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Research report

# The short term effect of atlanto-axial high velocity low amplitude manipulation with cavitation on Edge Light Pupil Cycle Time☆

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**Abstract**

*Background:* Edge Light Pupil Cycle Time (ELPCT) is a measure of the pupillary light reflex mediated via the autonomic nervous system (ANS). ELPCT is a measurable constant, unaffected by eye measured (i.e. left versus right eye), gender, visual acuity, refractive error, eye colour and pupil size. Previous research suggests that spinal manipulation techniques can produce distant effects mediated in part by the ANS.
*Objective:* To investigate the immediate effects of atlanto-axial high velocity low amplitude manipulation on ELPCT.
*Design:* A three group randomised controlled study.
*Methods:* Thirty participants (mean age = 23.8) without eye, central or autonomic nervous system pathology had their ELPCT measured in both eyes pre- and post-manipulation. The manipulation technique used was a high velocity low amplitude (HVLA) rotatory thrust, with the applicator localised to the atlanto-axial joint on the left ($n = 10$) or right ($n = 10$) determined randomly. All HVLA manipulations were associated with audible cavitation. The control group ($n = 10$) underwent the same protocol, including pre-positioning for the manipulation, but without the thrust.
*Results:* ELPCT measures demonstrated a significant decrease between groups ($P = 0.004$) and between groups according to eye measured ($P = 0.022$). Significant decreases between pre- and post-manipulation measures of ELPCT indicated an association between side manipulated and eyes, with right-sided manipulation producing a decrease in ELPCT in the right eye ($P = 0.001$) and a left-sided manipulation producing a decrease in the left eye ($P = 0.013$). No other significant changes were observed.
*Conclusion:* ELPCT, mediated via the ANS, is directly influenced by HVLA manipulation with cavitation to the atlanto-axial joint. The ANS changes observed in this study demonstrated a unilateral response to HVLA manipulation.


*Keywords:* Edge Light Pupil Cycle Time; HVLA thrust; Manipulation; Autonomic nervous system; Osteopathic medicine

## 1. Introduction

High Velocity Low Amplitude (HVLA) manipulation of the cervical spine is a common treatment modality used by a variety of different manual medicine disciplines. Spinal HVLA thrust techniques are commonly associated with an audible "crack" that is widely accepted to

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represent cavitation of a spinal zygapophysial joint.[1] Research into the effects of cervical manipulation has investigated its local impact upon pain[2–6] and range of motion.[4,7–13] Researchers have also investigated remote effects of manual therapy applied to the cervical spine on blood pressure,[14] cardiac autonomic activity,[15] distal skin temperature,[16–18] electrical skin conductance,[17] digital blood flow[19] and edge light pupil cycle time (ELPCT).[20]

How the remote effects of cervical manipulation are mediated is not fully understood. It has been postulated that the mechanism of action may be via stimulation of the autonomic nervous system (ANS), especially via the sympathetic nervous system (SNS).[15,16,19,21–24] Further research is required to test the hypothesis that manual medicine techniques applied to the spine produce remote effects mediated by the ANS.

Pupillary light reflexes are mediated through the ANS and are measurable and reproducible. The ELPCT is the time taken for constriction and re-dilation of the pupil when exposed to light, usually a thin beam of light from a slit lamp. The ELPCT is the persistent oscillation of the pupil that can be established by focussing a slit of light at the margin of the pupil. The slit of light projected into the edge of the pupil stimulates the pupillary light reflex. Once the pupil has constricted, the pupil is no longer in the light. Because no light reaches the pupil, the pupil then dilates until its margin is again overlapping the slit of light. Thus the cycle is repeated. The period of these cycles can easily be measured and recorded.[25,26] The iris is exclusively innervated by the ANS and measurement of the ELPCT provides a simple way of quantifying its function.[26] ELPCT is a reliable and readily reproducible measure of the pupillary light reflex that is not significantly affected by the eye measured (i.e. left versus right eye), gender, iris colour, visual acuity, refractive error, pupil size during the examination, pupil unrest, oscillation amplitude and regularity, accommodation and light adaptation.[25] Only increasing age and stimulus intensity has demonstrated a small but significant increase in ELPCT.[25]

ELPCT occurs via the pupillary light reflex arc.[25] The pupillary light reflex arises from the stimulation of the two iris muscles, the sphincter iridis supplied by the parasympathetic division of the ANS and the dilator pupillae innervated by the sympathetic division of the ANS. Parasympathetic nervous system (PNS) control arises from the Edinger–Westphal nucleus, the sub-nucleus of the oculomotor nuclear complex, located in the midbrain and mediates pupillary constriction.[27] Sympathetic nerves arise from the hypothalamus and descend in the brainstem tegmentum into the intermedio-lateral grey cell column of the spinal cord.[27] A second order neuron is given off and exits the spinal cord via the white rami communicantes. The fibres then ascend in the sympathetic chain and synapse in the superior cervical ganglion. Sympathetic fibres enter the eye through the superior orbital fissure and travel with the long and short posterior ciliary nerves to the dilator muscle.

ELPCT can be prolonged in whiplash patients,[28] optic neuritis and multiple sclerosis,[29] optic nerve compression,[30] oculomotor nerve palsy,[31] and Horner's syndrome.[32] Specific medical conditions may interfere with the normal interaction between the parasympathetic and sympathetic components of the reflex and can alter ELPCT. Nonetheless, in normal individuals ELPCT is a reproducible and easily measured reflex response reflecting activity in the ANS.

A pilot study into the effects of an atlanto-axial HVLA manipulation on the ELPCT showed that there was a significant decrease in ELPCT immediately post-manipulation.[20] These effects appeared to be a function of the side manipulated, with significant unilateral change in ELPCT occurring only in the right eye with a right-sided atlanto-axial HVLA thrust manipulation. This finding could possibly have arisen by chance as the study had low participant numbers. The aim of the current study was to further investigate the immediate effect of an atlanto-axial HVLA thrust manipulation on ELPCT in normal individuals using a randomised controlled design.

## 2. Materials and methods

### 2.1. Subjects

Thirty healthy volunteers aged between 18 and 32 years (age = 23.8 ± 3.8 years) were recruited from the student population at Victoria University, Melbourne. Exclusion criteria were previous history of eye pathology (e.g. optic nerve degeneration/compression/neuritis) and previous history of ANS pathology (e.g. Horner's Syndrome). All subjects provided informed consent and the study was approved by the Victoria University Human Research Ethics Committee.

### 2.2. Procedure

Each subject had their ELPCT measured in both eyes by a researcher trained and competent in this technique, using a method adapted from that described by Miller and Thompson[25] and used in a previous study of the effects of HVLA manipulation on ELPCT.[20] Participants removed any glasses or contact lenses and were seated comfortably in front of the slit lamp (Hag-Streit, Bern, Switzerland) in a dimly lit room. ELPCT measurement involved the participants focusing on a distant point and a vertical slit beam of light (0.50 mm) was directed perpendicular to the plane of the iris at the lateral limbus. The beam was slowly moved medially until it overlapped the margin of the pupil, which then constricted. The beam was then held in position so that the constricted iris