ISSN 0973-2063 (online) 0973-8894 (print)

Bioinformation 22(10): 7415-7418 (2026)

©Biomedical Informatics (2026)

BIOINFORMATION
Discovery at the interface of physical and biological sciences

BIOMEDICAL INFORMATICS

www.bioinformation.net

Volume 22(10)

Research Article

Received October 1, 2026; Revised October 31, 2026; Accepted October 31, 2026, Published October 31, 2026

DOI: 10.6026/973206300227415

SJIF 2026 (Scientific Journal Impact Factor for 2026) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Declaration on Publication Ethics:
The author's state that they adhere with COPE guidelines on publishing ethics as described elsewhere at https://publicationethics.org/. The authors also undertake that they are not associated with any other third party (governmental or non-governmental agencies) linking with any form of unethical issues connecting to this publication. The authors also declare that they are not withholding any information that is misleading to the publisher in regard to this article.

Declaration on official E-mail:
The corresponding author declares that lifetime official e-mail from their institution is not available for all authors

License statement:
This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. This is distributed under the terms of the Creative Commons Attribution License

Comments from readers:
Articles published in BIOINFORMATION are open for relevant post publication comments and criticisms, which will be published immediately linking to the original article without open access charges. Comments should be concise, coherent and critical in less than 1000 words.

Disclaimer:
Bioinformation provides a platform for scholarly communication of data and information to create knowledge in the Biological/ Biomedical domain after adequate peer/editorial reviews and editing entertaining revisions where required. The views and opinions expressed are those of the author(s) and do not reflect the views or opinions of Bioinformation and (or) its publisher Biomedical Informatics. Biomedical Informatics remains neutral and allows authors to specify their address and affiliation details including territory where required.

Edited by Ashwini Dhopte
E-mail: ashwinidhopte@gmail.com
Citation: Deepak *et al*. Bioinformation 22(10): 7415-7418 (2026)

Cone-beam computed tomographic evaluation of canalis sinuosus and accessory canals in a South Tamil Nadu population

John hearty Deepak*, N.J. Nagaraj, Allsun Sweetline, K.M. Asnika, Anushya Murugan & Gracelin Ranjitha

Department of Oral Medicine and Radiology, Rajas Dental College and Hospital, affiliated with The Tamil Nadu Dr. M.G.R. Medical University, Kavalkinaru, Tirunelveli, India; *Corresponding author

Affiliation URL:
https://rajasdentalcollege.edu.in/

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 7415-7418 (2026)
©Biomedical Informatics (2026)

Author contact:
John hearty Deepak - E-mail: johndeepak.dent@gmail.com; Phone: +91 9894440202
N.J. Nagaraj - E-mail: dr.njendo1992@gmail.com; Phone: +91 8075583038
Allsun Sweetline - E-mail: allsunsweetline163@gmail.com
K.M. Asnika - E-mail: asnika2021@gmail.com; Phone: +91 8300817153
Anushya Murugan - E-mail: anushyamurugan21@gmail.com; Phone: +91 9003160737
Gracelin Ranjitha - E-mail: gracelinranjitha@gmail.com; Phone: +91 9786927772

Abstract:
Canalis sinuosus is a neurovascular canal of the anterior maxilla that may be overlooked during routine treatment planning. Therefore, it is of interest to evaluate the prevalence, sidedness, diameter, course, termination, accessory canals and associations with age and sex in 500 scans from a South Tamil Nadu population. Canalis sinuosus was identified in 493 scans (98.6%), was predominantly bilateral (92.9%) and was accompanied by 602 accessory canals, most commonly terminating in the anterior palatal region near the central and lateral incisors. No significant associations were observed between prevalence and age or sex, although minor side-related anatomical variation was present. Thus, data support careful CBCT assessment of the anterior maxilla before implant, endodontic and oral-surgical procedures where neurovascular injury could occur.

Keywords: Canalis sinuosus, accessory canals, cone beam computer tomography (CBCT), anterior maxilla, anatomical variation

Background:
Canalis Sinuosus, or CS, first described by Frederic Wood Jones in 1939, is a bony canal in the anterior maxilla that transmits the anterior superior alveolar neurovascular bundle. It originates from the infraorbital canal, with a tortuous path medially and downward along the lateral nasal wall, extending to the nasal floor and incisive region. It generally ends near the nasal septum and incisive canal, innervating the anterior maxillary teeth **[1, 2].** Radiographically, it is observed as a small radiolucent canal, which may be confused with periapical pathology on two-dimensional imaging modalities. However, using cone beam computed tomography, especially in the axial and sagittal planes, the accurate diagnosis of this canal is possible. According to recent research, the Canalis sinuosus and its auxiliary canals are more prevalent and have more anatomical variety than previously considered, thereby requiring thorough preoperative evaluation **[3, 4 and 5].** Although CBCT offers precise three-dimensional visualization, which helps with accurate diagnosis and safer treatment planning, conventional 2D imaging can be insufficient **[6].** The anterior maxilla is often considered a safe zone for implants; however, the Canalis Sinuosus (CS) and its accessory canals (ACs) are variable neurovascular structures that may be overlooked. It follows a sinuous course and may terminate near critical implant sites **[7].** Therefore, it is of interest to evaluate the prevalence, anatomy and variation of Canalis Sinuosus and its accessory canals, including gender differences, in a South Tamil Nadu population using CBCT.

Methods:
A cross-sectional retrospective CBCT study was conducted at Rajas Dental College and Hospital using archived scans acquired from 2020 to 2025. Five hundred scans that fulfilled the eligibility criteria were evaluated. Patients were grouped by age as ≤20 years (n = 60, 12.0%), 21–40 years (n = 220, 44.0%), 41–60 years (n = 158, 31.6%) and ≥61 years (n = 62, 12.4%). Eligible scans were from patients aged 18–70 years, included the entire anterior maxilla from the piriform aperture to the alveolar crest, had a voxel size ≤0.4 mm and showed no significant distortion or artefact. Scans with motion or beam-hardening artefacts, intraosseous pathology, cleft palate or craniofacial syndromes, previous anterior maxillary trauma or surgery, maxillary fracture, or severe periodontal bone loss were excluded.

Sample size statistics:
A post-hoc precision analysis was conducted. With a sample size of 500 and an observed prevalence of 98.6% for the Canalis Sinuosus, the 95% confidence interval (Wilson method) is 97.2% to 99.4%, indicating excellent precision with a margin of error of approximately ±1.1%. For the comparison of accessory canal counts between right and left sides ($p = 0.04$), a post hoc power analysis using G*Power with a two-tailed $\alpha = 0.05$ and a small-to-medium effect size ($w = 0.15$) revealed an achieved power of 0.86, exceeding the conventional threshold of 0.80. These findings confirm that the sample size of 500 was adequate to detect statistically significant differences where present.

Image accession:
CBCT imaging was performed with the NewTom GiANO HR 3D system and analysed using NNT software. The selected field of view was 10 × 6 cm and the voxel size was approximately 0.08 mm, allowing high-resolution evaluation of small neurovascular canals. Tube voltage was approximately 90 kVp and tube current approximately 4.0 mA, with exposure adapted to patient size according to the acquisition protocol. Multiplanar reconstructions were reviewed using standardized display settings.

Analysis of the diameter, distribution, location and branches of the canalis sinuosus:
CBCT scans were assessed in axial, coronal and sagittal planes. The recorded variables were: (1) presence or absence of canalis sinuosus; (2) sidedness (unilateral right, unilateral left, or bilateral); (3) terminal position of the canal in relation to the central incisor, lateral incisor, interdental region, canine, or first

premolar; (4) presence and number of accessory canals; (5) accessory-canal course; (6) origin and terminal location of accessory canals; and (7) accessory-canal diameter, categorized as <1 mm or ≥1 mm. Measurements were made on the clearest multiplanar reconstruction and verified in an orthogonal plane.

Statistical analysis:
Data were summarized using frequencies, percentages, means and standard deviations as appropriate. Associations of categorical variables with age group, sex and side were evaluated using the chi-square test or Fisher's exact test when expected cell counts were small. The Shapiro–Wilk test was used to assess normality of continuous measurements before parametric summaries or comparisons. Statistical significance was set at $p < 0.05$.

Results:
Table 1 summarizes age-stratified prevalence (493/500 scans, 98.6%), whereas **Table 3** details right–left accessory-canal counts. The latter table uses side counts that do not reconcile directly with the stated 500 scans and 602 accessory canals; denominators and reported side-comparison p value need checking against original scan-level records. Canalis sinuosus was identified in 493 of 500 scans, corresponding to a prevalence of 98.6%. Prevalence did not differ significantly across age groups ($p = 0.37$). These data indicate that the canal was frequently identifiable throughout the studied age range; however, the retrospective design does not establish developmental stability over time. Among CS-positive scans, bilateral presentation predominated (92.9%), whereas unilateral canals were uncommon (7.1%). Unilateral occurrence was slightly more frequent on the right (4.5%) than on the left (2.6%), but the side difference was not statistically significant ($p = 0.14$). Thus, the observed distribution was strongly bilateral without evidence of a significant unilateral side preference. Accessory canals most frequently originated in the central and lateral incisor regions across age groups, supporting a predominantly anterior distribution. Accessory canals arising near the first premolar were uncommon and were observed more often in the oldest age category; because subgroup counts were limited, this pattern should be interpreted descriptively rather than as an age-dependent effect. Canal-course distribution differed significantly across the recorded course categories ($p < 0.001$), with a straight vertical course observed most frequently. In contrast, the distribution of canal course did not differ significantly between the right and left sides ($p = 0.61$), suggesting broadly similar course patterns bilaterally **(Table 2)**. Accessory-canal diameter did not differ significantly between the right and left sides ($p = 0.79$). The mean diameter was 0.82 ± 0.11 mm in canals measuring <1 mm and 1.23 ± 0.19 mm in canals measuring ≥1 mm. These findings indicate that canal dimensions were similar between sides in the present sample. A total of 602 accessory canals were identified. The most common terminal region was the anterior palate (55%), consistent with the predominantly anterior origin of accessory canals. Canals arising from more posterior sites, such as the canine or premolar regions, more often terminated buccally or near the incisive region. This anatomical variability is relevant to implant placement, endodontic surgery and other invasive procedures in the anterior maxilla. No statistically significant association was detected between sex and the presence of canalis sinuosus ($p = 0.49$) or accessory canals ($p = 0.58$). In this sample, therefore, these structures occurred with similar frequency in male and female patients.

Table 1: Prevalence of canalis sinuosus by age

Assessment	≤20	21–40	41–60	≥61	Total	p value
CS absent	2	4	1	0	7	
CS present	58	216	157	62	493	
Total	60	220	158	62	500	
Prevalence (%)	96.7	98.2	99.4	100	98.6	0.37

Table 2: Course of the accessory canal

Classification	Right	Left	Total	Percentage (%)	p value
Straight vertically	217	211	428	71.1	
Curved medially	31	32	63	10.5	
Curved laterally	29	27	56	9.3	
Curved distally	26	26	52	8.6	
Other	1	2	3	0.5	
Total	304	298	602	100	<0.001*
Side comparison p value	0.61				

Table 3: Number of accessory canals

Number	Right	Left	p value
0	182	189	
1	142	136	
2	102	96	
3	39	46	
4	21	19	
≥5	8	7	
Total	294	289	0.04*
SD	0.60 ± 0.87	0.59 ± 0.88	

Discussion:
Cone-beam computed tomography provides three-dimensional visualization of small osseous neurovascular channels that may be poorly demonstrated on conventional two-dimensional imaging **[8, 9].** The present study found canalis sinuosus in 98.6% of scans, with bilateral presentation in most CS-positive cases, reinforcing the view that the structure is common rather than exceptional in the anterior maxilla. Previous CBCT studies have also documented substantial variation in the number, diameter, course and terminal foramina of CS accessory canals **[9–13].** Such variation has direct procedural relevance because injury to these channels during implant osteotomy, apical surgery, grafting, or other anterior maxillary procedures can contribute to bleeding, pain, paraesthesia, or diagnostic confusion **[14–21].** In the current series, accessory canals most often originated around the central and lateral incisor regions and most frequently terminated in the anterior palate; right-left differences in diameter and course were not significant. Recent CBCT studies likewise report frequent accessory foramina and emphasize careful three-dimensional mapping before implant surgery **[22, 23].** A recent systematic review further highlighted heterogeneity in reported CS prevalence and morphology across populations and imaging protocols, while consistently supporting the clinical value of CBCT when a procedure

approaches the anterior maxillary neurovascular anatomy **[24].** Published CBCT studies from South Africa and India similarly identify canalis sinuosus and its accessory branches as clinically relevant in the anterior maxilla; variation in CBCT inclusion criteria and canal detection thresholds may explain differences in measured prevalence. **[25] [26] [9]**. The very high prevalence observed here may partly reflect the use of high-resolution CBCT and broad criteria for identifying the main canal and accessory branches. Because this was a retrospective, single-centre imaging study, the results should not be generalized to all populations without external validation. Future multi-centre studies should use standardized definitions, calibrated observers and reproducibility testing and should relate canal morphology to specific procedural risk zones.

Conclusion:

Canalis sinuosus is a consistently identified anatomical structure in this South Tamil Nadu CBCT sample and was most commonly bilateral. Accessory canals showed clinically relevant variation in course and termination, supporting careful three-dimensional assessment of the anterior maxilla before implant placement, endodontic surgery and other invasive procedures.

References:

[1] https://thelifesaversblog.wordpress.com/wp-content/uploads/2015/11/textbook-of-head-and-neck-anatomy.pdf
[2] https://shop.elsevier.com/books/textbook-of-oral-and-maxillofacial-surgery/balaji/978-81-312-6469-0
[3] Jones FW. *J Anat*. 1939 **73:**583. [PMID: 17104781]
[4] de Oliveira-Santos C *et al. Clin Oral Implants Res*. 2013 **24**:1044. [PMID: 22587228]
[5] von Arx *T et al. Surg Radiol Anat*. 2013 **35:**783. [PMID: 23539212]
[6] Orhan K *et al. Folia Morphol (Warsz*). 2018 **77:**551. [PMID: 29345719]
[7] Machado VC *et al. Int J Oral Maxillofac Surg*. 2016 **45:**1586 [PMID: 27720336]
[8] https://www.ncbi.nlm.nih.gov/books/NBK592390/
[9] Devathambi TJR *et al. J Clin Imaging Sci.* 2024 **14**:8. [PMID:38628609]
[10] Ferlin R *et al. Oral Surg Oral Med Oral Pathol Oral Radiol*. 2019 **127:**545 [PMID: 30772255]
[11] Wu TH *et al. BMC Med Imaging*. 2025 **25:**461 [PMID: 41225379]
[12] Alkis HT *et al. J Stomatol Oral Maxillofac Surg*. 2023 **124:**101406 [PMID: 36736732]
[13] Tomrukçu DN & Köse TE. *Med Oral Patol Oral Cir Bucal*. 2019 **25:**e124 [PMID: 31880280]
[14] Romanos G *et al. J Oral Implantol*. 2023 **49:**428 [PMID: 37527148]
[15] McCrea SJJ. *et al. Case Rep Dent*. 2017 **2017:**5969643 [PMID: 28785491]
[16] Olenczak JB *et al.Ann Plast Surg*. 2015 **75:**543 [PMID: 25710550]
[17] Volberg R & Mordanov O *Case Rep Dent*. 2019 **2019:**15 [PMID: 31934462]
[18] Shah P *et al. J Conserv Dent*. 2017 **20:**479 [PMID: 29430105]
[19] Shelley A *et al. Br Dent J*. 1999 **186:**378 [PMID: 10365458]
[20] Jabali S *et al. J Adv Periodontol Implant Dent*. 2024 **16:**139 [PMID: 39758264]
[21] Mohammadhosseinzadeh A *et al. Oral Sci Int*. 2026 **23**:e70032. [DOI: 10.1002/osi2.70032]
[22] Schnutenhaus S *et al. J Clin Med*. 2025 **14**:1083. [PMID: 40004614]
[23] Aktuna Belgin C *et al. Oral Radiol*. 2024 **40**:530. [PMID: 39060842]
[24] Kałuża O *et al. Folia Morphol*. 2026 **85**:e01726020. [PMID: 40524622]
[25] Beckenstrater MA *et al. Oral Radiol*. 2024 **40**:367. [PMID: 38337132].
[26] Denny C *et al. F1000Res*. 2026 Jul **16** 15:174. [PMID: 42311218]

Caveat Emptor is applicable among the literate community where required and possible. The publisher, its journal, editors and the internal/external reviewers take adequate steps to check, evaluate, correct, edit, revise and improve content where possible and required.