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Article

Does the kart fit?

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Abstract. *Background*: the incidence of biomechanical pain related to Go-Kart Racing remains high, as high studies are not made due to the fact that racing with a go-kart is often not intended as arrival point but as a starting point of major racing career. In light of discontinuous racing pain, no theories about biomechanics have been suggested as possible contributor to solve the racing related pain. Perhaps no study has been conducted on the biomechanics of go-kart racing. However, the decision making process for the determination of the best racing position affecting driver's symptoms has not been described. Therefore, the purpose of this case report is to describe the biomechanical reasoning within the go-kart racing framework for a group of four driver reporting different symptoms.

Case Description: a single racing class as race-experience subject, male driver presented with low back pain, neck fatigue, forearms numbness and perceived reduced braking effort, limiting his ability to race and threatened his goal to run in upcoming races. Several features of their video-analysis examination, indicated a non referenced driver positioning on the kart, during driving functional tasks.

Outcomes: the subject was able to achieve his goals including a return to participation in his weekly driving routine and competing in Cup races. Objective examination features about range of motion, was developed.

Discussion: the diagnosis and treatment of go-kart racing related pain remains a sport science challenge. This case report, describes the examination and biomechanical reasoning on frameset fitting, and proposes a treatment progression to address this fitness limitation.

Keywords: Motorsport, go-kart, driver's tailored biomechanics, comfort.

Introduction

Racing related injuries are quite common among drivers , even among recreational drivers (O Minoyama, 2004) . Have been reported among single seat racing car, two main trends injuries incidence at neck of 34% and at lower limbs of 24%. Go-Kart racing, have closer way of driving to a single seat car, excepting for the speed reached. In this case report, all aspects of go-kart racing biomechanics have been investigated to attempt to identify modifiable factors which may contribute to injury, pain, discomfort and lower human performance. These include Heart Rate measure, biomechanical analysis of functional racing angles as requested go-kart driving tasks, internal racing suit temperature, rate of perceived exertion (RPE) with a BORG scale (Borg G.A., 1982), reported racing discomfort with a non specific scale (PORTER J. M., 1998), flexibility [Seat and Reach Test (Wells, 1952 n.23)]. However, the evidence is unclear regarding the role that each of these factors play in the go-kart racing related pain and injuries.

The observed inconsistencies regarding which factors may affect the incidence of injury and pain occurrence, has led to different paradigms regarding the role that track and joint reaction forces and muscle activity play in determining the control of the go-kart driver, during the task of racing. During the biomechanical description of driving, we take inspiration from the concept-idea of muscle tuning, where impact forces serve as an input signal to the neuro-musculoskeletal system to "pre-activate" the muscles of the lower back (closer to the seat) in order to control the joints and limb segments as low back segments and attenuate impact forces, in addition to steering as cornering movements (in case the racing track has hollows, holes or roughness). However, this theory was recently refined. The combined implication of these paradigms is that individuals will utilize unique muscular strategies to maintain a predetermined ("preferred") movement path, even if it does not fit at all, without complaining during the drive but just after the drive, when the chronometred times are done. Further, these muscular strategies may be different across individuals, yet result in similar kinematic patterns.

Vehicles with same vibrant events characteristics, as impact force characteristics, are tractor. In a more comprehensive way, (Bovenzi M, 1994) studies about vehicle with same characteristics, reported that have seemed evident, among occupational drivers the increase in risk of developing back pain. As go-kart racing drivers, they are exposed to whole body vibration, and their work often includes exposure to several other risk factors for low back pain, particularly the seated posture and manual materials handling. Excessive demands in racing posture, are likely to be aggravated by vibration and vice versa. Moreover, in this study appeared that the risks may be further compounded when manual materials handling works is performed during driving.

This means that finding a performing biomechanical angles, could solve this problem and improve the safety of go-kart driving. This raises a unique challenge for technicians as the use of driving positioning video-analysis, relies on kinematic assessment of driver's segments. However, what is observed kinematically, partially reflect the underlying kinetics or muscular strategies utilized by individual drivers, and more analysis are supposed to be done, in order to verify this detail. Thus, technicians may need to rely on other evaluation strategies or different elements of the examination to identify subjects' impairments when altered muscle activation patterns or neuromuscular control dysfunction are suspected in the etiology of a driver's symptoms. Different movement screening methods have been developed to assist technicians and clinicians with the identification of potentially disadvantageous movement angles. These tests and measures aim to identify gross low back movements or limitations in movement that may be affecting function with other activities. If neuromuscular control dysfunction is identified with tests, technicians and clinician can begin to reason that there is a greater likelihood of similar deficits with higher level tasks either causing or contributing to pain and/or injury in the driver. Once muscular non performing angles as other reasons are identified, it behooves technicians and the clinician, to begin hypothesizing about causes underlying those deficits (i.e. strength, performing angles, coordination, proprioception, flexibility, joint mobility, etc.). One proposition, regarding non-proper fitting angles, is that the demand of driving task has anthropometric related characteristics of body segments, for manage with adequate control the driving related motion angles (driving enclose braking, cornering, starting, overtaking etc.), necessary to complete the task. For example, the length of upper limbs has to be linked with steering wheel characteristics (tube thickness as steering width) as performing angle of limbs muscles. Specifically, the unlinking of these different units of measure, develop non-performing driving style comparisons and non-specific weight as forces distribution on the racing go-kart. The weight distribution is about go-kart and driver together putted upon the tires, who play an important role of course, but let us just consider the weight distribution issue a little further. A racing go-kart plus a driver, weighs not a lot overall and is distributed between front and rear. When the driver gets on the brakes, the total static weight remains the same, but the effective – or dynamic – distribution, is altered. Weight is effectively shifted to the front wheels but since the total remains the same, the rear effective weighs less. Since there is less to press the rear tires to the road, they will slide more easily, because the balance of the racing go-kart has changed, and this change makes the difference in the racing go-kart's behavior.

The weight, has been lifted from the rear wheels, but they are still receiving a similar amount of braking effort (forget ABS because is not allowed inside CIK-FIA® (CIK-FIA® (Commission Internationale de Karting – Federation Internationale de l'Automobile, 2018) go-kart racing), and this makes them more likely to lock. A correct driver positioning, could not help to solve the weight-shifting issue, but give him the best racing handling position in both weight transfer as standing weight base conditions, in terms of biomechanics performance. Moreover, driver's positioning, will not affect tire's ability to grip: the improvement are on the handling of the vehicle and, in case of better go-kart handling, the driver found exacerbated feelings about tires as new tires managing opportunities. It is also possible, that the driver may utilize increased better handling-force production (from the overall muscles) to help control the driving motions.

For example, this increase in handling-force production from the neck, may lead to fatigue and accumulation of abnormal stress to this muscle resulting in irritation and/or pain in either the neck (as the force production of this muscle may increase) or the upper limbs (as these muscles are attempting to control a load greater than they are capable of managing), or both. Further, this shift in muscular strategy may go unnoticed with 2D static drive analysis, if the shared loading of muscle forces is sufficient to maintain a given kinematic profile, or "preferred movement path". Nonetheless, this shift would alter the kinetic distribution of forces across tissues in the trunk and the back. Thus, identification of other components about muscular control during go-kart racing, may be helpful to infer muscular control dysfunction, in the etiology of low back pain in go-kart drivers in addition to static driving analysis. Clearly, the nature of many musculoskeletal conditions can be quite complicated, and the nuances of individual subject presentation can make the management of subjects (from examination, evaluation, anthropomeasure, to intervention planning and goal setting) very challenging. In light of this, is proposed the use of a common language, documentation, technical and clinical reasoning schemes, in this case report: one organizational scheme which seeks to consider the driving condition and driver's positioning on the vehicle.

The driver's position, is a resultant interaction between an individual's health condition and his or her personal attributes while also considering environments, anthropometrics, and context influences. In addition to this, this case report, seeks to create a systematic and encompassing framework as a reference to navigate through the process of racing driver management.

Case description

Subject History

The subject was a 41-year-old female experienced driver (Ht: 165.5 cm; Wt: 68.6 kg; BMI: 25.05) referred by his primary care provider with a medical diagnosis of low back pain, neck pain and hand tingling. Symptoms began approximately two months prior to initiating physical training, and persist during training and at the end of training. He described the onset of symptoms as having occurred after driving five training laps of the 'Valle del Liri International Circuit'. He noted having had to drive two hours the day prior to the training laps. He had no familiar sensation of mentioned pain, leading up to five laps, but in the subsequent weeks following a training race of 17 laps, he began to notice buttock pain and symptoms down the forearms which were preventing his from increasing his training laps background. He denied any other changes in his training regimen regarding driving training (two sessions of 15 lap twice a week), lap-timing average speed or week schedule (this wasn't managed from no technician). He had been consistently using the same model of racing suit, seat's brand and had not used any type of insert or orthotic, apart of licensed ribs protection. Elbows, were reporting bruises coming from the contact with candle pipe at the head of the go-kart's engine, as showed in **photo 2**.

He had not reported any kind of crash during his racing career, and have not got any noticeable clinical issues. He also used to race in other motorsport class (old class motorbike) as hobby. Treatment had consisted of self-management of symptoms with stretching, but symptoms continued to increase as he attempted to further his training. His previous left sided pain of the back, was reported to be less severe than his current symptoms and partially resolved with stretching and a brief period of reduced training laps background. No other health conditions or medical problems were identified by the subject upon questioning. His primary goal was to be able to resume his training regimen and progress a typical go-kart racing weekend distance, in preparation for a scheduled Cup-Race, six months from the date of his initial presentation.

Technical impression #1

From subject history and from go-kart driving related tasks, emerge different cause of pain related to go-kart driving as described in **Figure 1**. These limitations and his reported symptoms led to the inclusion of multiple diagnoses within the hypothesis list of potential health issues as technical material's conditions. The onset and location of his pain, placed both normal as go-kart driving position in primary consideration. Additional symptom generators, were considered including back muscles, sacroiliac joint, the lumbar spine, and adverse dynamics. A short look to forearms-tingling bibliography is supposed to do after the first technical impression, in order to treat different factors in different moments.

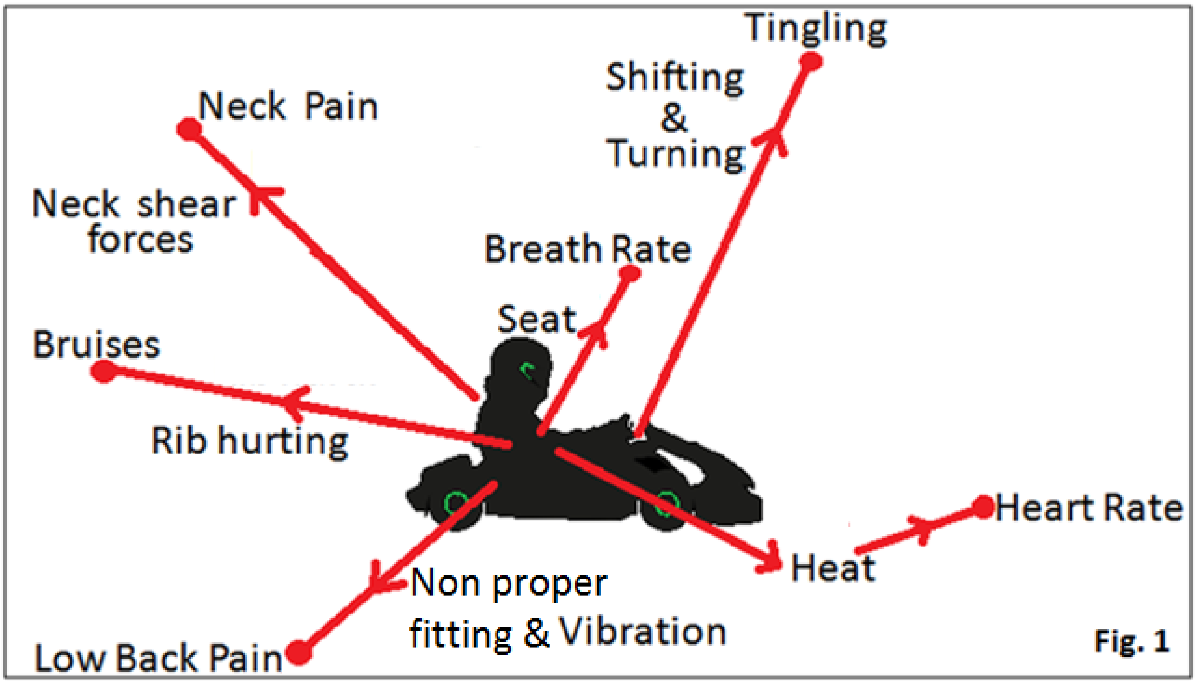


Fig. 1

Evaluation #1

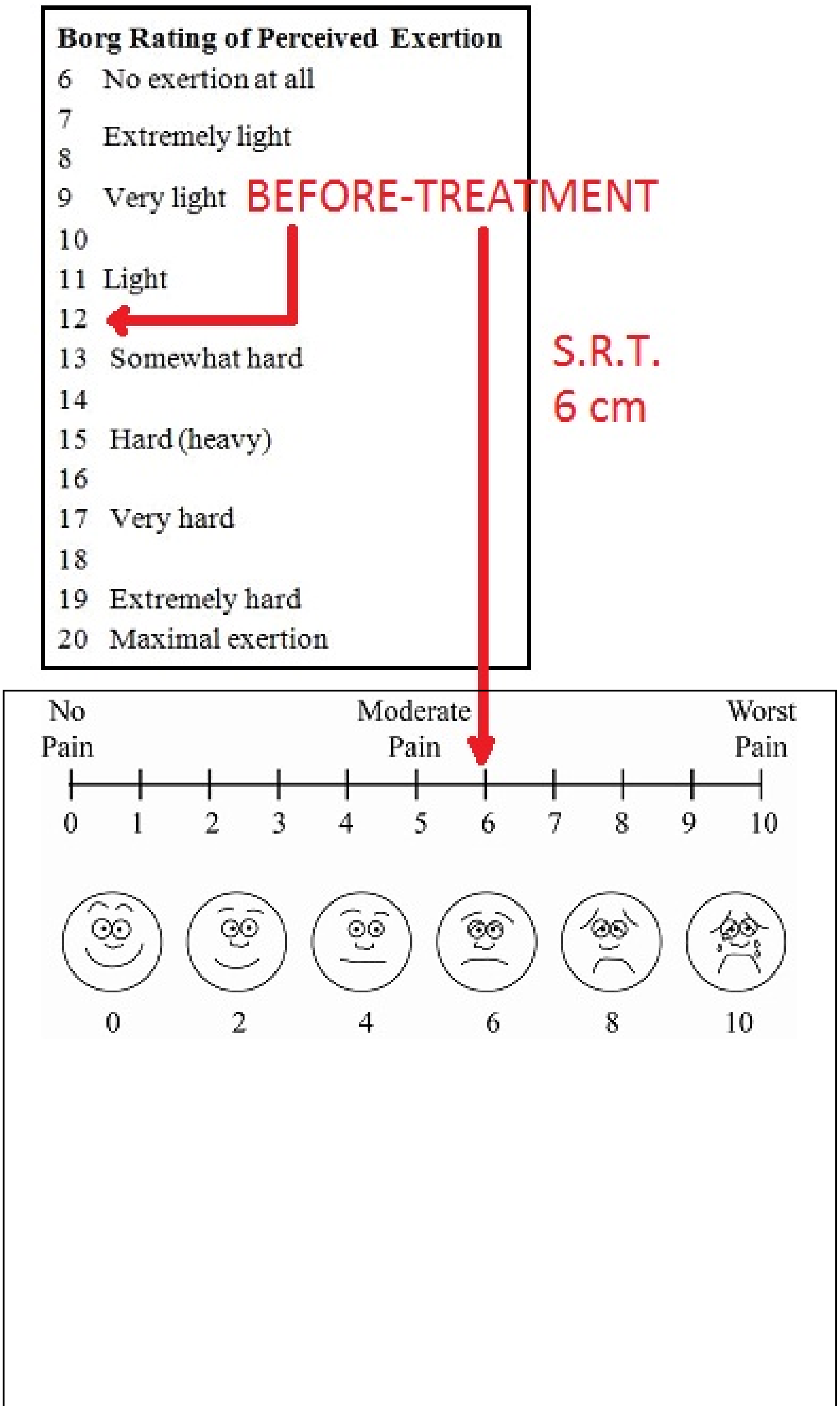
At his initial status, pain was located essentially in the left side of the low back. Symptoms, at rest, were rated 12/20 (in terms of RPE using the BORG scale) and would reach 12/20 after periods of prolonged street driving. Seat and Reach Test, was done in order to measure his lumbar spine flexibility and his results was 6 cm; the test was conducted without any discomfort. His discomfort score on the self-assessed index (in terms of pain using the VAS scale), was 6. As symptoms increased some radiation into the posterior thigh was noted by the subject.

Functional limitations included a need to frequently reposition due to discomfort with sitting and reduced tolerance to driving and jumping. No gross visual estimations of quality and quantity of motion were utilized as support to asses quality of motion. The reliability of the methodology utilized in this case report has not been studied. However, provocation of symptoms occurred was observed when exacerbating the distance between body segments and brake lever as steering wheel. Further estimation of impaired movement, included assessment of elbow's range motion and flexibility using standard goniometric video-estimation with computer basic software (free non-commercial license's software). Overall limitations in range of motion were present, bilaterally, and due to asymmetric seat position, it was also asymmetrical for the lower limb. Endurance testing, included repetitive steer turning in static situation and driving of eight full training laps, with the subject reporting increased fatigue on the left side of the back, compared to the right over the same number of laps. No attempt was made to identify trigger points or miofascial restriction as the reliability of manual assessment has been declined.

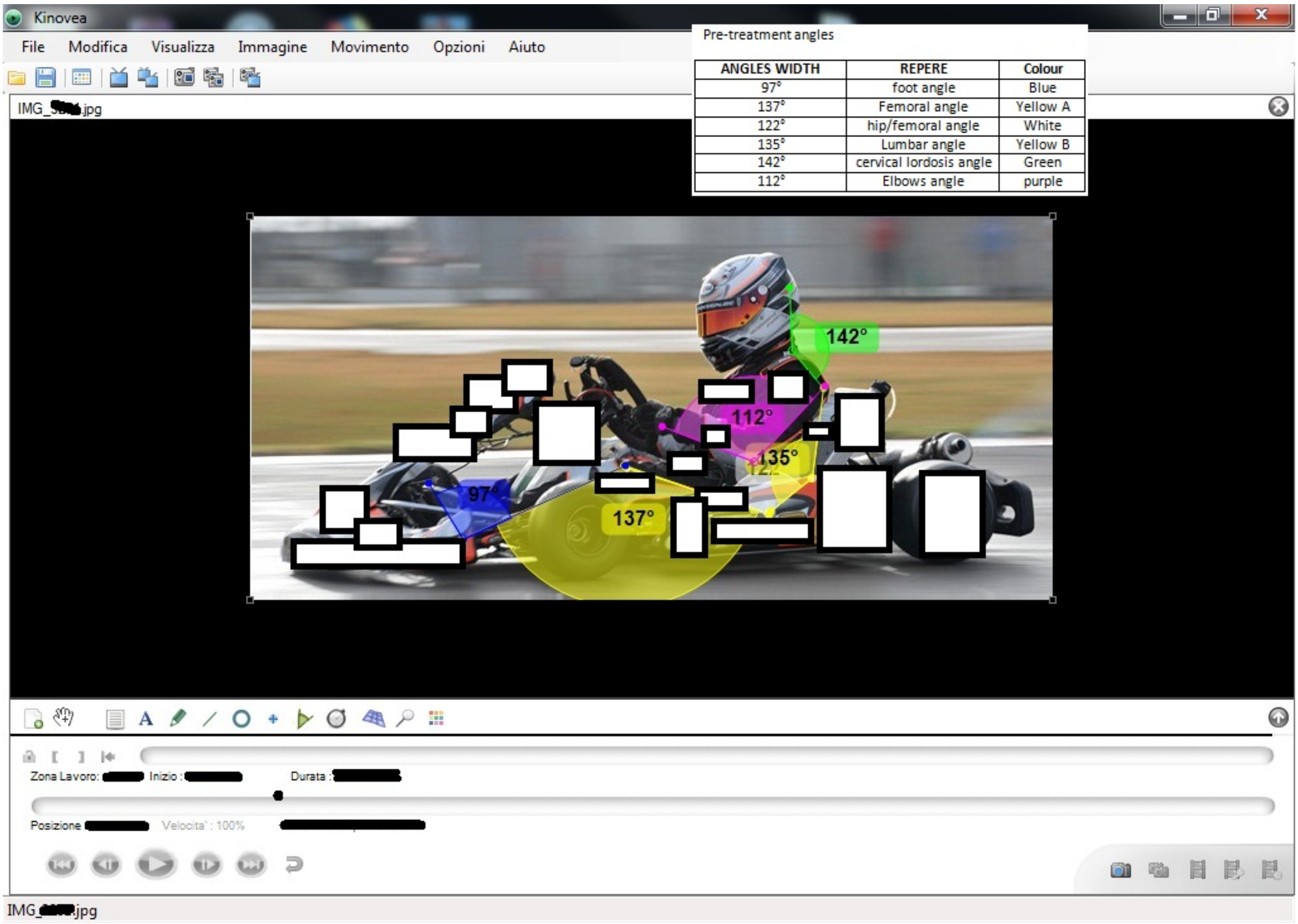
Pre-treatment angles

ANGLES WIDTH	REPERE	Colour
97°	foot angle	Blue
137°	Femoral angle	Yellow A
122°	hip/femoral angle	White
135°	Lumbar angle	Yellow B
142°	cervical lordosis angle	Green
112°	Elbows angle	purple

BORG, VAS, Seat and Reach Test



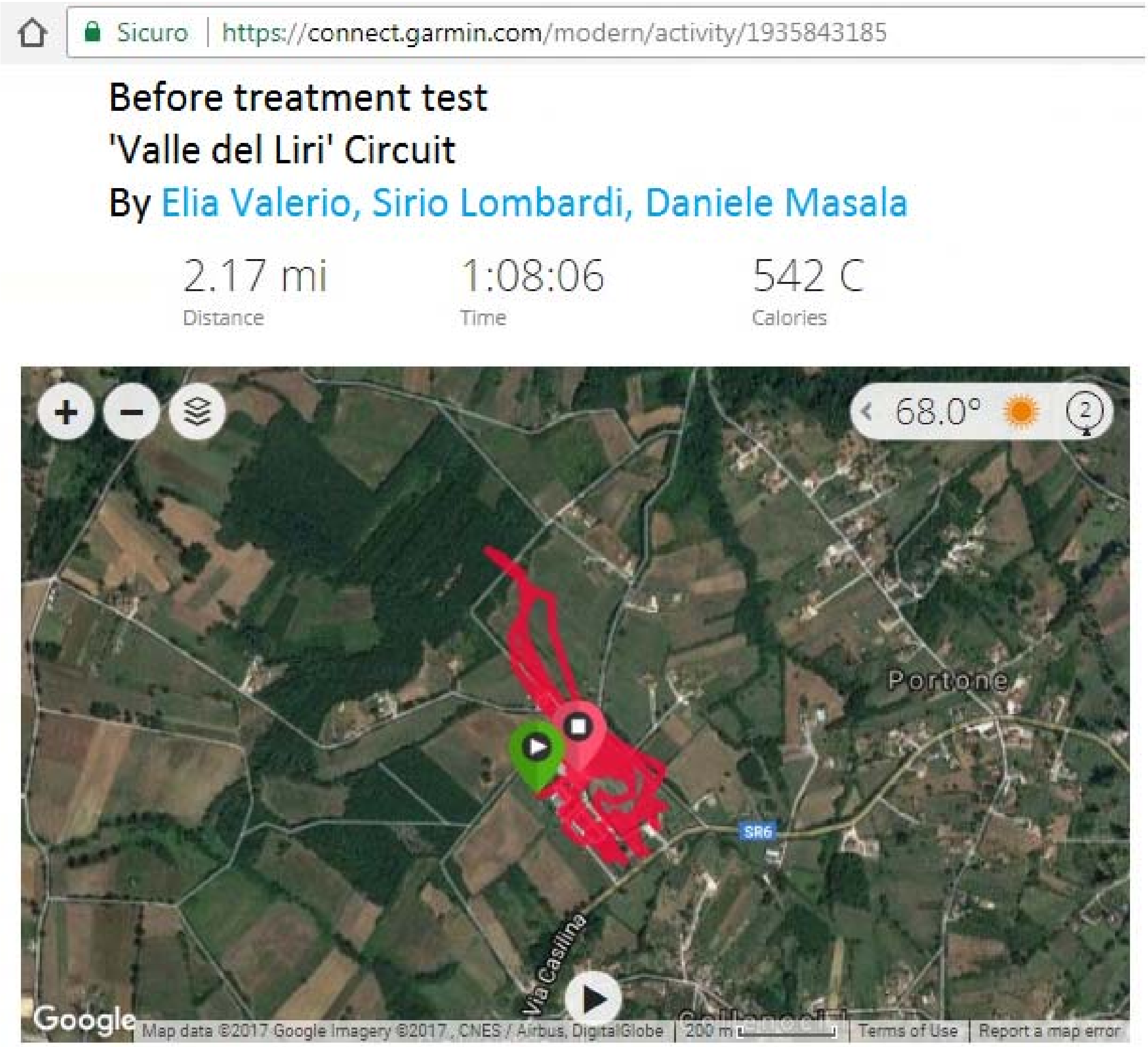
Before treatment – photo 1

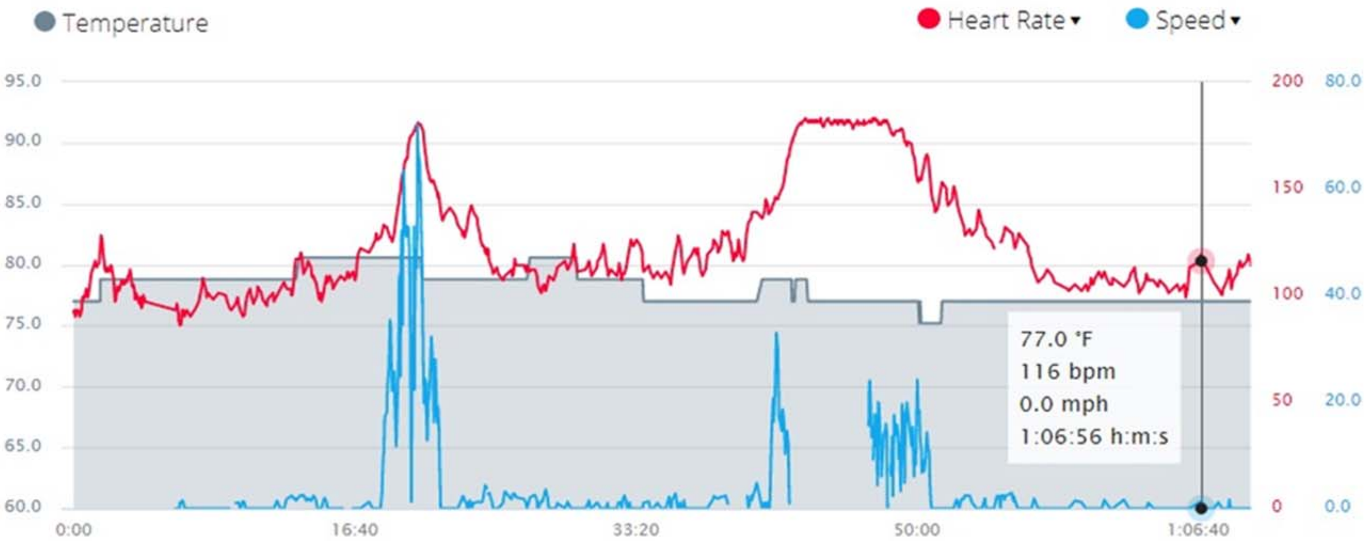


Pre-treatment angles

ANGLES WIDTH	REPERE	Colour
97°	foot angle	Blue
137°	Femoral angle	Yellow A
122°	hip/femoral angle	White
135°	Lumbar angle	Yellow B
142°	cervical lordosis angle	Green
112°	Elbows angle	purple

Before treatment – Human Telemetry files





Technical impression #2

After evaluation and before treatment, a list of specific impairments of body structure/function was including limited shoulder and lumbar range of motion, limited flexibility. Furthermore, evaluation of these specific impairments made it possible to hypothesize underlying contributors and potential causes of these impairments, similar to diagnosing an underlying proper fit condition. As shoulder and hand motion did not provoke his symptoms, no tenderness was present with segmental mobility assessment of the upper limbs. Seat and Reach Test did not reproduced his primary symptoms, it was reasoned that his symptoms were being generated from non correct proper fitting of the go-kart racing position, as opposed to possible lumbar or sacroiliac dysfunction. Additionally, he did not demonstrated deficits with back stretching endurance and corrective balance strategies at the sacrum.

Symptoms were provoked during dynamic driving, and it underlies little limitations of lumbar spine motion during driving without proper drive-position fitting. And, he demonstrated also a functional back flexibility. Thus, it was hypothesized that his symptoms were likely a result of muscular control abnormality about the back and neck region. Driving gait was assessed taking photo from video recorded on the track, therefore, and it seemed to have altered driving biomechanics prior to treatment. However, the above findings supported the initial hypothesis of muscular control dysfunction that appeared in low back pain, and treatment was initiated to address those impairments identified during his evaluation.

Intervention

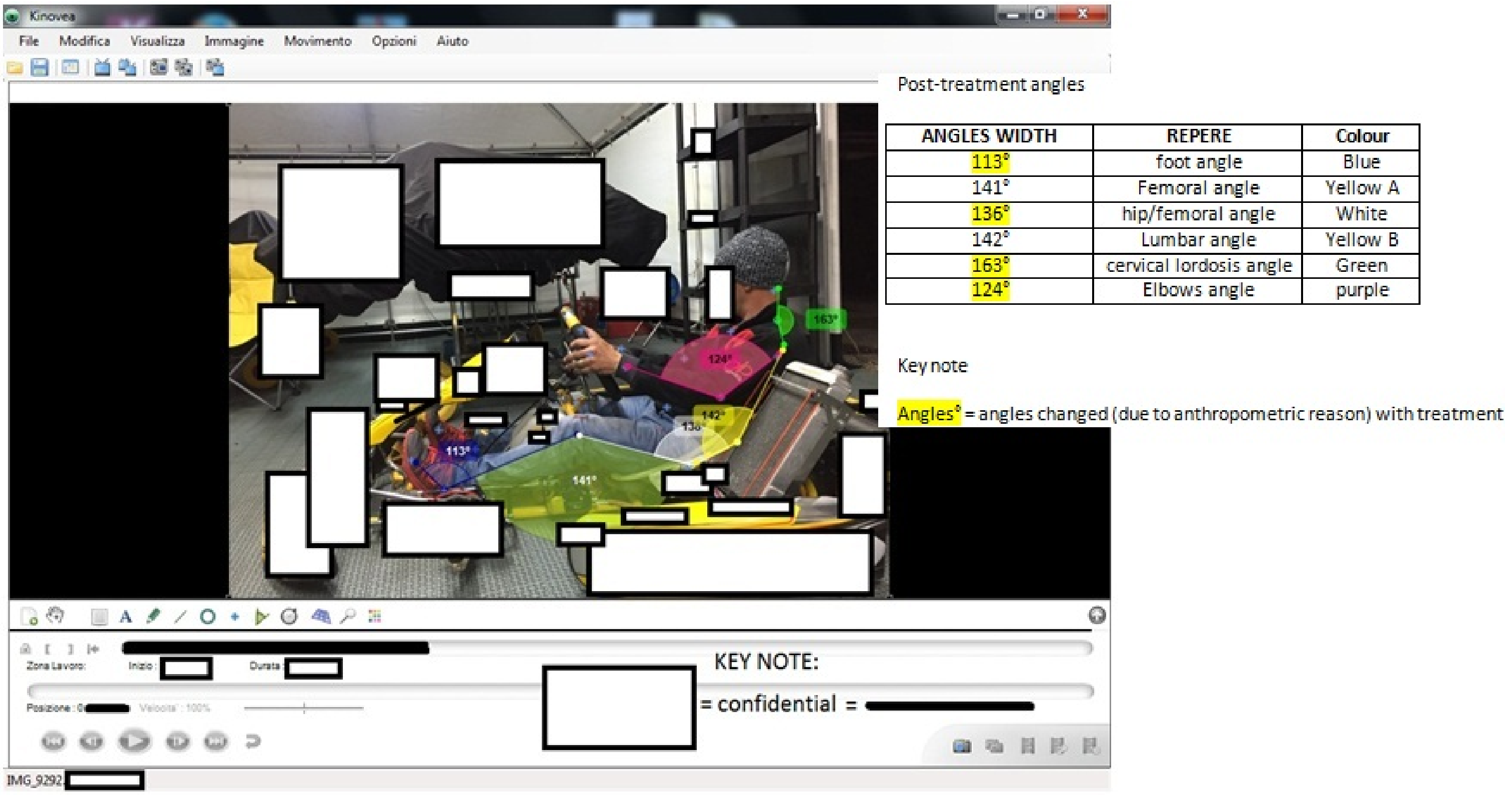
The subject's primary activity limitation was with the task of driving, which threatened his primary goal of participation with an upcoming weekend of race. The treatment plan was organized to allow him, to continue with the activity of driving and permit gradual progression towards her ultimate participation goal. Fitting biomechanics prescription, was aimed at addressing his primary impairments of body structure/function, namely reduced low back pain, neck pain and forearms tingling. His racing position, consisted of photographing of static driving evaluation and racing image-evaluation, calculate performing range of motion, reproducing and adapting it to anthropometrical measure of the driver, tuning and changing of his race position with new evaluated performing position and put the driver in a position that is supposed to minimize the influence of the low back pain, and also to improve functional muscle work. Small side-lying hip abduction, address the reported increased fatigue during go-kart turning with the steering wheel: usually, the driver is asked to use the inner side of the seat to improve the projection of the mass center base of the go-kart on the tires and enhance more grip. As he reported aggravation of his symptoms with exacerbating the distance as the range of motion from the core, he was instructed to limit his driving to no more than seven laps after the intervention, and to make a strong report about his feelings during the drive session. He was also instructed to monitor his symptoms, and if he was going to have symptoms when driving, to communicate by radio, at what lap he began to notice them.

Post-treatment angles

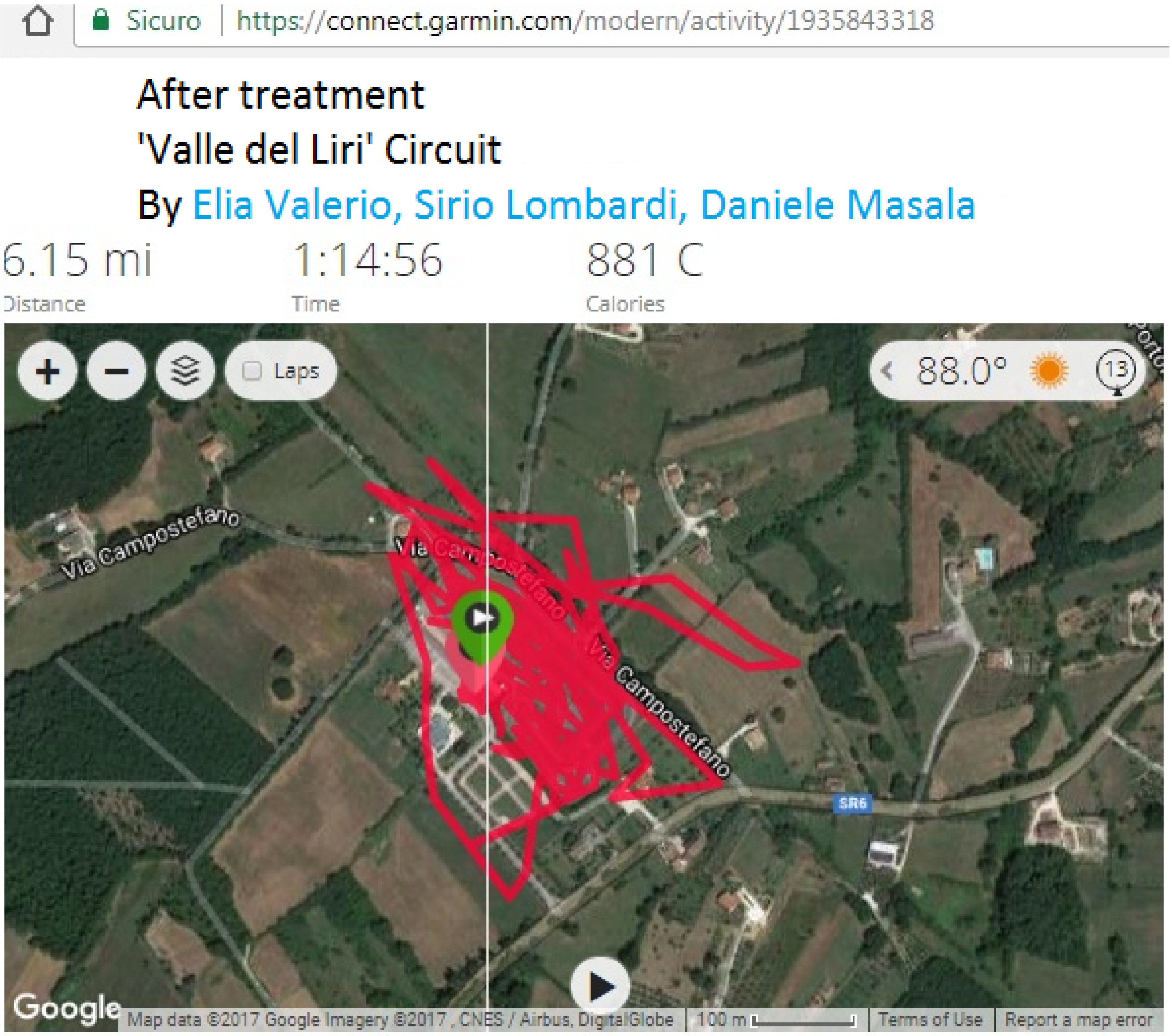
ANGLES WIDTH	REPERE	Colour
113°	foot angle	Blue
141°	Femoral angle	Yellow A
136°	hip/femoral angle	White
142°	lumbar angle	Yellow B
163°	cervical lordosis angle	Green
124°	Elbows angle	purple

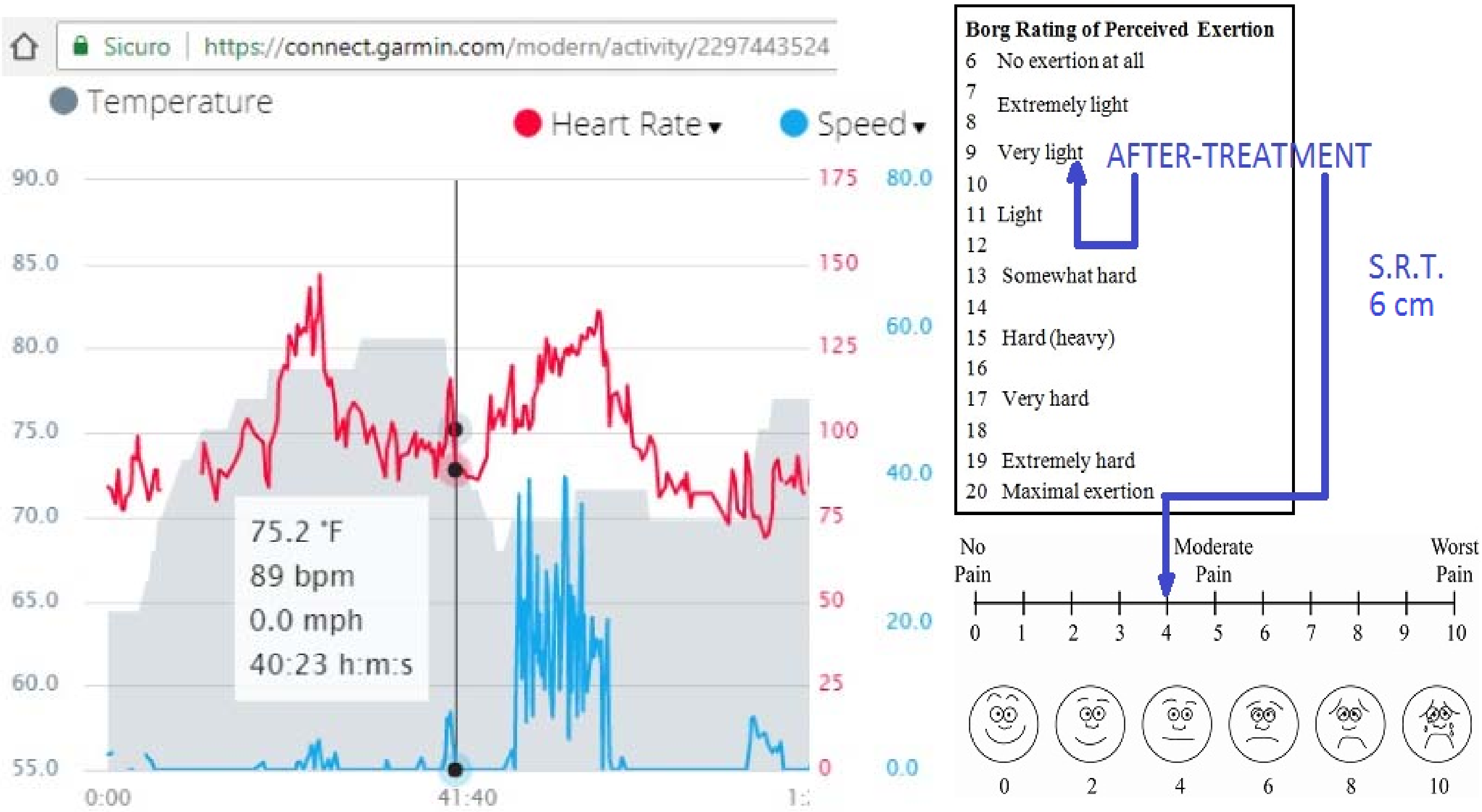
Key not Angles° = angles changed (due to anthropometric reason) with treatment

After treatment – photo 2



After treatment – Human Telemetry files




Sicuro
https://connect.garmin.com/modern/activity/2297443524
Temperature
Heart Rate
Speed
90.0
85.0
80.0
75.0
70.0
65.0
60.0
55.0
175
150
125
100
75
50
25
0
80.0
60.0
40.0
20.0
0.0
75.2 °F
89 bpm
0.0 mph
40:23 h:m:s
0:00
41:40
Borg Rating of Perceived Exertion
6 No exertion at all
7
Extremely light
8
9 Very light
10
11 Light
12
13 Somewhat hard
14
15 Hard (heavy)
16
17 Very hard
18
19 Extremely hard
20 Maximal exertion
AFTER-TREATMENT
S.R.T.
6 cm
No Pain
Moderate Pain
Worst Pain
0 1 2 3 4 5 6 7 8 9 10
0 2 4 6 8 10

Evaluation #2

He reported having had to cease driving, as his symptoms were aggravated by this activity. He noted that, over the prior 10 days of no training driving, he had less discomfort in the buttock zone and could tolerate sitting for longer times, with fewer symptoms into his low back and neck. Given the increase in his symptoms with continued efforts at driving, he was instructed to refrain from driving for the following week without racing replacement. Specific instructions including slow and controlled motion during eccentric movement of braking, were given in an attempt to facilitate carry over from static driving to more dynamic exercises.

During the week, he noted having attempted a long working drive with a truck, which resulted in an acute increase in his symptoms resulting in a return of posterior back discomfort and increased buttock pain. Given the increase in his symptoms, measurable range of motion's loss, dry needling was incorporated into his treatment regimen. It was reasoned that the increase in muscular tenderness may be the result of acute change in activity resulting in an applied load, which exceeded the muscular capacity to complete the driving tasks he attempted. This novel load may have contributed to the progression of latent trigger points to active trigger points causing an increase in pain in the hip and referral to the posterior thigh. Only biomechanics factor have been treated to help differentiate potential sources of his current pain. This resulted in a within training-drive session toleration of different degrees in different body segments, for passive trunk flexion and steering wheel rotation, respectively. He was instructed to continue with his training program. One week later, he noted much improvement in his resting symptoms and tolerance to prolonged symptoms, and absence of posterior back discomfort. He rated the treatment as 9/20 with a BORG scale, 4/10 the VAS scale and achieving 6 cm at Seat and Reach Test. However, some continued discomfort at the buttock as well as sacral region was present. As his symptoms appeared to be improving from a combination of rest and the biomechanical treatment, progression toward returning to a race-training program was made.

Outcomes

The primary outcome utilized for this study was his ability to participate in and complete a scheduled race weekend. This race weekend, was consisting of: travelling to race circuit on Thursday, race free practice 1, 2, 3 and 4 on Friday, qualification practice and qualification manche 1 & 2 on Saturday, and race 1 and 2 on Sunday. At his final follow-up evaluation, he reported having completed the full race weekend in second overall position. He was able to drive the entire laps distance (17 laps) without any noticeable types of pain. He noted overall status as 90% at three weeks following the race weekend after some increased soreness and feelings of tightness following the race. He felt that his symptoms were improving with his training program and were not limiting himself. Impairment goniometric visual measures of elbow range of motion, were all stable **(photo 2**) and considered to be acceptable measures to track clinical change. Although a categorization scheme was not utilized in this study to assess change in functional movements, the qualitative measures were improved. This in combination with his reduction in symptoms suggests a change in these motions occurred although this cannot be stated as the psychometric properties of these measurements have not been determined.

Discussion

The etiology of low back pain is multi-factorial and requires different figures to take a holistic and comprehensive approach to subject management to facilitate evaluation as well as treatment planning. Further consideration, should be given to any underlying health conditions as well as primary impairments to make hypotheses regarding the source of a subject's symptoms in order to curtail treatment selection and to allow complete symptoms improvement. Without inference into the underlying cause of a subject's pain, recurrent issues may develop. Thus, the primary aim of this case report, was to highlight the physical reasoning process in establishing a hypothesis of low back pain in an experienced driver. The approach to this case began with considering the subject's primary activity limitations and participation restrictions. By determining his primary limitations as occurring with the task of driving resulting in reduced participation with training laps driving and possibly prohibiting him from participating with a scheduled race weekend, mutual goals were established and treatment was curtailed towards improving his ability to complete these activities. From determination and description of his primary limitations, the subjective history focused on discerning salient external factors that may have impacted his plan of competition. It was upon consideration of the multiple reports of pain related to the lower back, in an experienced driver.

With subsequent questioning, additional components of the subject's history were also consistent with body pain, including the insidious onset, the location of symptoms. To test the hypothesis of these muscular symptoms being the result of neuromuscular control dysfunction, examination and evaluation of impairments of body structure and function were completed with findings supporting this hypothesis. Given the subjects continued participation with driving and high level of reported function, examinations began with 2-D (bi-dimensional) video-assessment of driving motion. He demonstrated some limitations in multi-segmental motions in both the sagittal and transverse planes (extended seating backward flexion and extension and asymmetrical legs rotation above 30 degrees). These limitations, supported the primary hypothesis of erroneous vehicle fitting. Further, the low back pain as neck pain symptoms with multi-segmental flexion and extension, were findings which would not be expected if his symptoms were lumbar at all, without any pre-treatment correlation with driving position. The motion limitations, were present bilaterally and asymmetrically. Further, he probably had tiredness in muscles which either were linked to low back pain. The limitations in range of motion and flexibility of back muscles, may have change the biomechanics of the race-driving tasks subject related. With these limitations, the underlying cause behind these motion deficits was likely not due to an increase in muscular tone in the presence of pain on the involved back's joints. Thus, it was reasoned that these motion's limitations, were due to a not known biomechanics, which supported the primary hypothesis. Treatment addressing vehicle fitting, with specific anthropometric related interventions were done. Dynamic muscular and skeletal components were the main goal, but the tailoring of anthropometric related measures of the vehicle has been the difficult part of this case report. Heart rate as internal suit temperature, were supposed parameters not directly related to discomfort and back pain, so they were just used for initial monitoring. The motion angles have been decided looking to the movement done by drivers during race driving, without referring to a scientific background, due to a lack of knowledge. The above mentioned angles, are angles related to performing muscular characteristics of the body segments involved in driving and their sine-cosine calculation starting from the external measure of skeletal segments. Example the motion angle of leg extension, was between 120° and 135°, with regards to vehicle characteristics and progressed upon driver's fitting characteristics. This was then progressed to a reverse lunge of brake pedal and throttle pedal, requiring him to maintain single leg effort on both the pedals.

This progression was selected also to attempt to mimic aspects of his primary activity problem (driving with pain). After several weeks of incremental training upon the new fitting measures, and allowing the gradual reduction as ending of his symptoms. This seems to have been the case as he was able to progress without pain onset. As symptoms resolved it was deemed appropriate to examine his static driving. The static driving examination was allowed by software of videoanalysis about video taken from the side of him in his box. This revealed an interesting aspect of his clinical, with his driving analysis showed no adverse motions as absence of visible movement faults. The video was taken on the entry of corner 4. By this case report, authors suggests that muscle activity is used to ensure that skeletal motion remains on a certain path while the degree of that movement can vary between individuals and depending on the demanding conditions of the task. The example of demanding conditions, consist in differences between qualifying lap demands and race lap demands, where managing the tires can modulate the demanding conditions of the driving task, as muscle activity can vary to maintain this path the control strategy being utilized by an individual may still be "altered", but the observed kinematics may look normal or similar. It is hypothesized that this was occurring in the above case report. As the subject demonstrated multiple control deficits with lower level tasks including training race laps, it was reasoned that it was likely that similar deficits with control would be present during race driving. However, the video analysis utilized was about taking a slow-motion video and stop it for a screenshot of a high video quality frame, where it was possible to make measurements. This method, could show no overt qualitative faults, and is a future proposal, to improve also this method and not mention this inside the case report limitations. Nevertheless, it was hypothesized that driver can develop a control strategy utilizing alternative muscle combinations. Specifically, if he was reporting symptoms of reduced muscular endurance, is possible to assume that he may also develop a strategy where he utilizes increased certain muscle effort to control motion of other muscles, leading to overuse and pain in the first assumed muscle. Or, the increased utilization of the first assumed muscle, may allows him to reduce the load to other muscles and could partially explain a reduced endurance of the others muscles; this reduced endurance may predispose drivers to irritation of certain muscles as he attempted to increase his laps experience. Whether the pain generated is not sure to be coming from muscles or no vehicle fitting, some combination of them is not known with certainty, but an altered muscular recruitment strategy (as outlined above) could explain pain to any of them. To treat this, in this case report a one-fold approach was taken in order to analyze better one external factor (unfitting vehicle) that is able to modify all the biomechanics of the driver and reduce the pain: his vehicle fitting. The vehicle fitting, was done upon his anthropometrical measure, and mathematical calculation concerning sine and cosine. No specific formula are provided to the case report, in order to a confidential agreement. Utilization of growing volume of training laps, was then done to accelerate the building of his driving volume in preparation for his upcoming race weekend. The growing lap volume, was done to allow physiological adaptation and gives back the idea that dose/response lap, has not been monitored in this case report and it can be another point of view to analyze in the future. The subject was able to progress through the race weekend, achieving a 2nd overall place at the KZ3over 'Italian Cup' at the 'Viterbo International Circuit' without provocation of pain symptoms, achieving the main goal of participating in a complete race weekend.

Limitations

It is important to note that the primary hypothesis of low back pain was not diagnostically confirmed (currently there is not a back pain specific battery of exams), but was rather a conclusion based on interpretation of driver available symptoms examination on his movement quality and its potential impact on the motorsport science, during the task of race driving. And, core muscle function was not assessed and thus we are not able to determine what contribution these muscles may have had on the subject's presentation. Inherent to case report methodology and the fact that no control was used for comparison, it is not possible to state if any of these interventions were the cause of his improvements, but the back pain ending is assumed to be done with vehicle fitting. Further, it cannot be stated with certainty which component of the intervention plan led to his improved status. This case report only serves to present and highlight the reasoning process employed to arrive at the treatment strategy utilized in the motorsport science. Finally, it cannot be stated if the intervention actually resulted in a changed muscular strategy during driving or assessment of functional motion.

However, improved quality of driving motion was observed upon re-evaluation. This implies that improved movement control was present. Further study using musculoskeletal modeling techniques investigating estimates of muscle force production and EMG analysis would be required to elucidate what types of muscular activation and force strategies occurred resulting in the changed quality of motion.

Conclusion

Discomfort related to non-anthropometrical go-kart driving, has resulted to be controlled. The diagnosis and treatment of race-related Low Back Pain, remains a challenge also for clinicians. This case report highlights how features of the examination may assist in diagnosing the absence of vehicle fitting inside racing team, as vehicle fitting methods in the literacy. In the future of motorsport, it is assumed to be a relevant feature of the sport science, it confirm the biomechanics technician as a role inside race management and racing safety. Drivers, often are just putted inside the racing vehicle without any reference methods, and the outcomes of no vehicle perception as the LBP, are supposed to be non proper fitting related.

The authors declare no conflicts of interest.

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