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Impact of Manipulative Treatment on Professional Drivers

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Abstract

The experimental research, presented in the study, focuses on track tests with the aim of highlighting changes in lap times after manipulative treatment of drainage of the glymphatic system and stimulation of the sympathetic nervous system. **Introduction:** The experimental research, presented in this study, focuses on analyzing the potential effects of a manipulative treatment on the performance of a professional driver. The main objective is to evaluate the change in lap times after the application of the treatment, trying to understand whether it can actually positively influence the driver's performance. The study stands an important opportunity to extend knowledge, regarding the use of manipulative therapies in the context of optimized driving skills. The results obtained could provide useful insights and contribute to improving the performance of professional drivers by offering new perspectives and strategies to improve their performance. Leveraging a rigorous scientific approach and a sample of highly skilled drivers, the research aims to provide concrete evidence on the effectiveness of manipulative treatment in driving skills. Monitoring lap times before and after the intervention also capture any temporary or long-term effects of the treatment, ensuring a thorough and reliable analysis of the results. **Materials and methods:** 15 professional drivers, aged 18 to 36 years, with at least 10 years of experience as drivers, participated in this study. The test consisted of analyzing lap times before and after treatment.

Keywords

Drivers, Manipulative Treatment, Sympathetic Nervous System, Glymphatic System

1. Introduction

The automotive industry is characterized by a demand for high precision, timely response and vehicle control. In a competitive environment in which every fraction of a second counts, improved driving skills would go a long way toward ensuring driver safety and success.

This publication presents a pioneering scientific study designed to examine the effectiveness of an innovative manipulative treatment, called "DriveSense", in the quest to optimize the performance of professional drivers. The treatment is based on the application of manipulative techniques aimed at improving driver's neuromotor coordination, movement accuracy and visual perception.

The study aims to carefully examine the impact of "DriveSense" treatment on drivers driving skills through a rigorous, controlled experimental examination. A selected group of highly trained professional drivers have participated in the experiment, undergoing "DriveSense" treatment sessions, followed by in-depth evaluations of driving performance.

The ultimate goal of the study is to provide scientifically valid and concrete results regarding the effectiveness of "DriveSense" manipulative treatment in optimizing the performance of professional automobile drivers. The emerging data could offer new perspectives and approaches for improving driver education and training, helping to raise the level of motorsports competition and promoting safer and more effective driving.

1.1. The Sinuses of Dura Mater

The venous sinuses of the dura mater, dural sinuses or cranial sinuses are a complex network of venous channels contained within the thickness of two encephalic dura mater folds (periosteal lamina and meninges) and drain the refluxed blood from the encephalon and skull to flow into the internal jugular vein. They are formed by the splitting of the dura mater or included between the dura mater and the endocranium. They have a triangular or circular or semi-circular shape in section.

They consist of a thin endothelial layer and a sub-mesothelial layer of elastic connective tissue, as well as the fibrous tissue of the dura mater. These sinuses have walls that do not cooperate and their lumen cannot be changed, because the walls are made up of dense, rigid, anaelastic tissue. Unlike other veins, they have no valves, so the direction of flow is reversible; another difference with veins is that they do not contain smooth muscle tissue in the constitution of their walls. They have trabeculae or septa within them and can take on a cavernous or plexiform appearance; at the outlet of meningeal and diploic veins, they have irregular cavities, the venous lacunae; in addition, emissary veins connect them to the extra cranial venous circulation. In fact, in addition to the veins of the meninges, the veins of the inner ear and the diploic veins included in the thickness of the flat bones of the vault of the skull, the encephalic veins and the ophthalmic veins head to them. The sinuses of the dura mater discharge their blood into the internal jugular vein, and some of them also communicate with other extra cranial veins by means of so-called emissaries, passing through foramina of the skull cavity. Certain dura mater sinuses have lateral diverticula, called blood lakes. They may be unequal and median, or even and symmetrical [1] [2].

1.2. The Glymphatic System

The glymphatic system is a network of lymphatic vessels in the brain that plays a crucial role in the removal and drainage of metabolic wastes and toxins from the central nervous system. This system was discovered relatively recently and represents a significant discovery in the field of neuroscience and brain physiology.

The glymphatic system is composed of functional lymphatic vessels lining the dural sinuses. These structures express all the molecular characteristics of lymphatic endothelial cells, are capable of transporting both fluid and immune cells from cerebrospinal fluid, and are connected to deep cervical lymph nodes [3].

The lymphatic system of the brain plays a vital role in the circulation of cerebrospinal fluid and, therefore, in the removal of metabolites. Therefore, it is involved in the incidence and development of some central nervous system (CNS) diseases. The optic nerve and retina are the extension of the CNS into the orbit. It is still unclear whether they have a lymphatic system and how they eliminate metabolites from the optic nerve and retina. Recent studies have found that the ocular lymphatic system has a crucial impact on ocular diseases, such as optic nerve and retinal disorders [4].

One of the most interesting aspects of the glymphatic system is its role in draining waste products, particularly amyloid-beta proteins, which are implicated in the formation of amyloid plaques typical of Alzheimer's disease. Dysfunction of the glymphatic system has been associated with a potential cause of accumulation of these proteins and may be linked to neurodegenerative conditions [5].

Further studies on the physiology and functioning of the glymphatic system could contribute to a better understanding of brain diseases and could open new avenues for the development of therapies for complex neurological conditions, such as Alzheimer's and other forms of dementia [6].

1.3. The Sympathetic Nervous System

It is not the intention of the study to delve into the anatomy of the autonomic nervous system, even if for a better understanding of the study itself, a careful description of some anatomical structures is necessary.

The sympathetic ganglia are referred to as the vertebral ganglia. They in most are aligned, along the length of the vertebral column, at the sides of the bodies of the vertebrae: lateral vertebral ganglia; some others are located instead at the front of the bodies of the first lumbar vertebrae: prevertebral ganglia, being accommodated within the celiac plexus of the sympathetic itself.

The lateral vertebral ganglia form, on each side of the spine, the trunk of the sympathetic; they are in fact connected to each other by the interposition of cords of nerve fibres, which are the intermediate longitudinal cords.

The sympathetic trunk extends from just below the base of the skull to the coccyx, where it joins the contralateral trunk by an anastomotic loop.

Each sympathetic trunk has about 24 lateral vertebral ganglia, including 2 or 3 cervical ganglia, 11 thoracic ganglia, 5 lumbar ganglia, 4 sacral ganglia, and 1 coccygeal ganglion.

The cervical tract of the sympathetic trunk extends from just below the external carotid hole at the base of the skull to the front of the neck of the 1 costa, where it continues with the thoracic tract. It lies in front of the transverse processes of the cervical vertebrae, applied to the deep cervical fascia.

The cervical tract of the sympathetic trunk has three ganglia: the superior cervical ganglion, spindle-shaped and about 3 cm long, which is located to the front of the transverse processes of the Il and III cervical vertebrae; the middle cervical ganglion, inconstant, which lies anterior to the transverse process of the V or VI cervical vertebrae; and the inferior cervical ganglion, which is to the front of the transverse process of the VII cervical vertebrae and is frequently fused with the I thoracic ganglion to form the stellate ganglion.

The following branches originate from the superior cervical ganglion:

1) The internal carotid nerve accompanies the internal carotid artery and breaks down, within the carotid canal of the temporal bone pyramid, into the internal carotid plexus (or carotid plexus) enveloping the 'same artery. The internal carotid plexus, gives rise, as collateral branches:

a) To the carotic-tympanic nerves, superior and inferior, which serve to participate in the establishment of the tympanic plexus;

b) At the deep petrous nerve;

c) To the sympathetic root of the ciliary ganglion, which travels to the ciliary ganglion and whose fibres, without interrupting in that ganglion, exit there with the short ciliary nerves and go to the eye to innervate the pupil dilator muscle. Other postganglionic fibres of the superior cervical ganglion destined for the motor innervation of the pupil dilator muscle pass from the internal carotid plexus into the semilunar (Gasser's) ganglion of the trigeminal nerve, then follow the ophthalmic nerve, then the nose-ciliary nerve, and, via the long ciliary nerves, reach the eye.

2) The external carotid nerves form the external carotid plexus around the external carotid artery and its branches; they also descend around the common carotid artery.

3) Pharyngeal branches are intended for the pharyngeal plexus.

4) Laryngeal branches are allocated to the laryngeal plexus.

5) The superior cardiac nerve descends to the arch of the aorta to participate in the constitution of the cardiac plexus, whence nerve fibres then depart for innervation of the heart and coronary arteries.

The following branches originate from the middle cervical ganglion.

1) The carotid branches form, together with the external carotid nerves of the superior cervical ganglion, the nerve plexus around the common carotid artery.

2) The middle cardiac nerve participates in the establishment of the cardiac plexus around the arch of the aorta.

The following branches originate from the inferior cervical ganglion.

1) Branches to the subclavian plexus surround the subclavian artery and then continue into the nerve plexuses accompanying the arteries that follow the sub-

clavian artery (axillary artery, brachial artery, etc.).

2) The inferior cardiac nerve arises around the arch of the aorta to participate in the establishment of the cardiac plexus.

Thoracic Part of Sympathetic

The thoracic tract of the sympathetic trunk follows the cervical one and reaches the diaphragm where, passing between the medial and middle pillars of the diaphragm itself, it continues with the lumbar tract. It extends in front of the rib heads, beginning with that of the 2nd rib, and is covered by the parietal pleura.

It generally has 11 thoracic ganglia, from which the following peripheral branches originate.

1) Aortic branches form the thoracic aorta plexus.

2) The pulmonary branches constitute, together with the bronchial branches of the vagus nerve, the pulmonary plexus for innervation of the lung.

3) Oesophageal branches take part with the oesophageal branches of the vagus nerve in the constitution of the oesophageal plexus for the innervation of the oesophagus.

4) The great splanchnic nerve is formed by the union of branches emerging from the VI, VII, VIII and IX thoracic ganglion.

5) The small splanchnic nerve originates from the union of branches emerging from the 10th and 11th thoracic ganglia [7].

1.4. Manipulative Treatment

After this premise, it seems clear that the approach to improve pilot performance will consist of 2 ways:

- Acting on the skull, with the intention of ideally performing a lymphatic drainage of the lymphatic system, eliminating its waste, improving the well-being and function of the entire nervous system. This intent will be accomplished by performing a drainage of the venous sinuses of the dura mater.
- Acting on the spinal column. Through it we are going to act on the lateral vertebral sympathetic chain, producing the effects we all know (increased heart rate, increased respiratory rate, ...). The desired stimulus will be produced by manipulation with HVLA technique.

1.4.1. Cranial Manipulative Treatment

It was in 1939 when Sutherland studying the skull wrote "The Cranial Bowl" [8], in which a biomechanical model of approach still practiced today was described. However, there are still controversial points in the original model of MRP (Primary Respiratory Movement); although logic may lead us to hypothesize mobility of cranial bones in relation to shape and sutures, as has been demonstrated in animals through the action of masticatory muscles [9] [10] [11], hypotheses about bony deviations due to intrinsic mobility of the central nervous system are not consistent with current results [12] [13].

Therefore, for this study, it was decided to use techniques that will go to viscoelastic deformation capacity [14] [15] [16] [17], and tissue mechanics, models rich in scientific demonstration [18] [19] [20] [21].

1.4.2. Vertebral Manipulative Treatment

While the main goal of vertebral manipulations is usually to improve joint mobility and reduce pain, HVLA techniques have also been shown to affect the autonomic nervous system by stimulating the sympathetic nervous system, which is involved in the "fight or flight" response, increasing heart rate, blood pressure, airway dilation, ...

Vertebral manipulations have effects on the autonomic nervous system through stimulation of the ganglia of the lateral vertebral chain located lateral to the vertebral bodies. Manipulation of a vertebra will produce a sympathetic neurovegetative effect to the innervation territory (organs, viscera, skin, ...) of the ganglion located lateral to it [22]-[33].

2. Materials and Methods

The study involves conducting a manipulative treatment on the skull and spine and evaluating whether this produces an increase in performance.

Motor racing is probably the sport that requires the most alertness, at high speeds long distances are covered in a very short time, and often the difference between an excellent manoeuvre and a mistake is a matter of fractions of a second.

Draining the central nervous system should improve the driver's lucidity, even improve his or her visual abilities, due to the fact that the optic nerve is an extension of the central nervous system, as mentioned earlier. Greater lucidity means shorter reaction times.

Stimulation of the sympathetic nervous system also serves the same purpose, as extensively described in this study, the sympathetic nervous system is activated during dangerous and high-stress situations.

It will have happened to everyone to experience a dangerous or high-stress situation and have the feeling that time dilates, as if everything is running in slow motion. What you want to recreate is exactly that state, the sensation of time slowing down, mixed with increased responsiveness and muscular alertness, as well as improved vision given by the effects of sympathetic on pupil and lens.

2.1. Sample Selection

In the course of designing an ambitious study to evaluate the effectiveness of a manipulative treatment on the performance of automobile drivers, a crucial challenge emerged: the careful selection of the sample of participants. This aspect proved crucial to ensure that the results obtained were valid, reliable, and capable of providing meaningful information.

One of the central questions concerned the skill level of the drivers included in the study. Given the complex variables involved in high-speed automobile driving and the importance of accurate and consistent measurements of lap times, it was essential that all participants could perform laps with an extremely high degree of accuracy. Any deviation could have compromised the accuracy of the results and the ability to draw meaningful conclusions from the analysis.

Given the goal of obtaining laps as uniformly as possible, it became apparent that the selection of participants would have to follow strict criteria. It was decided to focus on top automobile drivers who had demonstrated a consistent ability to maintain high standards in terms of lap times. This selection criterion was adopted to minimize variability in the results and ensure that the observed changes could be attributed to the manipulative treatment rather than to chance.

Fifteen professional pilots, aged 18 to 36 years, with at least 10 years of experience at a high level, were recruited for this study. Measurements were taken from June to September 2023.

2.2. Choosing the Track and Go-Kart

As part of a study dedicated to evaluating the effects of a manipulative treatment on the performance of automotive drivers, the selection of the go-kart and track was a key decision to ensure the accuracy and relevance of the results obtained.

The choice of a go-kart with a displacement of 420 cc was driven by the need to use a vehicle that offered high performance and could reach high enough speeds to require rapid responsiveness on the part of the driver. This is essential to highlight any change in performance that could be attributed to the manipulative treatment. A powerful and agile go-kart could have effectively highlighted any positive effect resulting from the treatment.

Rental tires were chosen to ensure consistency and uniformity of lap times. Tire deterioration can significantly affect vehicle performance and could have introduced unwanted variability in the results. By using rental tires, it was possible to better control this variable and ensure that lap times were primarily influenced by driver responsiveness and manipulative treatment.

The track selection was equally strategic. A track was chosen that was a combination of long straights, where the go-kart would be able to reach high speeds, and tight corners that required precise braking points and advanced driving skills. This choice was made to ensure that the track was challenging, testing participants' driving skills and allowing them to appreciate any performance improvements in complex and diverse driving situations.

The choice of go-kart and track was a crucial aspect in setting up a study that had validity and meaning. Through the choice of a high-performance go-kart, rental tires, and a challenging track, it was possible to create a complex and coherent framework that allowed any improvements in driver performance to be detected accurately and meaningfully. This carefully considered approach helped ensure the reliability and validity of the results obtained, making a valuable contribution to understanding the effects of manipulative treatment on automotive performance.

2.3. Test Execution

Prior to the execution of the test, each driver was allowed to run freely around the track for as long as they saw fit; these laps were essential to familiarize themselves with the vehicle, the 420 cc rental go-kart, and the track. No time limit was imposed during this phase, allowing drivers to also do several stints if necessary to feel comfortable with the characteristics of the vehicle and the track.

After gaining total mastery of the vehicle and the track, the drivers rested for as long as they saw fit, were allowed to drink and possibly have a snack. Afterwards, they were again let out on the track for data collection.

The first 5 laps were excluded from the evaluation, as they were used to warm up the tires and become familiar with any changes in track conditions, such as changes in temperature, humidity, in general grip.

Next, a sequence of 10 laps was considered, during which drivers were asked to maintain a steady and regular pace. It was reiterated that the main objective was not speed, but consistency of performance. The lap data were recorded and considered for further analysis.

After this initial data collection, the riders were made to leave the track, drink and rest as needed. Next, they were given the placebo treatment; they were told that they were being given the treatment to improve performance, but in fact they were being treated random body districts, with no intention on the part of the operator. After the placebo treatment, participants were immediately returned to the track.

Also in this second phase of data collection, the first 3 laps were excluded, serving to warm up the tires after the interruption. Then, a series of 10 laps was again collected, again in this phase the drivers were asked to maintain a consistency of performance and concentration, not to "push".

After this second data collection, the pilots were made to leave the track, drink and rest as needed. Next, they were told that in fact, they were given the placebo treatment, at which point they would actually receive the performance-enhancing treatment. After finally being treated with the experimental treatment, the participants were immediately returned to the track.

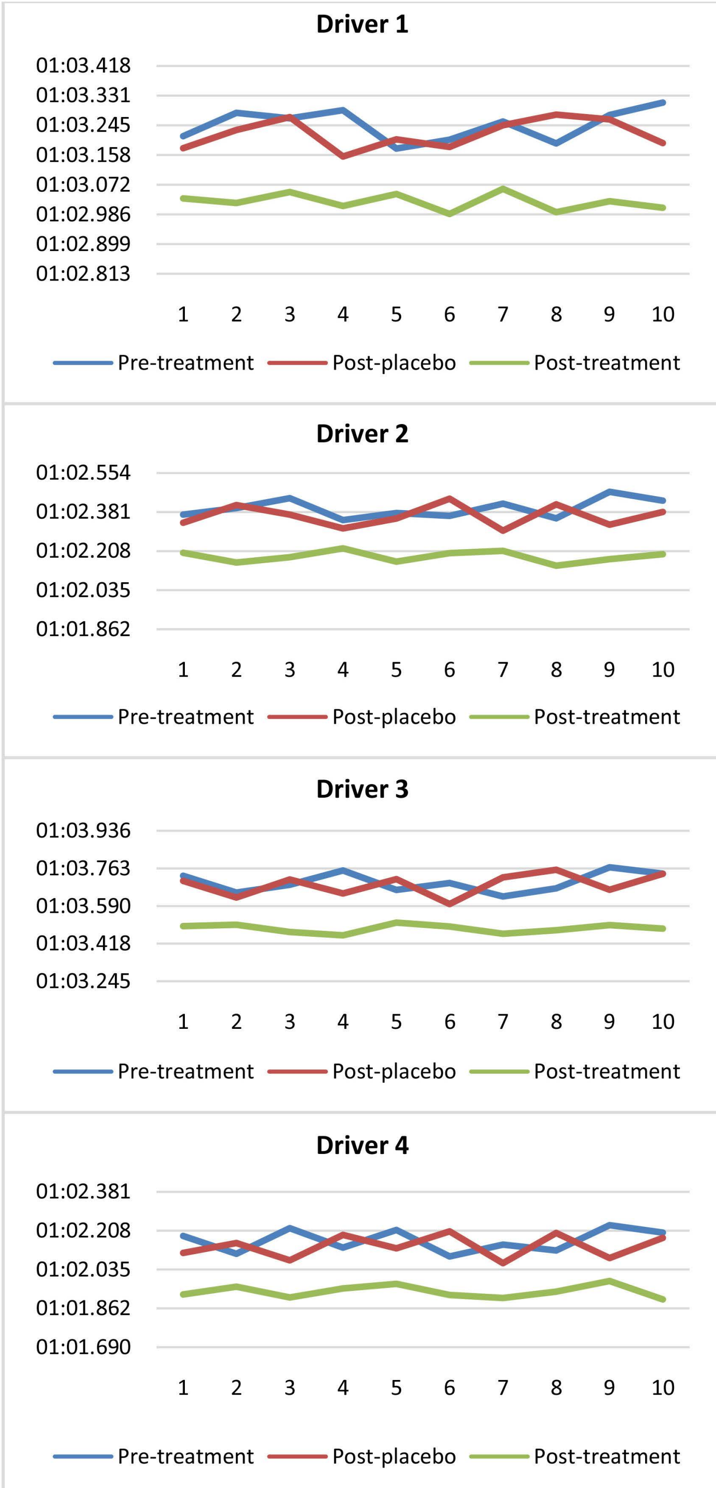
Also in this third phase of data collection, the first 3 laps were excluded, serving to warm up the tires after the interruption. Then, a series of 10 laps was again collected.

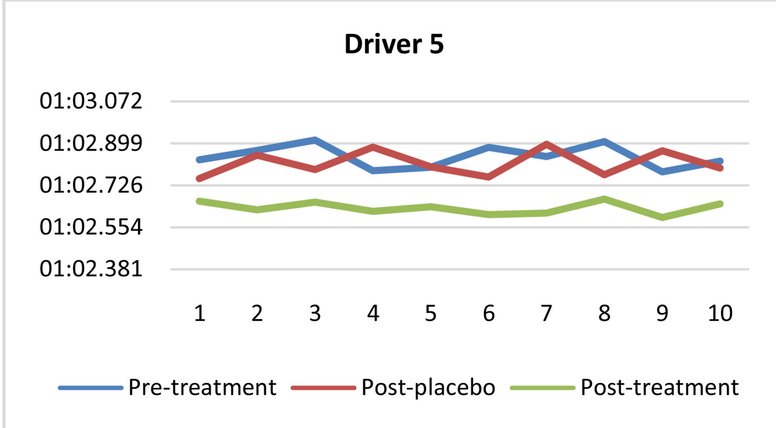
It should be emphasized that throughout the procedure, the drivers were never asked to "push" but, to focus on the repeatability of the laps, trying to keep them as similar to each other as possible. The focus was on maintaining the pace, avoiding errors that could compromise the quality of the data collected. The goal was to accurately capture any variation in performance that might result from the manipulative treatment.

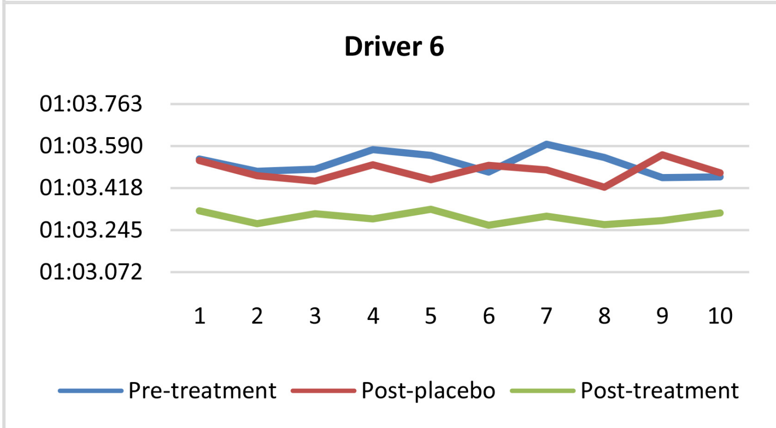
The entire procedure of performing the study was characterized by a detailed and thorough methodological approach. From the initial familiarization with the vehicle and the track, to the exclusion of any progress dictated by the placebo effect and the data collection phase and the manipulative intervention, every aspect was carefully orchestrated to ensure consistency and reliability of the results. This painstaking planning helped create a controlled testing environment in which any improvements in automotive performance could be accurately and meaningfully detected and analyzed.

3. Results

Data processing revealed very interesting results (**Figure 1**).




Driver 5
01:03.072
01:02.899
01:02.726
01:02.554
01:02.381
1 2 3 4 5 6 7 8 9 10
Pre-treatment
Post-placebo
Post-treatment


Driver 6
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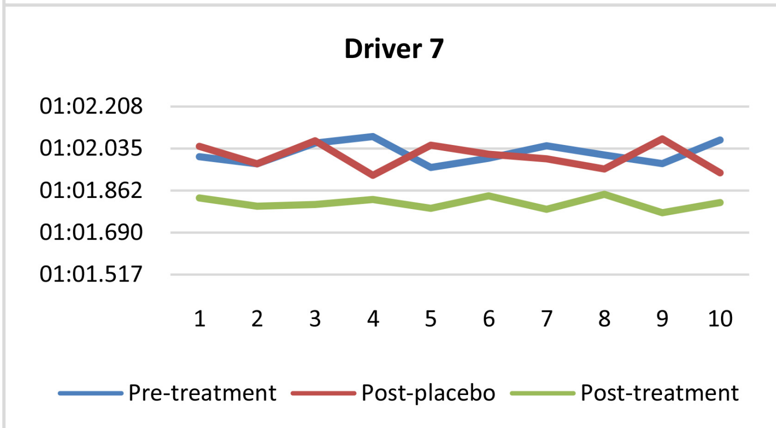
01:03.418
01:03.245
01:03.072
1 2 3 4 5 6 7 8 9 10
Pre-treatment
Post-placebo
Post-treatment


Driver 7
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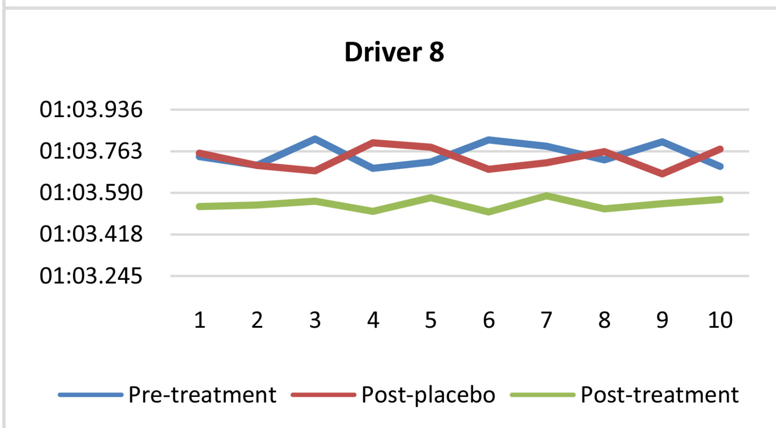
01:01.862
01:01.690
01:01.517
1 2 3 4 5 6 7 8 9 10
Pre-treatment
Post-placebo
Post-treatment


Driver 8
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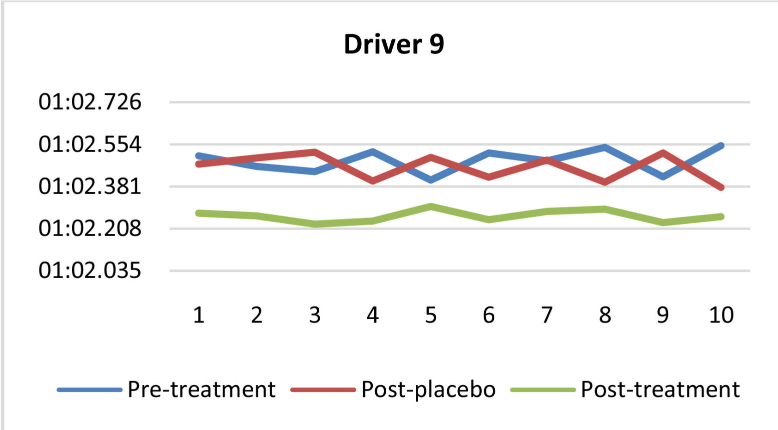
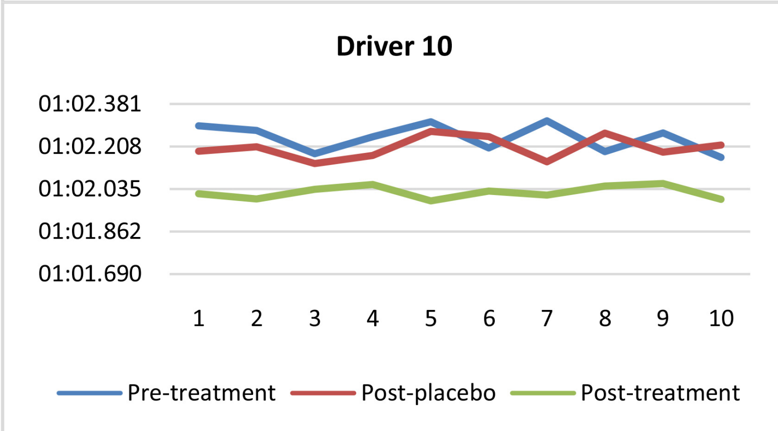
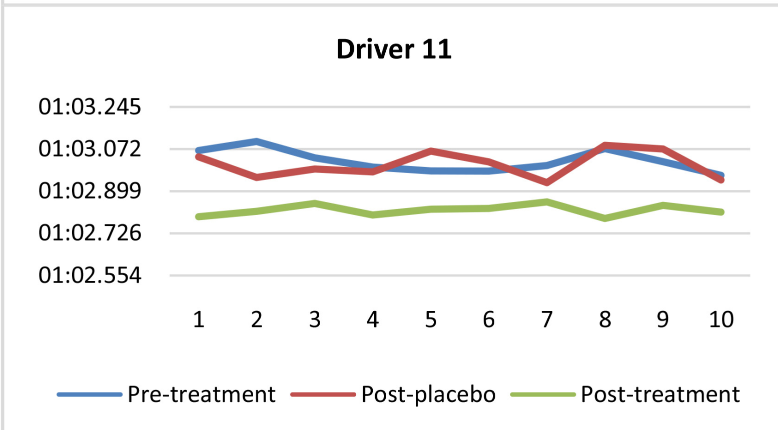
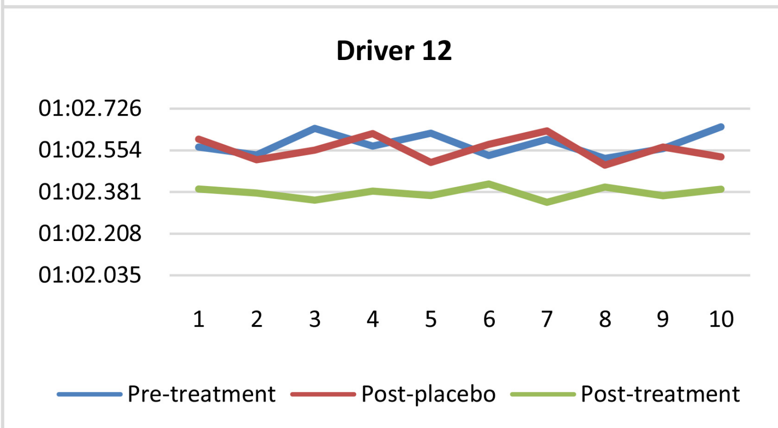
01:03.590
01:03.418
01:03.245
1 2 3 4 5 6 7 8 9 10
Pre-treatment
Post-placebo
Post-treatment


Driver 9
01:02.726
01:02.554
01:02.381
01:02.208
01:02.035
1 2 3 4 5 6 7 8 9 10
Pre-treatment
Post-placebo
Post-treatment


Driver 10
01:02.381
01:02.208
01:02.035
01:01.862
01:01.690
1 2 3 4 5 6 7 8 9 10
Pre-treatment
Post-placebo
Post-treatment


Driver 11
01:03.245
01:03.072
01:02.899
01:02.726
01:02.554
1 2 3 4 5 6 7 8 9 10
Pre-treatment
Post-placebo
Post-treatment


Driver 12
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Pre-treatment
Post-placebo
Post-treatment

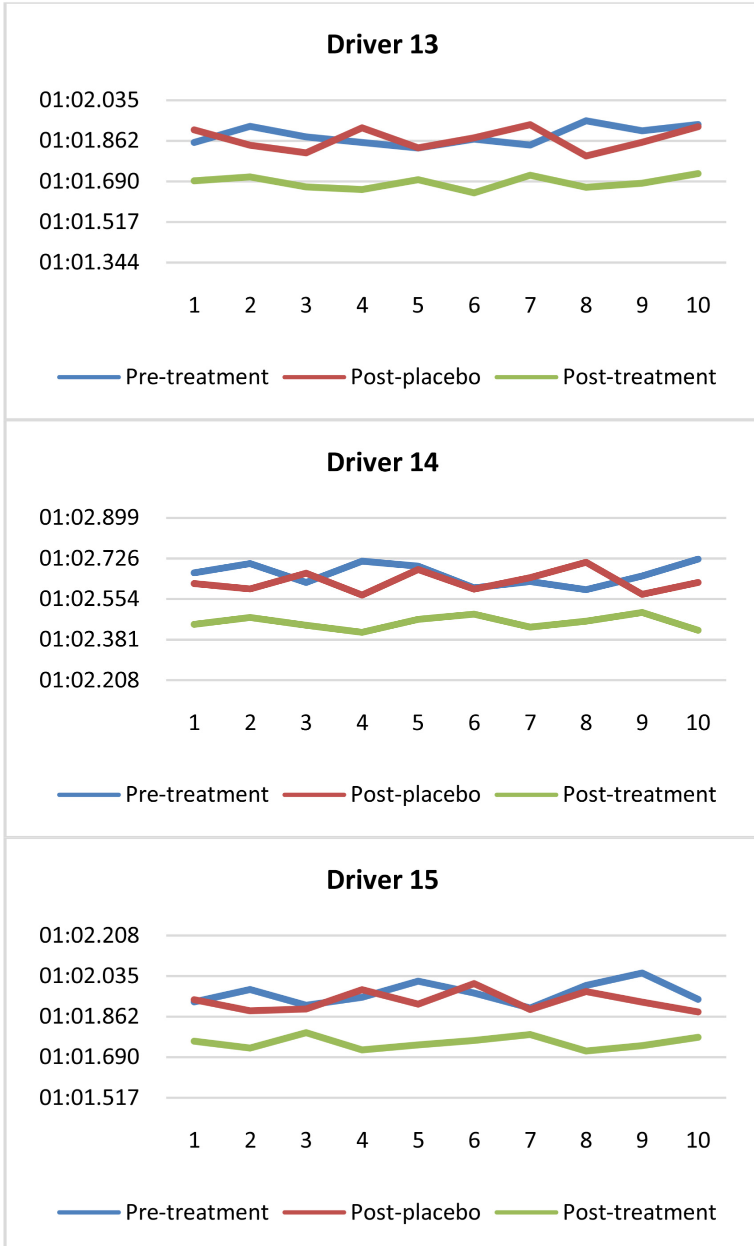

Figure 1. (Drivers 1 - 15) Telemetry of test pilots.

Most significant result is the improvement after treatment. The average improvement, with P < 0.01, is 0.213 seconds.

Interestingly, the placebo treatment also had an effect, albeit minimal, improving the performance of the pilots by 0.025 seconds P < 0.01.

Another very important parameter for the drivers is the "delta"; this parameter is the difference between the fastest lap and the slowest lap; it is an indicator of the driver's driving accuracy. The average delta of drivers before treatment was 0.133 seconds P < 0.01; placebo did not result in significant changes to this parameter which was 0.139 seconds P < 0.01; after treatment, the delta decreased becoming only 0.074 seconds P < 0.01.

4. Conclusion

The study showed that the treatment protocol, consisting of drainage of the glymphatic and stimulation of the sympathetic nervous system, leads to improved performance of top motor racing drivers.

5. Discussion

The in-depth analysis conducted as part of this study yielded extremely promising and encouraging results, shedding light on a context that has not yet been explored.

The results of the statistical analysis revealed a statistically significant improvement in performance in drivers after receiving the manipulative treatment. Lap times were on average faster and more consistent than the control stint and placebo, suggesting that the treatment had a positive impact on the participants' driving ability.

This investigation is particularly significant, considering that the context of manipulations and their implications on automotive performance is still unexplored. The data collected and analysis conducted provide a solid basis for the claim that manipulative treatment may be a key factor in improving driving skills.

"I felt like the world was moving in slow motion," M. Martucci.

"I immediately noticed a better vision, I felt charged and my reflexes were faster" V. Scarpetta.

"I felt more focused, more confident" R. Mazzola.

These are some of the comments from the riders, after finishing the laps under the effect of the treatment.

Conflicts of Interest

The authors state that there are no conflicts of interest.

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