A clinical study to evaluate the effect of umami taste on the oral stereognostic ability of complete denture patients

Um estudo clínico para avaliar o efeito do sabor umami na capacidade estereognóstica oral de pacientes usuários de prótese total

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ABSTRACT

Objective: This study aimed to assess the effect of umami taste on the oral stereognostic ability of patients with complete dentures. **Material and Methods:** Patients with complete dentures were recruited from a dental college and informed consent was obtained from all participants. The participants were randomly assigned to either the umami or control group. Their oral stereognostic ability was assessed using standardized test samples made from raw carrots presented in both plain and umami-flavored forms. Participants' ability to identify shapes within the oral cavity was recorded, and statistical analyses were performed to compare oral stereognostic ability scores between the umami and control groups. **Results:** Participants exposed to umami taste stimuli demonstrated significantly higher mean scores for oral stereognostic ability compared to those in the control group. The umami group achieved a mean score of 8.3 ($\pm$1.5), whereas the control group had a slightly lower mean score of 6.7 ($\pm$1.2). This difference was consistent across all test shapes, indicating a potential enhancement in oral sensory function associated with umami taste perception. Male participants achieving higher mean scores than female participants in both the umami and control groups. **Conclusion:** This study provides evidence supporting the potential benefits of umami taste perception in enhancing the oral stereognostic ability of patients with complete dentures. Further research is warranted to elucidate the underlying mechanisms and explore the long-term outcomes, ultimately contributing to enhanced patient care in prosthodontics.

KEYWORDS

Complete denture; Oral stereognostic ability; Prosthodontics; Sensory perception; Umami taste.

RESUMO

Objetivo: Este estudo teve como objetivo avaliar o efeito do sabor umami na capacidade estereognóstica oral de pacientes usuários de próteses totais. **Material e Métodos**: Pacientes usuários de próteses totais foram convidados por uma faculdade de odontologia e os termos de consentimento informado foram obtidos de todos os participantes. Os participantes foram aleatoriamente designados para o grupo umami ou controle. A capacidade estereognóstica oral foi avaliada usando amostras de teste padronizadas feitas de cenouras cruas apresentadas em formas simples e com sabor umami. A capacidade dos participantes de identificar formas dentro da cavidade oral foi registrada, e análises estatísticas foram realizadas para comparar as pontuações de capacidade estereognóstica oral entre os grupos umami e controle. **Resultados**: Os participantes expostos a estímulos de sabor umami demonstraram pontuações médias significativamente maiores para a capacidade estereognóstica oral em comparação com os participantes do grupo controle. O grupo umami atingiu uma pontuação média de 8,3 ($\pm$1,5), enquanto o grupo

controle teve uma pontuação média ligeiramente menor de 6,7 (±1,2). Essa diferença foi consistente em todas as formas de teste, indicando um potencial aprimoramento na função sensorial oral associada à percepção do sabor umami. Os participantes do sexo masculino atingiram pontuações médias mais altas do que as participantes do sexo feminino nos grupos umami e controle. **Conclusão**: Este estudo fornece evidências que apoiam os benefícios potenciais da percepção do sabor umami no aprimoramento da capacidade estereognóstica oral de pacientes usuários de próteses totais. Mais pesquisas são necessárias para elucidar os mecanismos subjacentes e explorar os resultados a longo prazo, contribuindo, em última análise, para o aprimoramento do atendimento aos pacientes que utilizam próteses dentárias.

PALAVRAS-CHAVE

Prótese Total; Capacidade estereognóstica oral; Prótese Dentária; Percepção Sensorial; Sabor Umami.

INTRODUCTION

Complete dentures serve as a vital prosthetic solution for individuals with missing teeth, restoring masticatory function and enhancing esthetics [1]. However, despite advancements in dental technology, many complete denture wearers encounter difficulties related to oral sensory perception, which can significantly affect their ability to discern textures, shapes, and tastes within the oral cavity [2,3]. Oral stereognosis, the ability to recognize objects placed in the mouth without visual assistance, is fundamental for effective mastication, speech, and overall oral health maintenance [4].

Umami, which is recognized as the fifth taste, along with sweet, sour, salty, and bitter tastes, is characterized by a savory, meaty flavor profile attributed to the presence of glutamate and nucleotides in foods [4]. Although umami taste receptors have been identified on the tongue and palate, their role in oral sensory perception among denture wearers remains relatively unexplored [5,6]. Emerging evidence suggests that umami taste may significantly enhance the flavor perception and overall palatability of foods, potentially influencing dietary preferences and nutritional intake [7].

Despite the potential implications of the umami taste for oral sensory function, there is a paucity of research investigating its effect on the oral stereognostic ability of complete denture patients. Understanding the impact of umami taste perception on oral sensory function in this population could provide valuable insights into optimizing prosthetic interventions and enhancing patient comfort and satisfaction [2,3,7].

Therefore, this study aimed to evaluate the effect of the umami taste on the oral stereognostic ability of patients with complete dentures in a randomized, double-blind, placebo-controlled trial. Firstly, to establish a baseline by determining the oral stereognostic score of complete denture patients presenting with an unflavored specimen. Subsequently, assessing the oral stereognostic ability score of complete denture patients when exposed to an umami-flavored specimen. This research endeavors to compare and evaluate the data derived from oral stereognostic scores between complete denture patients experiencing umami taste stimuli and those who did not. This study sought to contribute to the improvement of prosthetic interventions and to enhance the quality of life of individuals with complete dentures.

MATERIALS AND METHODS

Study design

This study adopted a prospective experimental design to rigorously investigate the influence of the umami taste on the oral stereognostic ability of patients with complete dentures. This design allowed for systematic collection of data following exposure to umami-flavored and plain samples, facilitating the establishment of a causal relationship between umami taste perception and oral sensory function.

Participant selection

Fifty edentulous patients were recruited for the study. Of these, 25 individuals constituted the control group. The inclusion criteria were individuals without prior denture usage or temporomandibular joint (TMJ) disorders with the mean age of 65 years. These criteria aimed to ensure homogeneity within the participant population and minimize confounding variables that could affect the study outcomes. Prior to participation, informed consent was obtained from all recruited individuals, emphasizing their voluntary involvement and understanding of the study procedures.

Ethical clearance

Ethical clearance was sought from the institutional review board to ensure compliance with the established ethical guidelines and safeguard participant welfare. Ethical clearance is essential for conducting research involving human participants, demonstrating a commitment to respect autonomy, beneficence, and justice in the conduct of scientific investigations.

Testing

Six shapes were chosen from the 20-item guide developed by the American National Institute of Health for stereognostic tests [8]. Twelve test samples for each patient (5 mm thick and 10-14 mm in diameter) were prepared from raw carrots to permit free oral manipulation and were divided into two groups (Group I - Plain samples and Group II - Umami flavor samples) (Figure 1). The test was performed in a quiet environment, and the patients were seated comfortably in an upright position.

After complete denture insertion, without showing the patient, test samples were placed on the mid dorsum of the tongue of each patient and allowed to be freely manipulated in the mouth. The patients were asked to identify the shape of the test sample and choose the corresponding shape from a set of 20 different shapes (Figure 2).

The 6-test samples from both groups were placed in random order. Patients were not informed of the correct answers at any point during testing. The scoring system followed Smith and McCord's method to record the response of each patient: score 2 for correct identification, score 1 for incorrect identification within the same group of shapes, and score 0 for incorrect identification [9]. All responses were recorded in a tabular form.

Blinding

To minimize bias in the responses, both the participants and researchers conducting the tests were blinded to the composition of the
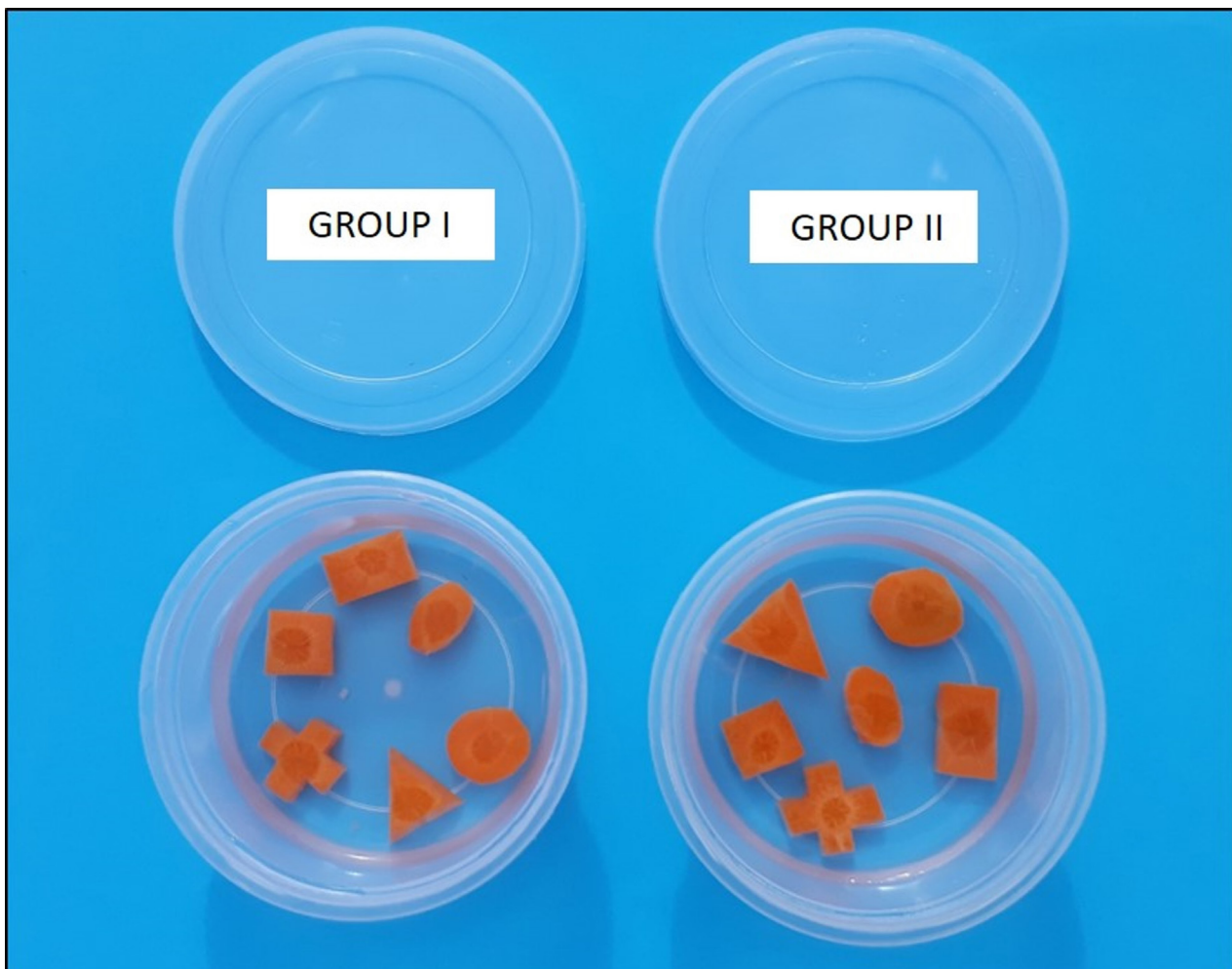

Figure 1 - Plain samples and Umami flavor samples for testing stereognostic ability.

test samples. Blinding ensured that neither the participants nor the researchers were aware of whether a sample was plain or umami-flavored during testing, thus reducing the risk of subjective influence on study outcomes.

Data collection

Responses were meticulously recorded in tabular format to ensure accuracy and consistency in data collection. Each participant completed testing with multiple samples from both the plain and umami-flavored groups, allowing for comprehensive assessment of oral stereognostic ability under different conditions. All the participants have equal number of samples in each group. Data collection procedures were standardized to maintain the integrity and reliability of the study findings.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 24. Descriptive statistics, including mean, standard deviation, and range, were calculated for oral stereognostic ability scores obtained from participants in both the umami and control groups. Inferential statistics, such as unpaired t-tests and analysis of variance (ANOVA), were employed to compare scores between groups and across different test shapes. Additionally, post-

hoc tests, such as Tukey's Honestly Significant Difference (HSD) test, were applied to identify specific group differences if the ANOVA results were significant. The significance level was set at $\alpha < 0.05$, to determine statistically significant differences between the experimental conditions.

RESULTS

The participant characteristics table provides important demographic information regarding the study population. In both the umami and control groups, the mean age of participants was similar, with values of 65.2 years (± 7.3) and 64.8 years (± 6.9) years, respectively. The sex distribution was also balanced, with 12 males and 13 females in the umami group and 13 males and 12 females in the control group. Furthermore, the duration of denture use was comparable between the two groups, with mean values of 6.4 years (± 2.1) in the umami group and 6.2 years (± 2.3) in the control group. These findings indicate that the two groups were well-matched in terms of age, sex distribution, and denture usage history, minimizing potential confounding factors in the analysis of oral stereognostic scores (Table I).

A comparison of the oral stereognostic ability scores between the umami and control groups revealed a significant difference in the mean scores. Participants exposed to umami-flavored samples achieved a higher mean score of 8.3 (± 1.5) than those in the control group, who had a slightly lower mean score of 6.7 (± 1.2). This difference in mean scores suggests that umami taste may enhance the oral stereognostic ability among patients with complete dentures. A narrower standard deviation in the umami group (± 1.5) than in the control group (± 1.2) indicated greater consistency in performance among participants exposed to umami taste stimuli (Table II).

A comparison of oral stereognostic ability scores by test shape revealed significant differences between the umami and control groups across all

Figure 2 - Patient identifying the test (Plain or Umami flavor) samples.

Table I - Participant Characteristics

Characteristic	Umami Group (n=25)	Control Group (n=25)
Age (years), mean ± SD	65.2 ± 7.3	64.8 ± 6.9
Gender (Male/Female)	12/13	13/12
Years of Denture Use	6.4 ± 2.1	6.2 ± 2.3

shapes tested. In particular, participants in the umami group consistently achieved higher mean scores than did those in the control group for each test shape. For example, for shape 3, the umami group exhibited a mean score of 8.6 ($\pm$1.2), whereas the control group had a lower mean score of 7.0 ($\pm$1.1). These findings suggest that umami taste significantly enhances oral stereognostic ability across various shapes, with p-values ranging from 0.004 to 0.025, indicating statistical significance (Table III, Figure 3).

Table IV presents the mean scores ($\pm$SD) for oral stereognostic ability in the umami group compared to the control group across different test shapes, along with the corresponding p-values. In each case, the umami group exhibited higher mean scores than the control group, indicating potentially superior oral recognition abilities. Statistical analysis revealed significant differences between the two groups for all test shapes: shapes 1 (p = 0.012), 2 (p = 0.021), 3 (p = 0.004), 4 (p = 0.017), 5 (p = 0.025), and 6 (p = 0.019). These findings suggest a plausible association between umami taste perception and heightened tactile recognition skills, as evidenced by the consistently superior oral stereognostic ability observed in the umami group across various shapes compared to the control group.

A comparison of oral stereognostic ability scores between male and female participants within each group revealed notable gender-based differences in oral sensory perception. In both the umami and control groups, male participants consistently achieved higher mean scores than did female participants. For example, in the umami group, male participants attained a mean score of 8.5 ($\pm$1.2), whereas female participants scored lower, with a mean of 7.9 ($\pm$1.4). Similarly, in the control group, male participants had a mean score of 7.0 ($\pm$1.3), whereas female participants had a lower score, with a mean of 6.4 ($\pm$1.2). There are no previous studies supporting whether the hormonal changes (menopause) in female participant's does affect the taste perception or not. These differences were statistically significant, with p-values of 0.003 and 0.005 in the umami and control groups, respectively (Table V).

Table II - Oral Stereognostic Ability Scores for Umami and Control Groups

Test Group	Mean Score (±SD)	Range
Umami	8.3 (±1.5)	6-10
Control	6.7 (±1.2)	4-9

Table III - Oral Stereognostic Ability Scores by Test Shape

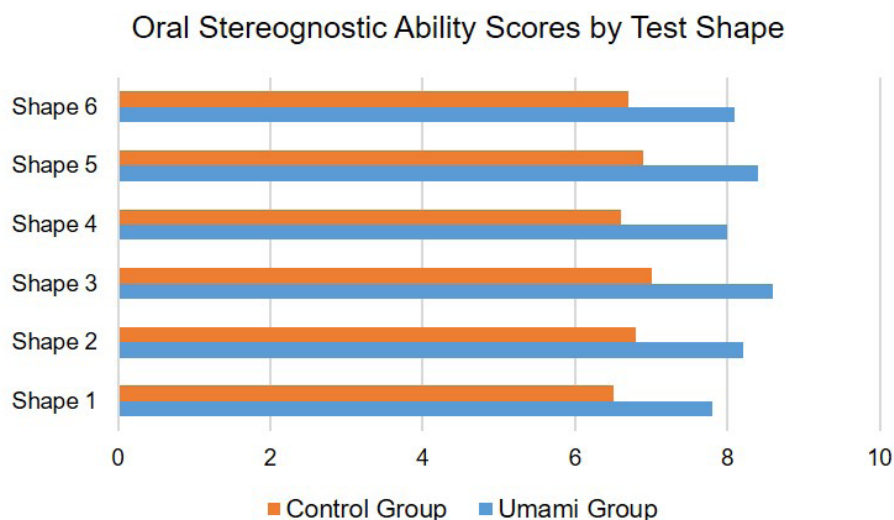| Test Shape	Umami Group (Mean ± SD)	Control Group (Mean ± SD)
Shape 1	7.8 (±1.3)	6.5 (±1.2)
Shape 2	8.2 (±1.4)	6.8 (±1.3)
Shape 3	8.6 (±1.2)	7.0 (±1.1)
Shape 4	8.0 (±1.3)	6.6 (±1.2)
Shape 5	8.4 (±1.5)	6.9 (±1.4)
Shape 6	8.1 (±1.4)	6.7 (±1.3)

DISCUSSION

Figure 3 - Oral stereognostic ability scores by test shape in the participants.

Table IV - Comparison of Oral Stereognostic Ability Scores by Test Shape

Test Shape	Mean Score Umami Group (±SD)	Mean Score Control Group (±SD)	p-value
Shape 1	7.8 (±1.3)	6.5 (±1.2)	0.012
Shape 2	8.2 (±1.4)	6.8 (±1.3)	0.021*
Shape 3	8.6 (±1.2)	7.0 (±1.1)	0.004*
Shape 4	8.0 (±1.3)	6.6 (±1.2)	0.017*
Shape 5	8.4 (±1.5)	6.9 (±1.4)	0.025*
Shape 6	8.1 (±1.4)	6.7 (±1.3)	0.019*

Legenda: *means statistical significant differences.

Table V - Comparison of Oral Stereognostic Ability Scores between Male and Female Participants

Gender	Umami Group (n=25)	Control Group (n=25)	p-value
Male	8.5 (±1.2)	7.0 (±1.3)	0.003*
Female	7.9 (±1.4)	6.4 (±1.2)	0.005*

Legenda: * means statistical significant differences.

The present study delved into a crucial yet relatively unexplored area in prosthodontics by investigating the impact of the umami taste on the oral stereognostic ability of complete denture patients. Using a meticulously designed experimental approach, this study aimed to elucidate the potential role of umami taste perception in enhancing oral sensory function in denture wearers.

The study's results revealed a significant improvement in oral stereognostic ability among complete denture patients exposed to umami taste stimuli compared to those in the control group. Participants who received umami-flavored samples consistently achieved higher mean scores across various test shapes, indicating enhanced ability to discern shapes within the oral cavity. This finding suggests that umami taste perception may play a pivotal role in augmenting oral sensory function, potentially alleviating common challenges associated with denture wearing, such as difficulty in mastication, speech impairment, and decreased dietary enjoyment [10,11].

Moreover, the observed sex-based differences in oral stereognostic ability underscore the need to consider individual variations in taste perception and sensory processing in prosthodontic treatment planning. Male participants exhibited consistently higher mean scores than female participants in both the umami and control groups, highlighting potential differences in taste sensitivity, tactile acuity, or cognitive processing between genders. This might be due to homogeneity or heterogeneity and further studies are needed to understand the genetic influences on the taste perception with relation to gender. This aligns with the growing bosy of literature that males and females respond differently at the muscular level to various tastes and show varied responses when eating different foods [12,13].

Understanding these disparities is essential for tailoring prosthetic interventions according to individual patient needs and optimizing the treatment outcomes.

Mechanisms underlying umami taste perception

To elucidate the mechanisms underlying the observed enhancement in oral stereognostic ability following exposure to umami taste stimuli, it is essential to consider the neurophysiological processes involved in taste perception and sensory integration [14]. Umami taste perception is mediated by specific taste receptors located on the tongue and palate, which primarily respond to the presence of glutamate and nucleotides in foods [15]. The activation of umami taste receptors triggers neural signals transmitted to the brain, eliciting perceptual responses associated with savory flavor profiles [16].

In the context of oral stereognosis, umami taste stimuli may modulate neural processing in the higher brain centers involved in sensory integration and perception, leading to enhanced cognitive processing of the oral stimuli [17]. Additionally, umami taste perception can interact

synergistically with other taste modalities, such as sweet and salty, to create a complex flavor profile that enhances overall palatability and sensory perception [18].

Moreover, umami taste stimuli may augment tactile acuity and proprioceptive feedback within the oral cavity, facilitating the discrimination of subtle textural and shape differences during oral manipulation [19].

CLINICAL IMPLICATIONS

The findings of this study have significant implications in the clinical practice of prosthodontics and oral rehabilitation. Incorporating umami-flavoring agents into denture materials or oral care products can improve patient satisfaction, comfort, and functional outcomes. By enhancing oral sensory perception, umami taste stimuli may alleviate the common challenges associated with denture wearing, thereby enhancing a patient's quality of life and well-being [20-22].

Moreover, personalized prosthetic interventions tailored to individual taste preferences could optimize treatment outcomes and promote patient-centered care in prosthodontics. Clinicians should consider conducting taste assessments and incorporating patient preference into treatment plans to enhance the acceptability and efficacy of prosthetic interventions. Additionally, patient education programs focusing on dietary modifications and oral hygiene practices could promote the adoption of umami-rich foods and flavors, thus supporting oral health and overall well-being among denture-wearers.

LIMITATIONS AND FUTURE DIRECTIONS

Despite its strengths, this study had several limitations that warrant consideration when interpreting the findings. First, the relatively small sample size may limit the generalizability of our results to the broader population of patients with complete dentures. Future studies with larger sample sizes and diverse demographic characteristics are warranted to validate the findings and explore the potential moderating factors influencing taste perception and oral stereognostic ability.

Second, the study utilized raw carrots as test samples to assess oral stereognostic ability, which may not fully capture the complexity of oral sensory perception in real-life scenarios. Future research could employ a broader range of test materials with varying textures, shapes, and flavors to comprehensively evaluate oral stereognostic ability and its modulation by umami taste stimuli.

Third, the study focused exclusively on umami taste perception's immediate effects on oral stereognostic ability, neglecting potential long-term outcomes and clinical implications. Longitudinal studies that track patients' oral health outcomes and dietary habits over time could provide valuable insights into the sustained effects of umami taste stimulation on prosthetic intervention efficacy and wellbeing.

CONCLUSION

In conclusion, the findings of this study underscore the potential role of the umami taste in enhancing the oral stereognostic ability of complete denture patients. Exposure to umami taste stimuli is associated with improved ability to discern shapes within the oral cavity, suggesting a promising avenue for optimizing prosthetic interventions and enhancing patient comfort and satisfaction. Further research is warranted to elucidate the underlying mechanisms driving these effects, explore potential sex-based differences in taste perception, and investigate the long-term effects of umami taste stimulation on oral health and well-being in denture wearers. By advancing our understanding of taste perception and sensory processing in prosthodontics, future studies hold promise for improving treatment outcomes and promoting patient-centered care in oral rehabilitation.

Author's Contributions

VB: Conceptualization, Manuscript Design, Manuscript Writing. SS: Conceptualization, Literature Search, Manuscript Design, Manuscript Review. KRN: Investigation, Manuscript Review. EMA: Literature Search, Investigation. AAA: Literature Search, Investigation. MAA: Literature Search, Investigation. FAE: Literature Search, Investigation. LNA: Literature Search, Investigation. FNA: Literature Search, Investigation.

Conflict of Interest

No conflicts of interest declared concerning the publication of this article.

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Regulatory Statement

This study was conducted in accordance with the local committee guidelines and policies of Institutional Ethics Committee. The approval number for this study is: 4-2-4/40.

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