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Investigation of Acute Effects of Thoracic Manipulation on Trunk Flexion and Balance in Athletes

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Research Article
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Abstract

The aim of this study is to examine the acute effects of thoracic manipulation on trunk flexion and balance characteristics in athletes. 60 male team athletes with a mean age of 22.60±0.32 years participated in the study voluntarily. Trunk flexion values and balance levels of all participants were determined before manipulation. After the measurements, the participants were randomly divided into two groups as the thoracic manipulation group (TMG) and the placebo manipulation group (PMG). Then, as a single session, thoracic manipulation was applied to the TMG group and placebo thoracic manipulation was applied to the PMG group. The trunk flexions and balance levels of each participant were remeasured after the application, and the differences before and after the application were examined. Since the data analyzed via SPSS 25.0 package program showed normal distribution, paired-t test was used to evaluate the pre-application and post-application results. The results were analyzed at the $p<0.05$ significance level. In the results of the study, it was determined that there was a significant improvement in the standard deviation of forward and backward sway (FBSD), medial-lateral sway (MLSD) and used perimeter (P) parameters in post-application static balance. A significant improvement in the mean balance error monitoring (ATE) parameter in the post-application dynamic balance was also determined. An increase in trunk flexion values was observed in the TMG group after the application. As a result, it is concluded that high-velocity, low-amplitude (HVLA) thoracic manipulation application provides instant positive contributions to trunk mobility and balance feature in athletes.
Keywords: Thoracic manipulation, Trunk flexion, Balance, Acute effect

Sporcularda Torakal Manipülasyonun Gövde Fleksiyonu ve Dengeye Akut Etkilerinin İncelenmesi

Öz

Bu araştırmanın amacı, torakal manipülasyon uygulamasının sporcularda gövde fleksiyonu ve denge özelliklerine olan akut etkilerinin incelenmesidir. Araştırmaya yaş ortalamaları 22,60±0,2 yıl olan 60 erkek takım sporcusu gönüllü olarak katılmıştır. Tüm katılımcıların manipulasyon öncesi gövde fleksiyon değerleri ve denge düzeyleri belirlenmiştir. Ölçümler sonrası katılımcılar randomize şekilde, torakal manipülasyon uygulanan grup (TMG) ve plasebo manipülasyon uygulanan grup (PMG) olarak iki gruba ayrılmıştır Daha sonra tek seans olarak, TMG grubuna torakal manipülasyon, PMG grubuna ise plasebo torakal manipülasyon uygulaması yapılmıştır. Her katılımcının uygulama sonrası gövde fleksiyonları ve denge düzeyleri yeniden ölçülmüş, uygulama öncesi ve sonrası farklılıklar incelenmiştir. SPSS 25.0 paket program aracılığıyla, verilerin normalliği sınanmış, veriler normal dağılım gösterdiğinden uygulama öncesi ve sonrası sonuçların değerlendirilmesinde paired-t testi kullanılmıştır. Sonuçlar $p<0.05$ anlamlılık düzeyinde analiz edilmiştir. Araştırmanın sonuçlarında, uygulama sonrası statik dengede, ileri ve geri salınımın standart sapması (FBSD), medial-lateral salınımın standart sapması (MLSD) ve kullanılan çevre (P) parametrelerinde, dinamik dengede de ortalama denge hatası izleme (ATE) parametresinde anlamlı iyileşme olduğu tespit edilmiştir. Gövde fleksiyon değerlerinde ise, TMG grubunda uygulama sonrasında artış olduğu görülmüştür. Sonuç olarak, sporcularda yüksek hızlı, düşük amplitüdlü (HVLA) torakal manipülasyon uygulamasının gövde mobilitesine ve denge özelliğine anlık olumlu katkılar sunduğu kanaatine varılmaktadır.
Anahtar kelimeler: Torakal manipülasyon, Gövde fleksiyonu, Denge, Akut etki

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INTRODUCTION

The thoracic spine is the largest part of the spinal complex. It consists of 12 vertebrae, intervertebral discs and ligaments. It also has a ventral curve that begins in utero and develops throughout life. The thoracic spine, which connects the cervical and lumbar spinal segments, needs sufficient flexibility and high stability while providing optimum force transmission from the upper body to the lower spine segments and performing three-dimensional movements. The intersegmental stability of the cervical and lumbar spine is mainly determined by the adjacent muscles, while the thoracic spinal segments are mostly stabilized by the additional bony and ligamentous structures of the rib cage due to their articulation with the rib cage. These joints lead to regional differences in movement patterns and function. For these reasons, the thoracic spine has a more rigid anatomical structure compared to the cervical and lumbar regions (El-Khoury and Whitten, 1993; Liebsch and Wilke, 2018; Oda et al., 1996; Takeuchi et al., 1999; Willems et al., 1996).

Structural changes and deteriorations in this rigid anatomical structure of the thoracic spine negatively affect the individuals' life quality. Various methods are used by experts to eliminate these negative effects. Mostly, manual therapy applications are at the forefront of these methods (Atchison et al., 2021; Cho et al., 2017; Honoré et al., 2018).

Manipulation of the thoracic spine is defined as skillful passive movements applied to the thoracic region, joints and related soft tissue at varying speeds and widths, including small amplitude and high-speed therapeutic movements. Thoracic manipulation is a therapeutic intervention applied by a number of professional groups, primarily physiotherapists (Adams and Sim, 1998; Walser et al., 2009). It is seen that the application is frequently used in the normalization of the messages coming from the somatosensory system and in the elimination of pain cases, loss of mobility in the thoracic spine and the resulting postural disorders (Harrison et al., 1999; Huisman et al., 2013; Romero et al., 2022).

From the point of view of sportive performance, balance is the process of keeping the body's center of gravity vertical and it is known that it plays an important role in the successful performance of many skills (Hrysomallis, 2011; Wong et al., 2019). In addition, the positive effects of the increase in trunk flexibility on motor performance are emphasized by the researchers (Myrick et al., 2019). Considering the changes caused by thoracic manipulation on the thoracic segments, the assumption that eliminating the deteriorations in neural physiology as well as providing optimum mobility in the thoracic spine may have an impact on postural control and trunk flexibility has been the subject of this research.

In the literature review, it is seen that the number of studies in which thoracic manipulation is used among the methods to increase motor performance elements in athletes is quite limited. For these reasons, the aim of this study is to examine the acute effects of HVLA thoracic manipulation applications on trunk flexion and balance characteristics in athletes.

METHOD

Research Model

The study was designed as a randomized controlled trial. During the current research, it has been acted within the framework of the higher education institutions scientific research and publication ethics directive.

Participants

The G-power 3.1 program was used to determine the sample size of the study. According to the power analysis made, it was seen that a total of 60 participants, 30 in the experimental group and 30 in the control group, were sufficient for this study at 95% power and 0.05 significance level (Cohen, 1992). 60 male team athletes, including 22 football players, 17 basketball players, 12 volleyball players, 9 handball players, who were students of the Faculty of Sports Sciences of Giresun University, with an average age of 22.60±0.32 years, participated in the research voluntarily. The research was carried out in Giresun University Faculty of Sport Sciences Performance Laboratory.

Inclusion criteria for the study were determined as being male, being an active competitor in team sports for the last five years, being between the ages of 19-28 and having a body mass index of 18.5-29.9. Participants who met these criteria were included in the study. Those with cardiopulmonary diseases, those with a history of trauma in the spinal column, those with sensitivity such as pain and swelling in the thoracic region, those who are too thin or overweight according to their body mass index were not included in the study.

Ethical Approval

Ethical permission of the research was approved by Giresun University Social Sciences, Science and Engineering Research Ethics Committee's decision dated 11.01.2023 and numbered 01/07 and was carried out in accordance with the Declaration of Helsinki.

Procedure and Data Collection Tools

After a 15-minute standard warm-up protocol, trunk flexion and balance levels of all participants were measured. After the measurements, the participants were randomly divided into two groups as the thoracic manipulation group (TMG) and the placebo manipulation group (PMG). Online randomization software (www.randomizer.org) was used to determine the groups.

Then thoracic manipulation was applied to the TMG group and placebo thoracic manipulation was applied to the PMG group in a single session. The trunk flexions and balance levels of each participant were re-measured after the application. The trunk flexions and balance levels of each participant were remeasured after the application, and the differences before and after the application were examined. All measurements and applications were conducted by the same researcher.

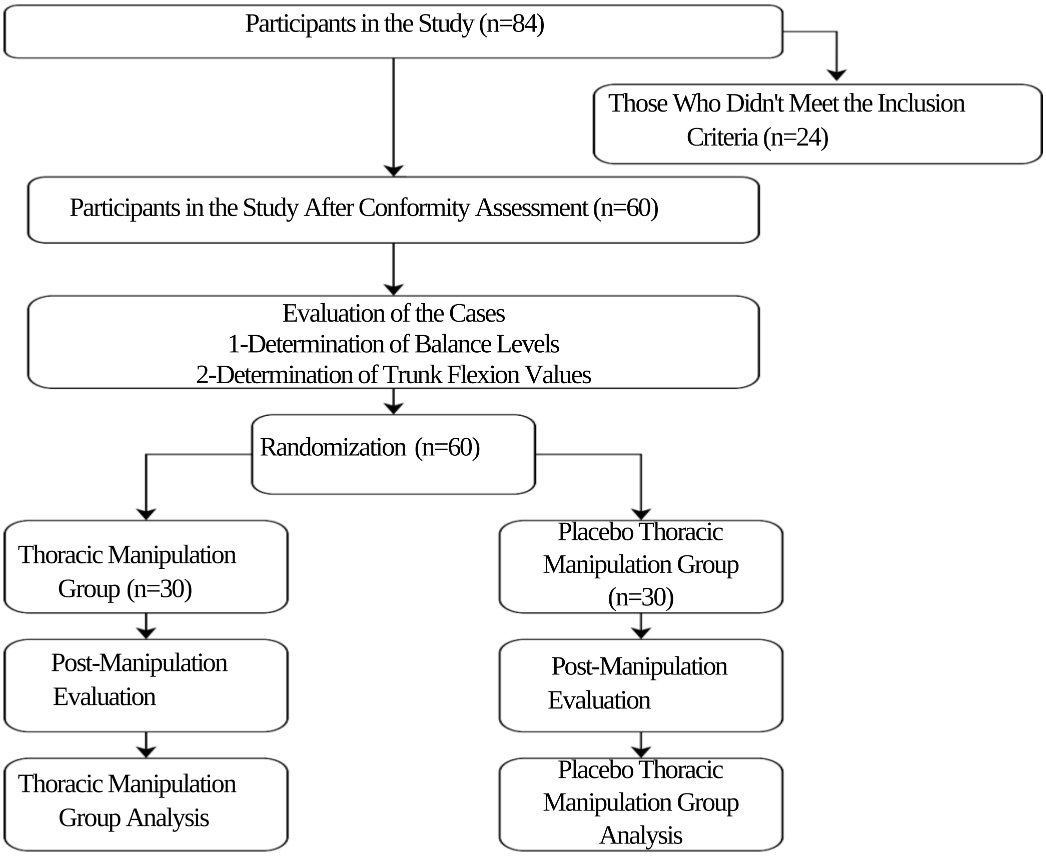

Figure 1: Study flow chart

Trunk Flexion Measurement: The sit and reach test was used to determine trunk flexion (Duray et al., 2018). For the sit and reach test, the participants were placed in a long sitting position with their legs stretched on the floor. The participants were asked to place the soles of their feet on the wall of the sit and reach board and lean forward with both hands overlapping on the board without bending their legs. The scores were recorded in cm by keeping the participants holding their hands at the furthest point they can reach for two seconds.

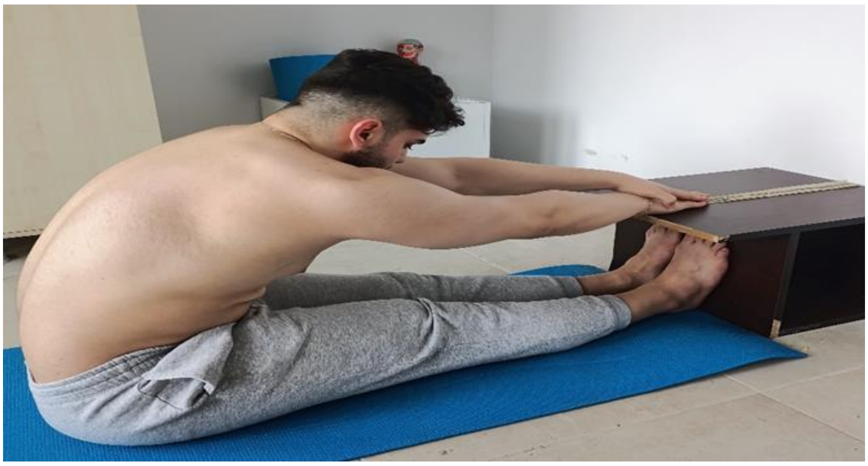

Figure 2. Trunk Flexion Measurement

Determination of Balance Levels: CSMI TecnoBody PK-252 isokinetic balance system measuring device was used to determine the balance levels of the participants. Balance measurements were made statically and dynamically. In this system, it is interpreted as an improvement in balance levels as the balance scores approach zero (0), and a worsening in the balance levels as they move away from zero (Sözen & Akyıldız, 2019).

Figure 3. Balance Measurement System area

Static Balance Measurement: In the static balance measurement, the device was first calibrated and the system was introduced to the volunteers. The "Static Stability Assessment" module of the device was selected, and the volunteers' feet were placed on the platform with reference to the x and y lines on the platform. In the measuring position, the hands were drooping and the feet were bare. Measurements were made for 30 seconds with bipedal and eyes open. The results were evaluated in 8 parameters.

Static Balance Parameters: The pressure applied to the average central X-point is denoted by COPX, while the pressure directed to the average central Y-axis is represented by COPY. FBSD indicates the standard deviation of forward and backward sway, and MLSD signifies the standard deviation of medial-lateral sway. AFBS refers to the average forward-backward speed, and AMLS represents the average medial-lateral speed. P denotes the used perimeter, and A corresponds to the used area.

Dynamic Balance Measurement: The multiaxial proprioceptive assessment module of the isokinetic measurement system was used to determine the dynamic balance levels. First, the device was calibrated and the system was introduced to the volunteers. The volunteers' feet were placed on the platform with reference to the x and y lines on the platform. In the measuring position, the hands were drooping and the feet were bare. Measurements were made in bipedal and 10 difficulty levels for 60 seconds. The test was stopped and restarted when situations such as falling or touching any part of the device occurred during the measurement. The results were evaluated in 3 parameters.

Dynamic Balance Parameters: Average track error is denoted by ATE, while average force variance is represented by AFV, and SI indicates stability index.

Thoracic Manipulation Application: Volunteers in the thoracic manipulation group were administered chiropractic high velocity low amplitude (HVLA) on the treatment table in the prone position, and the maneuver was completed with effective force transfer. Effective force transfer at the end of the application was determined according to the clinical judgment of the physiotherapist. On the other hand, the placebo thoracic manipulation group received manipulative application at a lower speed and without effective force transfer. The applications were made by a specialist physiotherapist.

Figure 4. Thoracic Manipulation Application

Data Analysis

Shapiro-wilk normality test was applied to the data via SPSS 25.0 package program to test the normality. Since the data showed normal distribution, paired-t test was used to evaluate the results before and after manipulation within each group. The results were analyzed at the $p<0.05$ significance level.

RESULTS

Table 1. Differences in static balance levels pre and post manipulation

		Pre-M X̄ ±SD	Post-M X̄ ±SD	P Value
COPX	TMG	0.53±1.04	0.23±0.68	0.130
	PMG	0.63±0.89	0.40±0.93	0.243
COPY	TMG	0.13±1.38	-0.13±1.01	0.368
	PMG	-0.47±1.22	-0.40±1.07	0.813
FBSD	TMG	5.30±2.41	4.27±2.00	0.039*
	PMG	4.80±2.06	4.50±1.81	0.467
MLSD	TMG	3.00±0.95	2.47±0.82	0.027*
	PMG	2.57±0.94	2.43±0.82	0.514
AFBS	TMG	10.67±4.01	10.33±3.14	0.559
	PMG	10.37±2.77	9.80±3.28	0.362
AMLS	TMG	8.67±3.22	8.30±2.85	0.356
	PMG	7.80±2.22	8.10±2.81	0.576
P	TMG	267.77±144.36	205.97±143.44	0.045*
	PMG	208.70±107.40	202.60±127.21	0.820
A	TMG	460.37±140.98	426.57±117.23	0.140
	PMG	437.70±96.29	428.70±122.38	0.711

COPX:Pressure to the average central x point, COPY:Pressure to the average central y axis, FBSD:Standard deviation of forward and backward sway, MLSD:Standard deviation of medial-lateral sway, AFBS:Average forward backward speed, AMLS:Average medial lateral speed, P:Used perimeter, A:Used area, TMG:Thoracic manipulation group, PMG: Placebo manipulation group, Pre-M: Pre-manipulation, Post-M: Post-manipulation, SD: Standard deviation, Paired t test, *p < 0,05. The bold p value shows a statistically significant result.

When the acute effects of manipulation on static balance levels were examined, it was observed that there was a statistically significant improvement between the values before and after the application in FBSD, MLSD and P parameters in the thoracic manipulation group (p<.05) while no significant difference was observed in other parameters. There was no difference in any parameter in the placebo manipulation group (Table 1).

Table 2. Differences in dynamic balance levels pre and post manipulation

		Pre-M X̄ ±SD	Post-M X̄ ±SD	P Value
ATE	TMG	83.77 ±35.43	68.87 ±26.55	0.001*
	PMG	82.27 ±31.71	84.33 ±33.96	0.311
AFV	TMG	1.04 ±0.81	1.13 ±0.94	0.633
	PMG	1.36 ±0.72	1.26 ±1.20	0.590
SI	TMG	2.23 ±1.00	1.95 ±0.75	0.052
	PMG	2.24 ±0.92	2.08 ±1.06	0.248

ATE:Average tracking error, AFV:Average force variance, SI:Stability index, TMG:Thoracic manipulation group, PMG:Placebo manipulation group, Pre-M:Pre-manipulation, Post-M:Post-manipulation, SD:Standard deviation, Paired t test, *p < 0.05. The bold p value shows a statistically significant result.

When the acute effects of manipulation on dynamic balance levels were examined, it was observed that there was a statistically significant improvement between the values of ATE parameter before and after the application in the thoracic manipulation group (p<.05), while no significant difference was observed in other parameters. There was no difference in any parameter in the placebo manipulation group (Table 2).

Table 3. Differences in trunk flexion values pre and post manipulation (cm)

	Pre-M **X̄±SD**	**Post-M** **X̄±SD**	**P Value**
TMG	19.98±11.14	22.97±10.61	0.000*
PMG	19.30±9.51	19.77±9.57	0.060

TMG:Thoracic manipulation group, PMG:Placebo manipulation group, Pre-M:Pre-manipulation, Post-M:Post-manipulation,SD:Standard deviation, Paired t test, *p < 0.05. The bold p value shows a statistically significant result.

When the acute effects of thoracic manipulation on trunk flexion values were examined, it was observed that there was a statistically significant improvement between the values before and after the application in the thoracic manipulation group (p<.05). No difference was found in the placebo manipulation group (Table 3).

DISCUSSION AND CONCLUSIONS

Reports on the effects of the HVLA (High-Velocity Low-Amplitude) method on asymptomatic individuals, especially on physical performance, contain different results and are limited in number. No comprehensive research has been found on the immediate effects of spinal manipulations on balance characteristics in athletes. This limitation reveals the originality of the research. When previous research was examined, a systematic review by Corso et al., (2019) reviewed the best studies investigating the effects of spinal manipulations on performance in healthy adults. In the results of this review, they stated that more, high-quality and performance-specific studies are needed to be able to interpret that spinal manipulation practices have performance-enhancing effects in general. Cardinale et al. (2015) emphasized in their research that there is a need for experimental evidence for the use of spinal manipulation to improve range of motion and motor control in asymptomatic individuals.

In line with this information and recommendations, the acute effects of thoracic manipulation on trunk flexion and static and dynamic balance levels in athletes were investigated in this study. In the results of the study, it was determined that there was a significant improvement in FBSD, MLSD and P parameters in static balance and in ATE parameter in dynamic balance after the application in the thoracic manipulation group (p<.05). In the placebo manipulation group, there was no significant change in any of the parameters before and after the application. It is stated that impairment in any part of the spinal segment reduces postural control (Michaelson et al., 2003). Manipulation applications to the vertebral column are reported to increase spinal stabilization by reducing the loss of normal displacement ability as a result of physiological loads (Cuesta-Vargas et al., 2011; Dvorak et al., 2011). The vertebral column is a kinetic chain in which movement in one joint is affected by other joints. Within this chain, neural signals from joints, muscles and tendons provide spinal stability (Donatelli et al., 2012; Panjabi, 1992; Vezina and Hubley-Kozey, 2000). Spinal Stabilization is a neuro-mechanical process that requires the analysis of sensorimotor signals to control body movements and maintain the desired position. This process involves coordinated movements of muscles and joints in multiple planes. It is emphasized by the researchers that the stability of the spine is the basic requirement to protect the nerve structures and prevent the early mechanical deterioration of the spinal components (Izzo et al., 2013; Reeves et al., 2007). It has been reported that minimizing the distortions on the spine and increasing spinal stabilization improves balance and athletic performance in athletes and sedentary people (Deutschmann et al., 2015; Espí-López et al., 2018; Okubo et al., 2010; Van Middelkoop, 2014). In the relevant literature, it is stated by researchers that manipulative applications to the spine increase stability and that increased stability has positive effects on physical performance. We think that the HVLA manipulative approach applied in this study provides instant contributions to spinal stabilization and that these contributions are among the reasons for the acute improvement observed in the balance feature in the research results.

It has been reported that high-speed and low-amplitude cervical and thoracic manipulations contribute positively to the integration between the central nervous system and sensory-motor, and increase sympathetic and parasympathetic activity (Haavik and Murphy, 2012; Rogan et al., 2019; Welch and Bone 2008). There is evidence showing that spinal manipulations positively affect the motor control system and the primary afferent neurons coming from paraspinal tissues (Pickar, 2002; Niazi et al., 2020). Spinal manipulations, especially on dysfunctional joints, can change motor control by increasing neural compliance (Taylor and Murphy, 2008). However, long-term clinical studies are recommended to determine the importance of neural responses to spinal manipulations (Gyer et al., 2019). We believe that the increased neurophysiological compliance after the application also contributed to the improvement in the balance control levels determined in this study.

Another result of the study is that a significant increase was observed in the trunk flexion values of the thoracic manipulation group after the application. There was no difference in the placebo manipulation group. Spinal mobility is among the factors affecting motor performance (Mischenko et al., 2020; Zemková et al., 2018). In order to provide this mobility at the optimum level, various interventions to the spine and its close components increase mobilization (Durmus et al., 2010; Spencer et al., 2016; Srokowska et al., 2019). Manipulative approaches are included in these interventions (Michener et al., 2015; Vieira-Pellenz et al., 2014). When the effects of manipulation applications on trunk flexibility and mobility are examined, it is reported that applications increase mobilization and increased mobilization improves trunk and thoracic flexion (Sung et al., 2014; Yang et al., 2015). In addition, it is emphasized by researchers that increased trunk flexibility improves physical performance and balance scores (Marshall et al., 2014; Knudson, 2018; Özmen & Güneş, 2017; Sueki et al., 2020).

The results of this study provide evidence that HVLA thoracic manipulation produces immediate biomechanical effects in areas distant from the application site. From these perspectives, it is seen that the relevant literature supports the study results.

The important limitations of this study are that only male team athletes are included in the study, thoracic application is a single session, balance characteristics and trunk flexion of the athletes are examined.

As a result, it is concluded that HVLA thoracic manipulation application provides instant positive contributions to trunk mobility and balance feature in athletes. However, what exactly the physiological causes of these instantaneous effects are and for how long these contributions can continue are important questions that need to be answered. In order for the HVLA approach to be included in the methods that contribute to sports performance in the training and competition processes of the athletes, it is especially necessary to carry out similar long-term studies.

Conflict of Interest

All authors declare that the study was done in the absence of any conflict of interest.

Authors' Contribution

Design of the Research: Research design NS, Statistical analysis NS; Preparation of the article, NS, RT; Data collection NS, RT.

Ethical Approval

Ethics evaluation committee: Giresun University Social Sciences, Science and Engineering Research Ethics Committee
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Ethics evaluation document issue number: 01/07

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