



# Correlation Between Vestibular Disorders and Superior Semicircular Dehiscence on High-resolution Computed Tomography at Tam Anh Ho Chi Minh General Hospital

## Tam Anh Ho Chi Minh Genel Hastanesi'nde Yüksek Çözünürlüklü Bilgisayarlı Tomografide Vestibüler Bozukluklar ve Superior Semisirküler Dehissans Arasındaki Korelasyon

© Cong Trinh TRAN<sup>1</sup>, © Thi Lan Huong LE<sup>1</sup>, © Tran Thi Thuy HANG<sup>1</sup>, © Nghi Hai MA<sup>2</sup>, © Ho Hoang PHUONG<sup>1</sup>, © Tran Phanchung THUY<sup>3</sup>

<sup>1</sup>Tam Anh Ho Chi Minh City General Hospital, Ho Chi Minh City, Vietnam

<sup>2</sup>Vietnamese Society of Otorhinolaryngology, Ho Chi Minh City, Vietnam

<sup>3</sup>Vietnam National University Ho Chi Minh City, School of Medicine, Ho Chi Minh City, Vietnam

### ABSTRACT

**Objective:** Superior semicircular canal dehiscence (SSCD) is a pathologic condition within the inner ear characterized by various vestibular manifestations. Numerous studies have reported an incidence rate of SSCD ranging from 3.6% to 9% in the general population. The objective of this medical study was to evaluate the prevalence of superior SSCD and investigate its correlation with vestibular symptoms among patients who underwent high-resolution computed tomography (HRCT) scans. To the best of our knowledge, there is limited research and awareness regarding SSCD in Vietnam. In addition, the secondary aim of our investigation is to assess the prevalence of SSCD in Vietnam and compare it with findings from previous studies worldwide.

**Methods:** This retrospective study was conducted at Tam Anh Ho Chi Minh General Hospital from March 2022 to February 2024. Medical records and HRCT scans of the patients were collected. Patients were categorized into two groups: those with and without vestibular disorders. SSCD was defined as the absence of bone overlying the superior semicircular canal facing toward the dura of the middle cranial fossa. Statistical analysis was performed to determine the correlation between vestibular symptoms and the presence of SSCD.

**Results:** A total of 362 patients (including 151 men and 211 women) were recruited. The prevalence of SSCD was 10.2% according to the HRCT scan results. The study found that 18.33% of patients with vestibular disorders had SSCD on HRCT scans, whereas only 6.2% of patients without vestibular disorders exhibited SSCD, indicating a significant association (p-value <0.001).

**Conclusions:** These findings highlight the importance of considering SSCD as a potential etiology in patients presenting with vestibular symptoms and emphasize the diagnostic utility of HRCT.

**Keywords:** Vestibular disorders, superior semicircular canal dehiscence (SSCD), high-resolution computed tomography (HRCT)

### ÖZ

**Amaç:** Superior semisirküler kanal dehissansı (SSKD), iç kulakta çeşitli vestibüler belirtilerle karakterize patolojik bir durumdur. Çok sayıda çalışma, genel popülasyonda %3,6 ila %9 arasında değişen bir SSKD insidans oranı bildirmiştir. Bu tıbbi çalışmanın amacı, yüksek çözünürlüklü bilgisayarlı tomografi (YÇBT) taramaları yapılan hastalarda SSKD prevalansını değerlendirmek ve vestibüler semptomlarla korelasyonunu araştırmaktır. Bildiğimiz kadarıyla, Vietnam'da SSKD ile ilgili sınırlı araştırma ve farkındalık bulunmaktadır. Buna ek olarak, araştırmamızın ikincil amacı Vietnam'da SSKD prevalansını değerlendirmek ve bunu dünya çapında daha önce yapılan çalışmalardan elde edilen bulgularla karşılaştırmaktır.

**Yöntemler:** Bu retrospektif çalışma Tam Anh Ho Chi Minh Genel Hastanesi'nde Mart 2022 ile Şubat 2024 tarihleri arasında gerçekleştirildi. Hastaların tıbbi kayıtları ve YÇBT taramaları toplandı. Hastalar iki gruba ayrıldı: Vestibüler bozukluğu olan ve olmayanlar. SSKD, orta kranial fossanın durasına doğru bakan superior semisirküler kanalın üzerinde kemik yokluğu olarak tanımlandı. Vestibüler semptomlar ile SSKD varlığı arasındaki korelasyonu belirlemek için istatistiksel analiz yapıldı.

**Bulgular:** Toplam 362 hasta (151 erkek ve 211 kadın) çalışmaya dahil edildi. YÇBT tarama sonuçlarına göre SSKD prevalansı %10,2 idi. Çalışmada, vestibüler bozukluğu olan hastaların %18,33'ünde YÇBT taramalarında SSKD bulunurken, vestibüler bozukluğu olmayan hastaların yalnızca %6,2'sinde SSKD görüldü ve bu da anlamlı bir ilişkiye işaret etmektedir (p-değeri <0,001).

**Sonuçlar:** Bu bulgular, vestibüler semptomlarla başvuran hastalarda SSKD'nin potansiyel bir etiyoloji olarak değerlendirilmesinin önemini ve YÇBT'nin tanısal faydasını vurgulamaktadır.

**Anahtar kelimeler:** Vestibüler bozukluklar, superior semisirküler kanal dehissansı (SSKD), yüksek çözünürlüklü bilgisayarlı tomografi (YÇBT)

**Address for Correspondence:** T. P. Thuy, Vietnam National University Ho Chi Minh City, School of Medicine, Ho Chi Minh City, Vietnam

**E-mail:** drthuytranent@gmail.com **ORCID ID:** orcid.org/0009-0002-1154-2262

**Received:** 04 April 2024

**Accepted:** 28 May 2024

**Online First:** 12 June 2024

**Cite as:** Tran CT, Le TLH, Hang TTT, Ma NH, Phuong HH, Thuy TP. Correlation Between Vestibular Disorders and Superior Semicircular Dehiscence on High-resolution Computed Tomography at Tam Anh Ho Chi Minh General Hospital. Medeni Med J 2024;39:117-121



## INTRODUCTION

Superior semicircular canal dehiscence (SSCD) refers to an osseous arch defect of the superior semicircular canal, first described by Minor et al.<sup>2</sup> in 1998, and is associated with vestibular syndrome, presenting symptoms such as vertigo, dizziness, lightheadedness, tinnitus, hearing loss, and vertigo induced by loud sounds, known as the Tullio phenomenon<sup>3</sup>. These manifestations arise due to an abnormal opening in the osseous roof of the canal, creating a “third window” phenomenon with aberrant sound conduction and pressure dynamics<sup>4</sup>. Diagnosis involves audiometric evaluation, vestibular assessment, and identification on temporal bone computed tomography (CT)<sup>5</sup> and supports management strategies such as pharmacotherapy or surgical intervention<sup>6</sup>. While autopsy studies indicate a low prevalence of SSCD (0.5%)<sup>7</sup>, imaging studies report higher rates (3.0% to 9.0%)<sup>8-12</sup>, underscoring the sensitivity of CT in detecting SSCD. Incidental findings of canal dehiscence in asymptomatic individuals prompt investigations into its association with vestibular dysfunction. Consequently, CT imaging is recommended for patients with vestibular symptoms to facilitate early detection and management<sup>1</sup>. However, research and awareness regarding SSCD remain limited in Vietnam. The objectives of this study were to assess the incidence and features of SSCD using high-resolution computed tomography (HRCT) and to evaluate the relationship between SSCD and vestibular disorder symptoms.

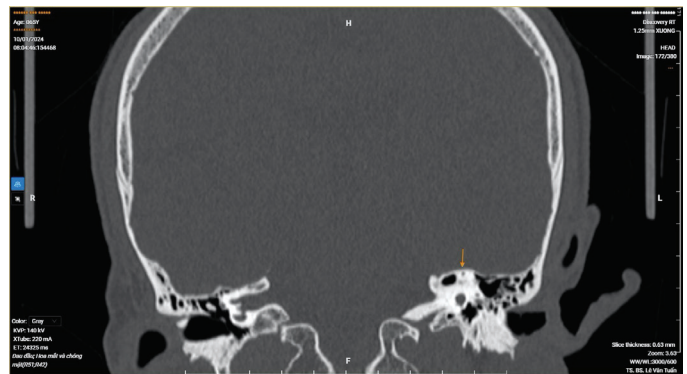
## MATERIALS and METHODS

The study was conducted at Tam Anh Ho Chi Minh General Hospital and received ethics approval from Tam Anh General Hospital, Ho Chi Minh City Review Board (reg. no: 371/CV- TAHCM, date: 25.03.2024).

### Study and Patients

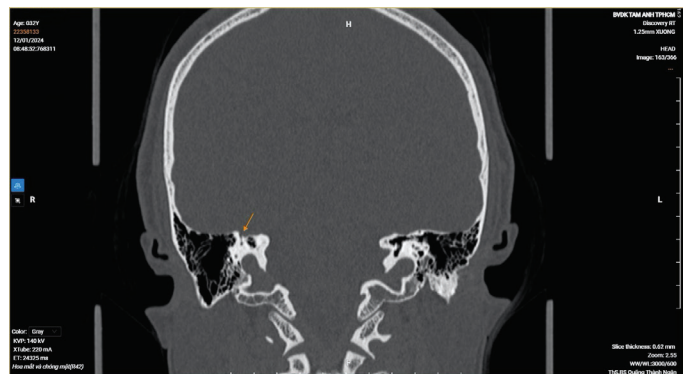
This retrospective study, conducted at Tam Anh General Hospital in Ho Chi Minh City between June 2023 and January 2024, included all patients visiting the Otorhinolaryngology Department who underwent HRCT scans of the temporal bone. Participants of all ages who underwent temporal bone CT scans had their comprehensive data documented within the electronic medical record system (Hsoft). The exclusion criteria comprised patients not undergoing CT scans following high-resolution temporal bone protocols, the visualization of the semicircular canal being obscured due to pathological conditions or foreign bodies or insufficient clinical information within the dataset. Sample size calculation, based on a significance level

of 0.05 and previous research by Williamson et al.<sup>12</sup> in 2003, indicated a minimum requirement of 125 patients. However, our retrospective examination of electronic medical records reviewed a total of 362 patients. CT scans were performed using 32, 128, and 768-slice CT scanners from Siemens Healthcare, Germany, with a slice thickness of  $\leq 1$  mm, distance of 0.375 mm, 120 kV (peak), 195 mA, pitch of 0.53, bone window, and matrix of 512x512. image acquisition was conducted in the axial plane with coronal orientation reconstructions ( $\leq 1$  mm thick,  $\leq 1$  mm distance), chosen as previous studies have demonstrated their adequacy in accurately determining the dehiscence of the superior semicircular canal (Figure 1,2) compared with the reconstructions according to the planes of Stenver (Figure 3) and Poschl (Figure 4)<sup>5</sup>.



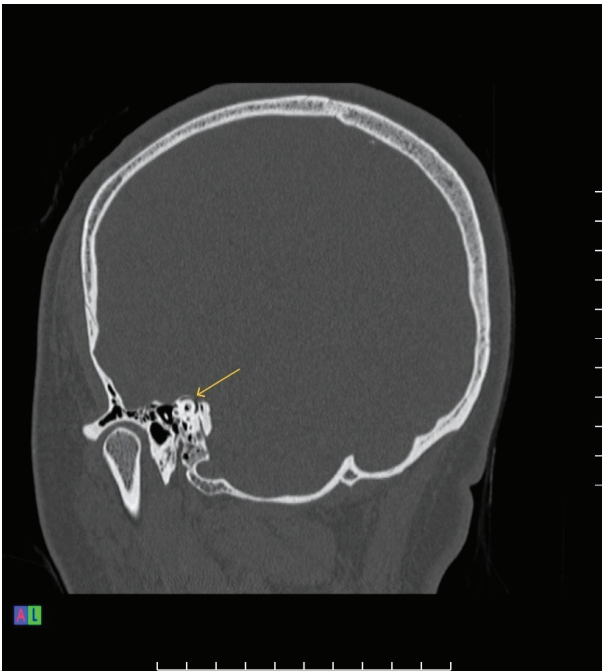
**Figure 1.** The superior semicircular canal appears intact. Coronal reconstruction of the temporal bone CT scan demonstrates an intact bony roof of the superior semicircular canal (arrow).

CT: Computed tomography



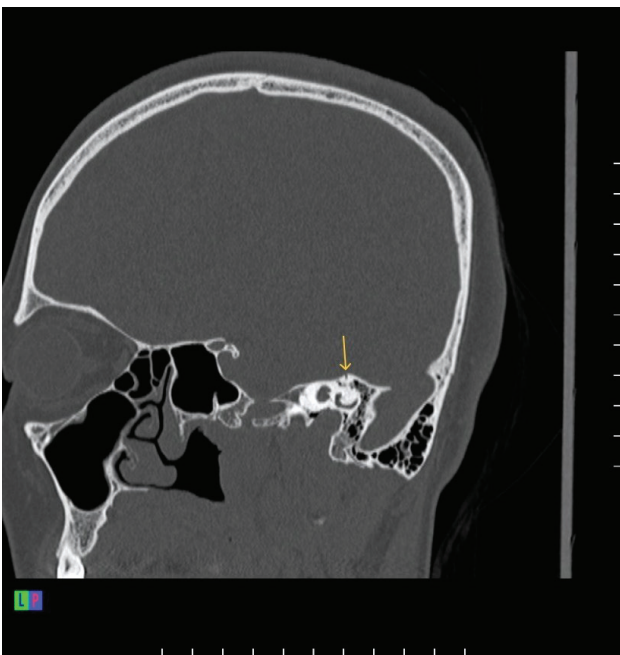
**Figure 2.** Superior semicircular canal dehiscence. Coronal reconstruction of the temporal bone CT scan in another patient reveals the absence of the bony roof of the superior semicircular canal (arrow).

CT: Computed tomography



**Figure 3.** Superior semicircular canal dehiscence in Stenvers view. Coronal CT reconstruction in the Stenvers plane of the same patient reveals a defect in the bony roof of the superior semicircular canal (arrow).

CT: Computed tomography



**Figure 4.** Superior semicircular canal dehiscence in Pöschl view. Coronal CT reconstruction in the Pöschl plane of the same patient reveals a defect in the bony roof of the superior semicircular canal (arrow).

CT: Computed tomography

## Data Collection

Electronic medical records were accessed to gather patient data along with HRCT imaging details. Following the interpretation of the scan results, subjects were categorized into two groups based on symptomatology: those exhibiting symptoms aligning with vestibular syndrome, as indicated by the International Classification of Diseases (ICD) code H81 documented by clinicians, and those lacking symptoms indicative of vestibular syndrome, as per the ICD code (patients without vestibular syndrome). Symptoms such as vertigo, dizziness, lightheadedness, tinnitus, hearing loss, and acoustic vertigo (Tullio phenomenon) were deemed consistent with vestibular syndrome.

## Statistical Analysis

In our study, we determined the prevalence of radiologic SSCD in both asymptomatic and symptomatic patient cohorts and estimated 95% confidence intervals using the Newcombe method for extreme percentages. To assess differences between these patient groups, we employed the Fisher Exact test for categorical variables and the Student t-test for continuous variables. We set a significance threshold of  $p < 0.05$  for all statistical tests. These calculations were executed using the Rstudio programming environment.

## RESULTS

Information from 365 patients was recorded at Tam Anh General Hospital between June 2023 and January 2024, resulting in the following findings:

### Population Demographics

In our study, the median age was determined to be  $45.7 \pm 18.6$  years, with the youngest participant being 1 year old and the oldest being 89 years old. Females constituted 58.3% of the cohort, whereas males comprised 41.7%. No significant age discrepancy was observed between genders, with a median age of 45 years for males and 46.2 years for females. The study population was categorized into two groups: 120 cases (33.1%) presenting with vestibular syndrome and 242 cases (66.9%) without vestibular syndrome. Upon comparison of ages, it was noted that individuals without vestibular syndrome were younger than those with vestibular syndrome, with median ages of  $43.7 \pm 19.4$  years and  $49.8 \pm 16.5$  years ( $p = 0.003$ ). Among the 120 cases exhibiting vestibular syndrome, symptoms included dizziness in 75% (90 cases), hearing loss in 16.67% (20 cases), tinnitus in 6.67% (8 cases), dizziness in 0.83% (1 case), and vestibular disorders in 0.83% (1 case).

### Prevalence of Superior Semicircular Canal Dehiscence and its Association with Vestibular Syndrome

In our study, the prevalence of SSCD was found to be 10.2% (37 of 362 cases). Among these cases, the incidence of SSCD in the group presenting with vestibular syndrome was 18.3% (22 out of 120 cases), whereas it was 6.2% (15 out of 242 cases) in the group without vestibular syndrome, as shown in Table 1. Notably, the prevalence of SSCD was nearly three times higher in individuals with vestibular syndrome than in those without ( $p=0.001$ ), demonstrating a statistically significant difference, as shown in Table 2. Gender-based analysis revealed no significant variation in SSCD prevalence. Furthermore, no association between SSCD and age was observed. However, within the vestibular syndrome group, the presence of SSCD was significantly associated with dizziness ( $p<0.001$ ).

### DISCUSSION

The prevalence of SSCD in our study was found to be 10.2% (37 out of 362 patients), which aligns closely with the reported frequency of 9% in a study conducted by Williamson et al.<sup>12</sup>. Despite a higher representation of females in our study cohort (58.3% vs. 41.7%), no significant association was observed between the occurrence of SSCD and gender, consistent with prior research findings.

Among patients presenting with vestibular syndrome, the prevalence of SSCD detected via HRCT was 18.3%,

resembling the findings reported by Ghany and Osman<sup>13</sup> who identified SSCD in 28 patients through HRCT scans. In contrast, Berning et al.<sup>14</sup> examined 610 patients, including 500 asymptomatic and 110 symptomatic individuals, who underwent HRCT scans, revealing a prevalence of 13.6% among those with vestibular symptoms and 2% among those without. Our study demonstrated a higher frequency of SSCD among symptomatic patients compared with that reported by Berning et al.<sup>14</sup>, which may be attributed to differences in sample size and patient population characteristics.

In patients without vestibular syndrome, the prevalence of SSCD detected via HRCT was 6.3%, similar to the findings reported by Nadgir et al.<sup>10</sup>. However, our study revealed a higher prevalence of SSCD among asymptomatic individuals compared with Crovetto et al.'s<sup>15</sup> study, which reported a frequency of 3.6%. These variations could be influenced by differences in sample size and demographic factors among the study populations.

Our retrospective analysis revealed a significantly higher prevalence of SSCD among patients with vestibular syndrome (18.3%) than among those without (6.2%), with a statistically significant difference ( $p<0.001$ ).

Consequently, we recommend that patients presenting with vestibular symptoms, particularly dizziness, undergo HRCT scanning to assess for SSCD.

**Table 1. Comparison of superior semicircular canal dehiscence rates between groups with and without vestibular syndrome.**

	SSCD		p-value (x <sup>2</sup> )	OR (CI 95%)
	Present (n=37)	Absent (n=325)		
Symptomatic	18.3% (22)	6.2% (98)	0.001	2.95
Asymptomatic	81.7% (15)	93,8% (227)		

SSCD: Superior semicircular canal dehiscence, OR: Odds ratio, CI: Confidence interval

**Table 2. Correlation between superior semicircular canal dehiscence and symptoms in the vestibular syndrome groups.**

	SSCD		p-value (x <sup>2</sup> )
	Present (n=22)	Absent (n=98)	
Dizziness	86.3% (19)	72.4% (71)	<0.001
Hearing loss	9% (2)	18.5% (18)	1
Tinnitus	4.7% (1)	7.1% (7)	1
Lightheadedness	0% (0)	1% (1)	1
Vestibular disorders	0% (0)	1% (1)	1

SSCD: Superior semicircular canal dehiscence

However, our study has several limitations inherent to its retrospective design, potentially leading to incomplete data collection and misclassification of patients with vestibular symptoms. In addition, the diverse clinical manifestations of SSCD and the possibility of other conditions mimicking its symptoms necessitate cautious interpretation of HRCT findings. Moreover, the ratio of SSCD cases to temporal bone HRCT scans in patients with vestibular syndrome should be interpreted with caution because of the relatively small sample size.

## CONCLUSION

The prevalence of SSCD detected via HRCT in our study did not differ significantly from prior research findings. Radiologists should remain vigilant in identifying this pathology during temporal bone HRCT imaging, particularly when it is correlated with clinical symptoms. Ultimately, we advocate the inclusion of HRCT scans in the diagnostic workup of patients presenting with vestibular syndrome, especially those experiencing symptoms such as dizziness. This approach facilitates the detection and evaluation of SSCD.

## Ethics

**Ethics Committee Approval:** The study was conducted at Tam Anh Ho Chi Minh General Hospital and received ethics approval from Tam Anh General Hospital, Ho Chi Minh City Review Board (reg. no: 371/CV- TAHCM, date: 25.03.2024).

**Informed Consent:** Retrospective study.

## Author Contributions

Surgical and Medical Practices: C.T.T., T.P.T., Concept: C.T.T., H.H.P., T.P.T., Design: C.T.T., H.H.P., T.P.T., Data Collection and/or Processing: C.T.T., T.L.H.L., T.T.T.H., N.H.M., H.H.P., T.P.T., Analysis and/or Interpretation: C.T.T., T.L.H.L., T.T.T.H., N.H.M., H.H.P., T.P.T., Literature Search: C.T.T., T.L.H.L., T.T.T.H., N.H.M., H.H.P., T.P.T., Writing: C.T.T., T.L.H.L., T.T.T.H., H.H.P., T.P.T.

**Conflict of Interest:** The authors have no conflict of interest to declare.

**Financial Disclosure:** The authors declared that this study has received no financial support.

## REFERENCES

- Bhatt AA, Lundy LB, Middlebrooks EH, Vibhute P, Gupta V, Rhyner PA. Superior Semicircular Canal Dehiscence : Covering Defects in Understanding from Clinical to Radiologic Evaluation. *Clin Neuroradiol.* 2021;31:933-41.
- Minor LB, Solomon D, Zinreich JS, Zee DS. Sound- and/or pressure-induced vertigo due to bone dehiscence of the superior semicircular canal. *Arch Otolaryngol Head Neck Surg.* 1998;124:249-58.
- Watson SR, Halmagyi GM, Colebatch JG. Vestibular hypersensitivity to sound (Tullio phenomenon): structural and functional assessment. *Neurology.* 2000;54:722-8.
- Rosowski JJ, Songer JE, Nakajima HH, Brinsko KM, Merchant SN. Clinical, experimental, and theoretical investigations of the effect of superior semicircular canal dehiscence on hearing mechanisms. *Otol Neurotol.* 2004;25:323-32.
- Branstetter BF 4th, Harrigan C, Escott EJ, Hirsch BE. Superior semicircular canal dehiscence: oblique reformatted CT images for diagnosis. *Radiology.* 2006;238:938-42.
- Minor LB. Clinical manifestations of superior semicircular canal dehiscence. *Laryngoscope.* 2005;115:1717-27.
- Carey JP, Minor LB, Nager GT. Dehiscence or thinning of bone overlying the superior semicircular canal in a temporal bone survey. *Arch Otolaryngol Head Neck Surg.* 2000;126:137-47.
- Gartrell BC, Gentry LR, Kennedy TA, Gubbels SP. Radiographic features of superior semicircular canal dehiscence in the setting of chronic ear disease. *Otol Neurotol.* 2014;35:91-6.
- Masaki Y. The prevalence of superior canal dehiscence syndrome as assessed by temporal bone computed tomography imaging. *Acta Otolaryngol.* 2011;131:258-62.
- Nadgir RN, Ozonoff A, Devaiah AK, Halderman AA, Sakai O. Superior semicircular canal dehiscence: congenital or acquired condition? *AJNR Am J Neuroradiol.* 2011;32: 947-9.
- Stimmer H, Hamann KF, Zeiter S, Naumann A, Rummeny EJ. Semicircular canal dehiscence in HR multislice computed tomography: distribution, frequency, and clinical relevance. *Eur Arch Otorhinolaryngol.* 2012;269:475-80.
- Williamson RA, Vrabec JT, Coker NJ, Sandlin M. Coronal computed tomography prevalence of superior semicircular canal dehiscence. *Otolaryngol Head Neck Surg.* Coronal computed tomography prevalence of superior semicircular canal dehiscence. *Otolaryngol Head Neck Surg.* 2003;129:481-9.
- Ghany AFA, Osman NM. Superior Semicircular Canal Dehiscence: A Missed Finding in Temporal Bone Multidetector CT Scans in Symptomatic Patients Presenting with Vertigo. *Int Adv Otol.* 2011;7:157-64.
- Berning AW, Arani K, Branstetter BF 4th. Prevalence of Superior Semicircular Canal Dehiscence on High-Resolution CT Imaging in Patients without Vestibular or Auditory Abnormalities. *AJNR Am J Neuroradiol.* 2019;40:709-12.
- Crovetto M, Whyte J, Rodriguez OM, Lecumberri I, Martinez C, Eléxpuru J. Anatomic-radiological study of the Superior Semicircular Canal Dehiscence Radiological considerations of Superior and Posterior Semicircular Canals. *Eur J Radiol.* 2010;76:167-72.