmet need for a bipedal CS model that can produce regionally specific spine malformations.

Methods: 57 specific pathogen-free eggs were incubated at standard conditions to embryonic day 3 (E3) after which eggs were windowed for intervention. Electroporation parameters were set to 50V, 3 pulses, 50 ms duration, 950 ms interval. Plasmid DNA constructs were not used. Current was delivered through electrodes placed superiorly (n=13), inferiorly (n=14), and in an oblique orientation to the vitelline vessels (n=19) in the treatment arm (Fig 1). Controls (n=11) underwent a sham procedure where no current was applied. Eggs were then sealed and re-incubated to E10/E11 after which embryos were sacrificed and gross observations were made. Histologic sections using Alcian Blue and Picrosirius Red staining were then also taken of representative specimens.

Results: Our protocol yielded high survival (n=33/46, 79%) and spinal deformity rates (n=29/33, 88%) with region-specific defects based on electrode placement (Table 1). Control embryos showed 100% survival (11/11) with no deformity development (0/11) demonstrating a significant difference in deformity rates between experimental and control groups (Fisher's exact test; $p<0.0001$). Curves were isolated to the cranial end in the superior group, to the caudal end in the inferior group, and in the oblique group complex multi-region curves were produced (Fig 2). Upon histologic assessment of deformed regions, segmentation defects between adjacent cartilaginous vertebral anlage were observed not present in controls (Fig 3)**.**

Conclusion: Through the induction of regionally specific vertebral failures of segmentation, we have established and optimized a method for modeling CS in the developing chicken embryo with 88% effectiveness in surviving specimens.

Table 1. Treatment Group

	Superior	Inferior	Oblique	Total
Egg #	13	14	19	**46**
Survive(%)	7 (53%)	10 (71%)	16 (84%)	**33 (72%)**
Deformity(%)*	7 (100%)	7 (70%)	15 (94%)	**29 (88%)**

Table 2. Control Group

	Superior	Inferior	Oblique	Total
Egg #	5	3	3	**11**
Survive(%)	5 (100%)	3 (100%)	3 (100%)	**11 (100%)**
Deformity(%)*	0 (0%)	0 (0%)	0 (0%)	**0 (0%)**

Fig 1

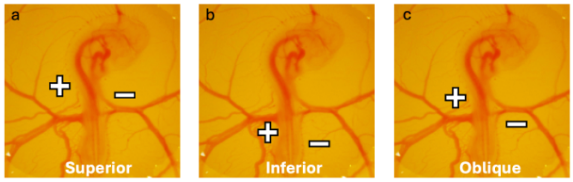


Fig 2

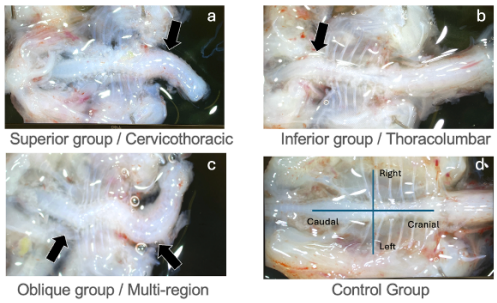


Fig 3

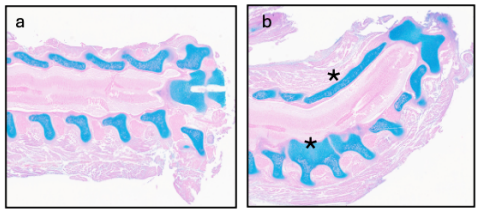


Table 1, 2: Proportion of surviving and deformed embryos by electrode orientation, *percentage of surviving specimens); Fig 1: Illustrative placement of electrodes in windowed E3 egg; Fig 2: Representative gross specimens demonstrating region specific scoliotic deformity by treatment group (black arrows identify area of observed spinal deformity); Fig 3: Representative histologic sections of control (a) vs treatment specimen (b), * identifies region of failed segmentation.