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# TREATMENT OF HEEL PAIN WITH MINERAL SALTS EXCHANGE: PROTOCOL FOR A CLINICAL PILOT STUDY

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**Abstract**

**Introduction:** The pain of the Achilles tendon and heel (ATHP) is a major concern, particularly for athletes, military people, and ordinary workers badly using inferior arts. Mineral displacement therapy to rescue the correct mineral balance in the osteoarticular districts can ameliorate heel pain.

**Methods:** The present study investigated if treatment with mineral salts in subjects suffering from ATHP can rescue their normal health and decrease pain. A cohort of 15 persons, aged 50-65 years equally sex distributed, suffering from chronic heel pain, underwent the administration of 5.0 mg copper sulfate and 200 mg disodium-hydrogen-orthophosphate (with 500 mg of ascorbate) dissolved separately in 100 ml of drinking water as a daily beverage, morning/evening one hour after meals for three weeks. In the study, pain perception was the main outcome measure.

**Results:** Mineral treatment improved ATHP with a different trend according to age and sex distribution. The scores of pain perception showed differential sensitivity among different genders. No one of the patients in the study experienced a relapse during the two years of follow-up.

**Conclusions:** The present study showed that the therapeutic supplementation with displaced minerals might address the concern of heel pain in males and females with encouraging results in the early elderly population. Placebo-controlled such trials involving large populations with monitoring of blood/hair mineral profiles are suggested and further recommended. Monitoring of quantitative mineral profiles in blood and hair should be considered during medications for any ill effects.

***Key words:*** *heel pain; Achilles tendon; plantar fascia; pain treatment; therapy; copper; phosphate; vitamin C.*

**Резюме**

# ЛЕЧЕНИЕ БОЛИ В ПЯТКЕ МИНЕРАЛЬНЫМИ СОЛЯМИ: ПРОТОКОЛ КЛИНИЧЕСКОГО ПИЛОТНОГО ИССЛЕДОВАНИЯ

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**Введение**: Боль в ахилловом сухожилии и пятке является серьезной проблемой, особенно для спортсменов, военных и рабочих. Минеральная терапия для восстановления правильного минерального баланса в костно-суставных тканях может облегчить боль в пятке.

**Методы.** В настоящем исследовании изучена эффективность лечения минеральными солями лиц, страдающих болью в ахилловом сухожилии и пятке, в отношении снижения боли. Когорта из 15 человек в возрасте 50-65 лет, распределенных по полу, страдающих хронической болью в пятке, подверглась следующему лечению: введение 5,0

мг сульфата меди и 200 мг динатрий-водород-ортофосфата (с 500 мг аскорбата), растворенных отдельно в 100 мл раствора, перорально ежедневно утром / вечером через час после еды в течение трех недель. Основным критерием оценки эффективности лечения было восприятие боли.

**Результаты**: Минеральная добавка улучшила течение заболевания с различной тенденцией в зависимости от возраста и пола. Оценка восприятия боли показала различную чувствительность у разных полов. Ни у одного из пациентов в исследовании не было рецидива в течение двух лет наблюдения.

**Выводы**. Настоящее исследование показало, что терапевтическая добавка минералов может решить проблему боли в пятке у мужчин и женщин с обнадеживающими результатами у людей преклонного возраста. Необходимо проведение плацебо-контролируемых испытаний с участием больших популяций с мониторингом минеральных профилей крови/волос. Во время приема лекарств для изучения любых побочных эффектов следует учитывать количественный мониторинг минеральных профилей в крови и волосах.

***Ключевые слова**: боль в пятке; пяточное сухожилие; подошвенная фасция; лечение боли; терапия; медь; фосфат; витамин С.*

**Түйіндеме**

# ӨКШЕ АУЫРСЫНУЫН МИНЕРАЛДЫ ТҰЗДАРДЫ ҚОЛДАНУ АРҚЫЛЫ ЕМДЕУ: КЛИНИКАЛЫҚ ПИЛОТТЫҚ ЗЕРТТЕУ ХАТТАМАСЫ

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**Кіріспе**: Ахиллес сіңірі мен өкшедегі ауырсыну, әсіресе спортшылар, әскери және жұмысшылар үшін үлкен мәселе болып табылады. Сүйек-буын тіндеріндегі дұрыс минералды тепе-теңдікті қалпына келтіруге арналған минералды терапия өкшедегі ауырсынуды жеңілдетеді.

**Әдістері.** Бұл зерттеу ауырсынуды азайтуға қатысты Ахиллес сіңірі мен өкшедегі ауырсынумен ауыратын адамдардың минералды тұздармен емдеудің тиімділігін зерттеді. 50-65 жас аралығындағы 15 адамның жынысы бойынша бөлінген, созылмалы өкшелік ауырсынумен ауыратын когорт келесі емдеуден өтті: 5,0 мг мыс сульфаты және 200 мг динатрий-сутегі-ортофосфат (500 мг аскорбат бар), 100 мл ерітіндіде бөлек ерітілген, үш апта бойы тамақтанғаннан кейін күн сайын таңертең/кешке ауызға. Емдеудің тиімділігін бағалаудың негізгі критерийі ауырсынуды қабылдау болды.

**Нәтижелері**: Минералды қоспалар аурудың ағымын жасына және жынысына байланысты әр түрлі тенденциямен жақсартты. Ауырсынуды қабылдауды бағалау әр түрлі жыныстағы әртүрлі сезімталдықты көрсетті. Зерттеудегі пациенттердің ешқайсысында екі жылдық бақылау кезінде рецидив болған жоқ.

**Қорытындылары**.

Бұл зерттеу минералды терапевтік қоспалар егде жастағы адамдарда жігерлендіретін нәтижелері бар ерлер мен әйелдердің өкшелік ауырсыну мәселесін шеше алатындығын көрсетті. Қанның/шаштың минералды бейіндерін мониторингілей отырып, үлкен популяциялардың қатысуымен плацебо-бақыланатын сынақтар жүргізу қажет. Кез-келген жанама әсерлерді зерттеу үшін дәрі қабылдау кезінде қан мен шаштағы минералды профильдердің сандық мониторингін ескеру қажет.

***Түйінді сөздер**: өкшедегі ауырсыну; өкше сіңірі; табан фасциясы; ауырсынуды емдеу; терапия; мыс; фосфат; С дәрумені.*

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**Introduction**

Athletes, military people, and conventional workers wrongly using inferior arts frequently experience Achilles tendon and heel pain (ATHP). The conceptualized "entheses organ" comprises Achilles tendon (AT) fibrocartilages, bursa, Kager's fat pad, calcaneus, and plantar fascia. All these components work in concert to dissipate pressure exerted through the variable intensity of physical activity. However, under pathological conditions as tendinosis/plantar fasciitis, normal functioning is usually damaged. Therefore, the hallmark of heel pain is very frequently represented by a slow degeneration of AT and or plantar fascia within 2-6 cm of their attachment with calcaneus.

Bone mineralization and the homeostasis of minerals in the plantar tasca or other articular districts may cause acute heel pain [18]. Being chief weight-bearing tissues, plantar fascia and AT get damaged through repetitive heavy loading, and mechanoreceptive Kager's fat pad manifests heel pain.

Mineral displacement therapy, which rescues the correct mineral balance in the osteoarticular districts, can ameliorate heel pain. Particularly in the case of anti-copper drugs, molybdenum is known to cause concentration-dependent competitive inhibition of certain minerals and induce dyshomeostasis resulting in the defective synthesis of collagen, degeneration, and bone resorption [6, 4, 14]. Copper is part of lysyl oxidase and tripeptide-GHK, which form covalent collagen cross-links giving tremendous strength to AT and plantar fascia comparable to steel. Normally fully hydroxylated collagen is resistant to most proteases. However, in the compromised integrity of extracellular matrix components, they are attacked by matrix metalloproteinases (MMPs), which are calcium-containing zinc-dependent endopeptidases. Molybdenum enhances zinc absorption, thus upregulating the activity of matrix metalloproteinases [11]. The role of minerals also regards the Achilles tendon.

The tendon to bone insertion is a complex interface biochemically, compositionally, and structurally comprising four different zones vs. tendon, fibrocartilage, mineralized fibrocartilage, and bone, i.e., these tissues are in a transition from soft tissue to bone. The deepest fibrocartilage is calcified as the adjoining hyaline cartilages, which remain attached at the insertion site even after maceration. There is a clear demarcation between the two regions called basophilic 'tide mark', probably due to calcium hydroxyapatite. These structures provide much-needed protection from wear and tear and ensure that the AT does not bend, splay out, or compress. Further, the magnetic resonance imaging reveals that the distal part of AT directly persists with the plantar fascia, and the heel fat pad is wedged in to provide compression tolerance in the adult stage [3]. The fat pad contains macrophages, fibroblasts, mast cells, and rarely fibrocartilage cells and might have some immunological implications. The Kager's fat pad is richly supplied with nerve fibers, which may be logically nociceptive and mechanoreceptive that monitor the changes in pressure around the AT insertional angle that is the source of pain in tendon injuries [16].

Normal tendons of humans comprise 30% as a dry mass, while the rest 70% is water. The dry mass of tendons consists of 86 % collagen, 2% elastin, 1-5% proteoglycan, and 0.2% inorganic minerals, including copper, magnesium, calcium, and sulfate. Collagen is of 28 types, but most of the collagen portion comprises type-I, with small portions of other types presented with increasing complexity [15]. The communication between cells occurs through gap junctions that respond to mechanical loading signals [8]. Tendinopathies can be acute or chronic and may be inflicted by intrinsic or extrinsic factors singly or in combinations. The insertion of AT and its adjoining tissues are most vulnerable to degeneration through dyshomeostasis of various minerals, which are intricately involved in its development and structural integrity. Different minerals, including calcium, magnesium, iron, manganese, copper, zinc, and molybdenum, play crucial roles at the molecular level for synthesis/degeneration/regeneration of the extracellular matrix and collagen. The most common pathological afflictions involving AT occur within 2-6 cm from the insertion at the calcaneus and are in athletes the most frequent diagnosed manifestation of posterior heel pain [1].

Similarly, degeneration of plantar fascia within 2-4 cm of its origin has been implicated in the lower, medial aspect of heel pain. Primarily the heel pain has been ascribed to degenerative changes at the site rather than inflammatory changes [10, 13]. The primary causes of mineral imbalances are usually nutritional in origin. However, their interactions in vivo do play an abiding role in their homeostasis. The interactions of most relevant minerals implicated in these processes are dealt with precisely in this paper.

**Materials and methods**

*Design*

Observational clinical study on 15 enrolled consensual patients suffering from chronic heel pain, dependent variables pain scores on a standardized questionnaire (total heel pain reduction, THPR), independent variables outcome score.

*Patients*

Patients were recruited following a signed consent according to the ethical committee of Punjab Agricultural University, which was granted for the research study, according to the approved guidelines. In the spirit of the Declaration of Helsinki [5], the Local Committee approved the experimental protocol. This study represents a first preliminary pilot investigation involving 15 persons encompassing an adult age range from 50 to 65 years, equally sex distributed, and suffering from chronic heel pain, treated as per the following schedule.

*Procedures*

Each patient undertook 5.0 mg of copper sulfate ($CuSO_4$), dissolved in about 100 ml of water once daily, orally one hour after morning meals for three weeks. Furthermore, each person received 200 mg of disodium hydrogen orthophosphate (anhydrous; $Na_2HPO_3$) dissolved in about 100 ml of water and given once daily orally one hour after dinner for three weeks. Then, about 500 mg of vitamin C was given once daily for three weeks to each patient. During these three weeks, all the patients were contacted weekly and enquired about their health regarding heel pain and any side effects of the medication. The

treatment was adopted conceptually and logically based on the hypothesis that molybdenum induces dyshomeostasis in minerals, which play pivotal roles in restoring the functional integrity of tissues comprising AT entheses organ complex. Keeping in view these preliminary observations involving the treatment of heel pain, a further randomized, double-blind controlled trial vs. placebo has been planned on larger populations before implementing in the clinical practice.

A self-perception score, based on the ability of the enrolled subjects to have a standardized walk for a defined time, allowed us to conceive a percentage of reduction of the pain during the treatment, where either the ability to complete the walking path amount or the time to complete it, were related to the reduction of the pain (i.e., the patient able to complete the exercise quite easily was attributed the "no pain" scoring).

*Statistics*

Conversely, a residual pain percentage (RPP) was calculated based on the scoring evaluation to elaborate covariance statistics in the experimental cohort. Covariance analysis and Pearson's tests were applied to RPP for separate groups. In the case of pairs coming from a non-correlated bivariate normal distribution, the distribution of samples for a certain function of the Pearson's correlation follows the Student's t-test distribution with degrees of freedom -2, i.e., the variable has a Student's distribution in the $H_0$ hypothesis, which could also be approximated for non-normally distributed samples if their sizes are not so small (≥30). When occurring, for very small sizes, a Spearman test was considered. For both tests, with a statistical significance of $p<0.05$, a Jarque-Bera and an Anderson-Darling Normality Tests were used.

**Results**

At the end of three weeks, a subtle relief from heel pain in some cases was observed, and subjects showed no ill effects from the medication. After a gap of two days from this treatment, one more similar schedule was repeated. After completing both the medication schedules, the patients reported that they felt a little pain in the heel and experienced no side effects from the medication whatsoever. However, all the patients were administered another course of the same treatment as above for three more weeks to recover from heel pain completely. All these patients were followed up for two years to see the untoward effect, if any, of the treatment or recurrence of the ailment, which proved negative, and the process was considered a cinch.

Table 1 shows the pain scores for the description addressed in Methods. Data report that the outcome evaluation increases if the pain disappears (0, gray area, Table 1) more rapidly following treatments and with increasing ages.

*Table 1.*

**Pain score evaluation panel of heel pain in the investigated cohort of patients.**

| N | PATIENT'S SEX-AGE | TIME WITH HEEL PAIN | 1 TREATMENT (1) | 2 TREATMENT (2) | 3 TREATMENT (3) | 4 TREATMENT (4) | TOTAL SCORE PAIN REDUCTION (TSPR) | OUTCOME % (5) | OUTCOME SCORE (6) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | male, 55 | 5 | 0 | 0 | 0 | 0 | 4 | 73.3 | 4.889 |
| 2 | female, 54 | 6 | 0.6 | 0.4 | 0.1 | 0 | 2.9 | 52.2 | 1.135 |
| 3 | female, 51 | 4 | 0.7 | 0.5 | 0.2 | 0 | 2.6 | 44.2 | 0.902 |
| 4 | male, 65 | 1 | 0 | 0 | 0 | 0 | 4 | 86.7 | 7.428 |
| 5 | female, 62 | 6 | 0.8 | 0.5 | 0.3 | 0 | 2.4 | 49.6 | 1.305 |
| 6 | female, 65 | 2 | n.d. | 0.7 | 0.3 | (mild) | n.d. | n.d. | n.d. |
| 7 | male, 55 | 3 | 0.7 | 0.6 | 0 | 0 | 2.7 | 49.5 | 1.650 |
| 8 | female, 60 | 6 | 0.6 | 0.2 | 0 | 0 | 3.2 | 64 | 2.400 |
| 9 | male, 56 | 4 | 0.2 | 0 | 0 | 0 | 3.8 | 70.9 | 4.836 |
| 10 | male, 53 | 3 | 0.1 | 0 | 0 | 0 | 3.9 | 68.9 | 4.398 |
| 11 | female, 59 | 6 | 0.2 | 0 | 0 | 0 | 3.8 | 74.7 | 5.468 |
| 12 | female, 64 | 3 | 0.7 | 0.4 | 0 | 0 | 2.9 | 61.9 | 2.578 |
| 13 | male, 62 | 5 | 0.5 | 0.3 | 0 | 0 | 3.2 | 66.1 | 2.610 |
| 14 | male, 60 | 2 | 0.2 | 0 | 0 | 0 | 3.8 | 74 | 5.700 |
| 15 | male, 69 | 1 | 0 | 0 | 0 | 0 | 4 | 92 | 8.903 |

*(1) after 1st three week schedule; (2) after 2nd three-week schedule; (3) after 3rd three-week schedule; (4) after two years*
*(5) is calculated as the following: OC =[(TSPR/n) x (age/100)]x100, where TSPR = [4- (sum of pain scores), and n = number of treatments before success, where the number of treatments considered = 3,*
*(6) outcome score: OS). This score is calculated as follows: [OC*/(100-age)], where OC* is calculated on the effective number of treatments before 0. OS has a cut off of 10, calculated on the $IC_{95}$ of the healthy population undergoing the risk of heel pain and encompassing the range 36-90 years.*

Higher ages should prevent a good outcome with lesser therapy interventions, and therefore the older patient able to get pain resolution with lesser treatments in the time has the best score. A score indicating the residual pain before the complete disappearance of the same is indicated for each treatment. The outcome score senses the effect of the number of treatments, e.g., patients 14, 13, and 5 have similar ages and decreasing OS values, quite perfectly in a proportional linear fashion (Table 1). The evaluation does not take account of sex differences, e.g., patients 12 and 13 have similar OS values (Table 1).

When covariance analysis and correlation tests were performed, a difference in the ability of males and females to respond to the mineral therapy surprisingly occurred.

The age distribution between males and females in the subject cohort is homogeneously dispersed (means, male = 58.125 ±4.086 SD and females = 59.286 ±5.155 SD). However, while a difference between female and male patients has been observed neither in the first (p =0.6288), nor in the second (p = 0.5940), nor the third treatment (p = 0.4481), the overall evaluation should suggest that males appeared to respond better to the therapy, needing a much lesser extent of treatment time than females (p = 0.009).

Male and female subjects respond to the therapy in a different way (Spearman correlation test (rho) ρ = 0.08571, p = 0.0919, linear regression p = 0.0203, Durbin Watson = 1.6216, non-Neumann ratio = 1.9459). Table 2 summarizes these results.

*Table 2.*

**Data analysis of the research study.**

| PATIENT DISTRIBUTION | | TREATMENT STATISTICS (Pearson ungrouped data) | | |
|---|---|---|---|---|
| Equally, sex distributed | | After 1st three-week schedule | After 2nd three-week schedule | After 3rd three-week schedule |
| mean age ± SD | | Covariance: -0.014<br>Correlation: -0.2529<br>2-sided P = 0.6288 | Covariance: -0.018<br>Correlation: -0.2777<br>2-sided P = 0.5941 | Covariance: 0.006<br>Correlation: 0.3873<br>2-sided P = 0.4481 |
| males | 58.125 ±4.086 | MALE VS FEMALES (OS) | | |
| females | 59.286 ±5.155 | Pearson ungrouped data p = 0.0098 (2-sided)<br>Spearman correlation test p = 0.9194 | | |
| Use of selective drugs | | Linear regression data | | |
| males | None reported | Beta = 0.0106 | Durbin-Watson 1.6216 | H0 TEST P =0.0203 |
| females | 1 exclusion | elasticity = 0.0040 | Von Neumann Ratio: 1.9459 | |
| | | rho (acc. Goldberger) -0.1727 | Tails 2 | |

Based on the clinical observations in the present study and other scientific investigations into heel pain, the nub of this illness, in essence, primarily converges to a mineral imbalance. Therefore, fifteen patients suffering from chronic heel pain were included in this pilot study and treated with copper sulfate, disodium hydrogen orthophosphate (anhydrous), and vitamin C. The recovery was spectacular at the end of the 3×3-week schedule of this treatment. This procedure proved a cinch as all the patients felt no pain even during the two-year follow-up period.

**Discussion**

Although the number of subjects recruited in the study is quite small, the results suggest that most probably there are fundamental factors to be considered in order to prevent the possibility of bias in the largest prospective and randomized controlled vs. placebo trials, which should be addressed in forthcoming projects. The first encouraging evidence is that mineral displacement therapy via a dietary assumption reached efficacy in all the patients (with one exception) investigated in the study.

First, female subjects are usually subjected to bone demineralization much more frequently than males. Second, pain perception in females is much lower than in males. Third, most probably muscular and tendinous strength and resistance in males are higher than in females. The heel pain, either acute or chronic, is caused by extrinsic and or intrinsic factors. Biochemically and structurally, the AT enthuses organ' constituents are primarily composed of collagen type-I (over 95%), elastin, and minerals. The homeostasis of the latter is fundamental also to prevent inflammatory immune responses. The cells of these tissues are exclusively in charge of the synthesis and renewal of extracellular macromolecules as collagen, elastin, proteoglycans, and glycoproteins. These molecules are the determinants of the structural integrity of AT enthuses organ tissues, as the biosynthesis and metabolism of collagen-I are very complex, involving intra- and extracellular phases precisely regulated by metalloenzymes involving copper, sulfur, calcium, phosphate, zinc, manganese, magnesium, iron and molybdenum as cofactors.

In this context, molybdenum is implicated in gout and aching joints in people exposed to its high levels of foods/water in certain areas. Higher levels of molybdenum per se may not be the direct cause of these pathologies, but its interference in the homeostasis of other minerals mentioned above might be a possible cause. The present study hypothesized that mineral imbalance and altered catalytic activities of metalloproteases (calcium and zinc-containing endopeptidases), molybdenum, xanthine

oxidase, copper, lysyl oxidase, alkaline phosphatase, etc., would be implicated at the molecular level culminating in degeneration of tissues leading to heel pain. The results of the present study appear encouraging, but they need further insightful confirmation. Heel pain/Achilles heel is probably the most common complaint reported to foot and ankle specialists, which varies from 11 to 15% in adult human beings and affects individuals usually between 35 to 65 years of age [12]. This pain has been referred to as a range of undifferentiated conditions. Recently, the terms plantar fasciitis/tendinosis/tendinopathies have been proposed to de-emphasize its possible inflammatory cause rather than stress upon the degenerative conditions and subsequent mechanical pressure resulting in variable afflictions. The pathological descriptions of pain along the plantar fascia/tendon attachments around the calcaneal bone are almost similar. The most common cause of heel pain has been claimed to be the biomechanical and strenuous effect on or around the calcaneal tuberosity. The causal factors usually quoted are obesity, working nature, windlass mechanisms, or tension of the plantar fascia in stance and gait [17]. While delving into the literature disparately, the attachment of the Achilles tendon (AT) and plantar fascia at calcaneus appears to be implicated in the cause of heel pain. However, this factor alone cannot be regarded as the focal point of pain, but other structures around the calcaneus might contribute to this pathology. All these structures function in concert to dissipate pressure exerted by physical activity, and all together, they form the "AT enthuses organ". This organ comprises AT, opposing sesamoid and periosteal fibrocartilages, bursa, Kager's fat pad, and plantar fascia.

The present study demonstrated that the treatment heals patients from the pain and that this outcome does not depend on the age if this one is in the range of 50-70 years. This would rely on the different lifestyles of subjects, and the best performances of individuals with respect to some decades ago, particularly due to an increase in life expectancy. Heel pain is represented by four types of nerve endings, i.e., Ruffini corpuscles, free nerve endings, Pacini corpuscles at tendon site, and Golgi tendon organs at muscle site [7].

However, the source of pain could be mechanical or biochemical, which may be induced by tendon degeneration and collagen breakdown. Nevertheless, the biochemical mechanisms appear more appealing as the chemical irritants and neurotransmitters might be generated at the injury site. Glutamate has been invariably found in high concentrations at the Achilles tendinopathies [2]. AT showed normal levels of prostaglandin E2, albeit no sign of inflammatory reaction was observed. Chondroitin sulfate and substance P may also be involved in these morbidities, but the exact origin of the pain is yet inconclusive [9].

Nevertheless, adipose tissue at the enthuses revealed major innervations which appear to play a proprioceptive role through monitoring changes in pressure at the insertional angle of AT and might be a source of the pain of tendon injuries [16]. Moreover, the Kager's fat pad might play an immunoprotective role in removing debris from the wear and tear of surrounding parts of the enthuses. Henceforth, injury at the 'enthesis organ' may lead to an inflammatory reaction with an immunological response in certain diseases. Such intricacies have a bearing and are worth consideration in heel pain and the pathogenesis of spondyloarthropathies.

The present study showed that the therapeutic supplementation with displaced minerals might address the concern of heel pain in males and females with encouraging results in the early elderly population. Placebo-controlled such trials involving large populations with monitoring of blood/hair mineral profiles are suggested and further recommended. Monitoring quantitative mineral profiles in blood and hair should be considered during medications for any ill effects.

***Conflict of interest:*** *The authors declare that they have no conflict of interest.*

***Ethical approval:*** *All procedures performed were in accordance with the ethical standards of the institutional and/or national research committee, and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.*

***Informed consent:*** *Informed consent was obtained from all individual participants included in the study.*

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