

Noninvasive Intervention Corrects Biomechanics and Upregulates Disk Genes for Long-Term Spinal Health

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Introduction

Studies examining associations between back pain and degenerated intervertebral disks (IVDs) produced evidence implicating IVDs as a significant factor in chronic back pain. Traditionally, treatment is focused on symptoms instead of at the root of discogenic back pain, the disk itself. Further, invasive treatments range from use of strong medications to surgery, which can have poor outcomes and problematic side effects. There is now a noninvasive intervention capable of correcting spinal biomechanics and has been “tuned” to upregulate the expression of IVD genes responsible for producing matrix proteins in hopes of therapeutically addressing discogenic back pain at its root. The intervention is called KKT and is based on the application of specific vibration to the spine for ~10 minutes per treatment, 2 to 3 per week, for about 6 weeks before re-evaluation. This abstract summarizes KKT safety and efficacy tests performed thus far.

Materials and Methods

Clinical reports were analyzed and experiments were designed to delineate safety and efficacy of KKT. First, a human trial consisting of single blinded, sham-controlled, and randomly assigned design utilizing mean axes of rotation (MAR) of cervical joints reported pain, and a disability index as outcomes ($n=44$). Outcomes were recorded before and after the typical 4 to 6 weeks of treatment. Second, a series of basic research experiments utilizing bovine tissue as a mean to measure both tissue injury and biosynthesis potential. Injury was assessed via visual inspection and TUNEL staining on a subset of disks (1/condition), embedded in paraffin, sectioned at 8 μm , and mounted on slides for 40 \times viewing. Tissue biosynthesis was assessed using real-time polymerase chain reaction for the following gene assay: aggrecan, biglycan, versican, collagen I, collagen II, decorin. Tissue was then vibrated with a range of frequencies, amplitudes, and durations. Based on vibration tests, parameters responsible for the most beneficial gene response were identified and evaluated when KKT was the vibration source.

Results

Clinical reports showed that no serious adverse events had occurred in over 10,000 treatments. The first experiment involving human trials showed (a) before treatment 76% of patients had at least one accompanying “abnormal” cervical MAR; (b) posttreatment KKT corrected 62% of MARs initially abnormal; (c) if MAR was corrected over treatment period there was a significant improvement in both pain ($p=0.024$) and disability ($p<0.001$) regardless of group; (d) KKT significantly improved disability over sham group ($p=0.044$) in those patients experiencing no change in MAR; (e) overall KKT significantly improved pain ($p=0.011$) and disability ($p=0.009$) over sham group.

During the second set of experiments, KKT safety was assessed via visual inspection of the disk and was observed to be normal with no signs of injury or degenerative changes. Further, TUNEL analysis indicated a mean background apoptosis rate of $10\pm 0.7\%$ (mean \pm SD). There was no significant difference between controls and frequencies tested ($p=0.08$), nonloaded and amplitudes tested ($p=0.44$), or annulus/nucleus ($p=0.53$).

According to ANOVA and Kruskal-Wallis tests, biosynthesis experiments showed that in a clinical emulation set-up KKT caused significant differences between treatments for aggrecan, collagen II, and versican ($p=0.039$, 0.039 , and 0.001 , respectively). Posthoc analysis indicated that aggrecan and versican expression were significantly higher than control ($p=0.016$; $p=0.026$, respectively).

Conclusion

KKTs loading protocol causes biomechanical changes in human spinal joints making them more “normal” and increases expression of genes responsible for producing disk tissue proteins without increasing apoptosis rates and with no reported serious adverse events. While it is clear that correction of abnormal MARs is a mechanism of efficacy there are other mechanisms of treatment that help symptoms of pain and disability despite no change in MAR after treatment; these mechanisms have yet to be discovered although we have hypothesized them to include vibration analgesia, and muscle relaxation through reduced gamma motor neuron activity.

In general, biosynthesis results indicate that KKT may have a positive effect on extracellular IVD matrix. Aggrecan and versican were above control levels for the protocol tested and are both important proteins for disk health. Aggrecan has a largely mechanical function in tissue matrix but has been shown to be critical in disk health if absent. While the function of versican is less understood it mirrors decreases in aggrecan expression during disk degeneration.

Together, results suggest that KKT is a safe and effective treatment for chronic pain over the course of the typical treatment period. We hypothesize that early success in treatment is due largely to MAR correction and we hope to maintain the correction for long-term spinal health via tissue restoration through noninvasive upregulation of disk genes. While current data are insufficient to determine whether increased gene expression translates to altered protein expression, KKT positively influences mRNA response in appropriate genes without increasing cell death rates.

I confirm having declared any potential conflict of interest for all authors listed on this abstract

Yes

Disclosure of Interest

None declared