



ISSN: 0975-833X

Available online at <http://www.journalcra.com>

International Journal of Current Research  
Vol. 10, Issue, 12, pp.75981-75984, December, 2018

DOI: <https://doi.org/10.24941/ijcr.32898.12.2018>

INTERNATIONAL JOURNAL  
OF CURRENT RESEARCH

## RESEARCH ARTICLE

### EVALUATION OF ANATOMICAL VARIATIONS OF CANALIS SINUOSUS - A CONE BEAM COMPUTED TOMOGRAPHY (CBCT) STUDY

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#### ARTICLE INFO

##### Article History:

Received 22<sup>nd</sup> September, 2018  
Received in revised form  
03<sup>rd</sup> October, 2018  
Accepted 14<sup>th</sup> November, 2018  
Published online 29<sup>th</sup> December, 2018

##### Key Words:

Canalis sinuosus;  
Anatomical variations;  
Anterior maxilla;  
Cone beam computed tomography

#### ABSTRACT

**Background:** Canalis sinuosus is a neurovascular canal in the anterior maxillary region. The importance of this anatomical variation can be considered during the surgical interventions in the anterior maxilla. Injury to this canal results in the paresthesia after surgery. CBCT plays a important role in evaluating these anatomical variations as it provides reliable images of maxillomandibular complex. CBCT helps the clinician to evaluate CS for treatment planning and to prevent the intra and post operative surgical complications. **Objectives:** To assess the anatomical variations of Canalis sinuosus (CS) by using Cone beam computed tomography (CBCT) and to emphasize CBCT is necessary before invasive procedures to preserve important anatomical structures. **Materials and methods:** The study involved the evaluation of 63 CBCT scans by carestream 3D software. Presence, occurrence, position and distance of CS from its emergence to nasal cavity floor, buccal cortical bone edge, crest of alveolar ridge were noted in saggital plane and distance from incisive foramen was noted in axial plane. **Results:** Out of the 63 scans performed Canalis sinuosus was present in 39.7%. Unilateral and bilateral occurrences were 30.2% and 9.5% respectively. The side predilection was more on the left side (22.2%). Position of CS near lateral incisor region is 12.7% on left side and 12.7% on the right side. There was no significant difference in the mean distance of CS from its emergence to nasal cavity floor, buccal cortical bone edge, crest of alveolar ridge and incisive foramen. **Conclusions:** Canalis sinuosus is a rare anatomical variation in the anterior maxilla region. Clinicians should carefully assess these variations and it should be highlighted that CBCT is necessary prior to any surgical intervention to decrease the risk of complications and to preserve important anatomical structures.

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Citation: Nagalaxmi Velpula, Faisal Taiyebali Zardi, Madhuri Kanakagiri and Roshni Tandon, 2018. "Evaluation of anatomical variations of canalis sinuosus - A cone beam computed tomography (CBCT) study", *International Journal of Current Research*, 10, (12), 75981-75984.

## INTRODUCTION

Surgical interventions in the anterior maxillary region is very crucial because it has a strong impact on facial esthetics (López Jornet, 2015). Incisive canal was the only anatomical structure considered in anterior maxillary region in most of the invasive procedures. There is another rare variation in this zone called Canalis sinuosus (CS) and injury to this canal results in complications (Wanzeler, 2015). Canalis sinuosus (CS) is a small branch issued by infra orbital canal on its lateral side close to its midpoint.

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It allows the passage of anterior superior alveolar nerve and its blood vessels. This neurovascular canal runs to the anterior and inferior wall of orbital cavity, lateral to the infraorbital canal. It medially bent toward the anterior wall of maxillary sinus, passing below the infraorbital foramen (Neves, 2012). The importance of this anatomical variation can be considered during the surgical interventions in anterior maxillary region like implant placement, surgeries of maxillary sinus, orthognathic surgeries, enucleation of cysts, extraction of impacted and supernumerary teeth (López Jornet, 2015). Injury to this canal may have impact on a patient's quality of life due to hyperesthesia, paresthesia, or pain (Rodella, 2012). These sensory impaiements may be temporary or permanent (Annibali, 2008). Before planning the surgical treatment the

radiological evaluation and visualization were considered to be important to prevent the complications. Conventional images have limited value in showing some intrabony courses of neurovascular structures (Kohavi, 1994 and Temmerman, 2011). This was because of their limitations like magnification and distortion resulting in intraoperative complications of unknown etiology (Faria, 1981). CBCT plays an important role in presurgical evaluation of anatomical variations by providing reliable images of maxilla and mandibular region. It enables the clinician to detect and evaluate the CS for treatment planning and surgery. The aim of this study was to evaluate the anatomical variations of Canalis sinuosus by using CBCT and to highlight the importance of CBCT.

## MATERIALS AND METHODS

This retrospective study was conducted in the Department of Oral Medicine and Radiology, Sri sai college of dental surgery, Vikarabad. 63 CBCT images were included in the study. These images were made by using a 9300 select 3D unit, with 90 kV, 4.0 mA, exposure time of 11.0 sec. Images were reconstructed using a high spatial frequency reconstruction algorithm.

### Inclusion Criteria

Male and female patients of age group between 20 and 80 years who had assessed their maxilla by CBCT for diagnostic purpose.

### Exclusion Criteria

- Congenital defects in the maxilla
- Trauma in the maxilla
- Pathological lesions in the maxilla
- History of any surgical procedures and bone grafting in the maxilla
- Poor quality (blurred and distorted) CBCT images

These CBCT images were analyzed by carestream 3D software in axial, sagittal and coronal planes and the following data was recorded.

### Sagittal plane

- Presence or absence of CS
- Occurrence of CS (Unilateral / Bilateral)

- Position of CS near (Central incisor / Lateral incisor / Canine)
- Distance (mm) of the CS from its emergence to the nasal cavity floor (NC), buccal cortical bone edge (BC), crest of alveolar ridge (RC).

**Axial plane:** Distance (mm) of the CS from incisive foramen (IC).

## RESULTS

First a descriptive statistical analysis was conducted for total sample. Out of 63 CBCT images CS was detected in 25 images (39.7%) and absent in 38 images (60.3%). Occurrence was unilateral in 19 images (30.2%) and bilateral in 6 images (9.5%). The most frequent side of occurrence is left (22.2%) and most frequent position is near lateral incisor region with 12.7% and 20.6% on right and left sides respectively (Table 1). Independent sample test was done for the distances of NC, BC, RC and IC. There was no significant difference in the mean distance of NC, BC, RC and IC on the left and right sides (Table 2).

## DISCUSSION

The anterior maxillary region which is also called as premaxilla is the frequent site of surgical interventions (Von Arx, 2013). To prevent intra operative, post operative complications and for better prognosis knowledge of anatomical variations is necessary. Hence these anatomical variations should be evaluated prior the surgical procedures. Canalis sinuosus the lateral branch of infraorbital nerve is a rare anatomical variation of anterior maxillary zone (Neves, 2012).

It was first proposed by Jones, as a neurovascular bundle which leaves the infraorbital foramen (Jones, 1939). Most of the clinicians were unaware of this variation which results in intra and post operative complications. These variations are hardly identified by conventional imaging techniques due to their limitations. Field of maxillofacial imaging is immensely expanding following the introduction of CBCT (Scarfe, 2008). Good image quality, volumetric analysis, short scan times, and relatively less radiation dose than conventional medical CT, has resulted in increasing demand of CBCT in various fields of dentistry (Rungcharassaeng, 2007). Hence the anatomical variations can be evaluated by using CBCT. In the present study of 63 CBCT scans CS was detected in 25(39.7%) scans.

**Table 1. Statistical data for occurrence, side predilection, and position of CS for total sample**

	Total	Occurrence					Side predilection				Position (R)			Position (L)		
		A	P	UL	BL	B	R	L	CI	LI	C	CI	LI	C		
Number	63	38	25	19	6	6	5	14	0	8	3	2	13	5		
Percentage	100	60.3	39.7	30.2	9.5	9.5	7.9	22.2	0	12.7	5.8	3.2	20.6	7.9		

A- Absent, P- present, UL- unilateral, BL- bilateral, B - both, R- right, L- left, CI-central incisor, LI - lateral incisor, C-canine.

**Table 2. Statistical data for the measurements NC, BC, RC and IC on left and right sides**

Distance	Right side(n= 13)		Left side(n= 21)		p-value
	Mean	SD	Mean	SD	
NC	15.7	3.19	15.8	3.35	0.9(NS)
BC	8.08	1.10	8.06	1.25	0.95(NS)
RC	6.70	3.92	6.21	1.74	0.62(NS)
IC	6.93	3.14	6.33	2.96	0.58(NS)

Nasal cavity floor (NC), buccal cortical bone edge (BC), crest of alveolar ridge (RC), incisive foramen (IC).  
Examples of CS presence in CBCT sagittal and axial sections

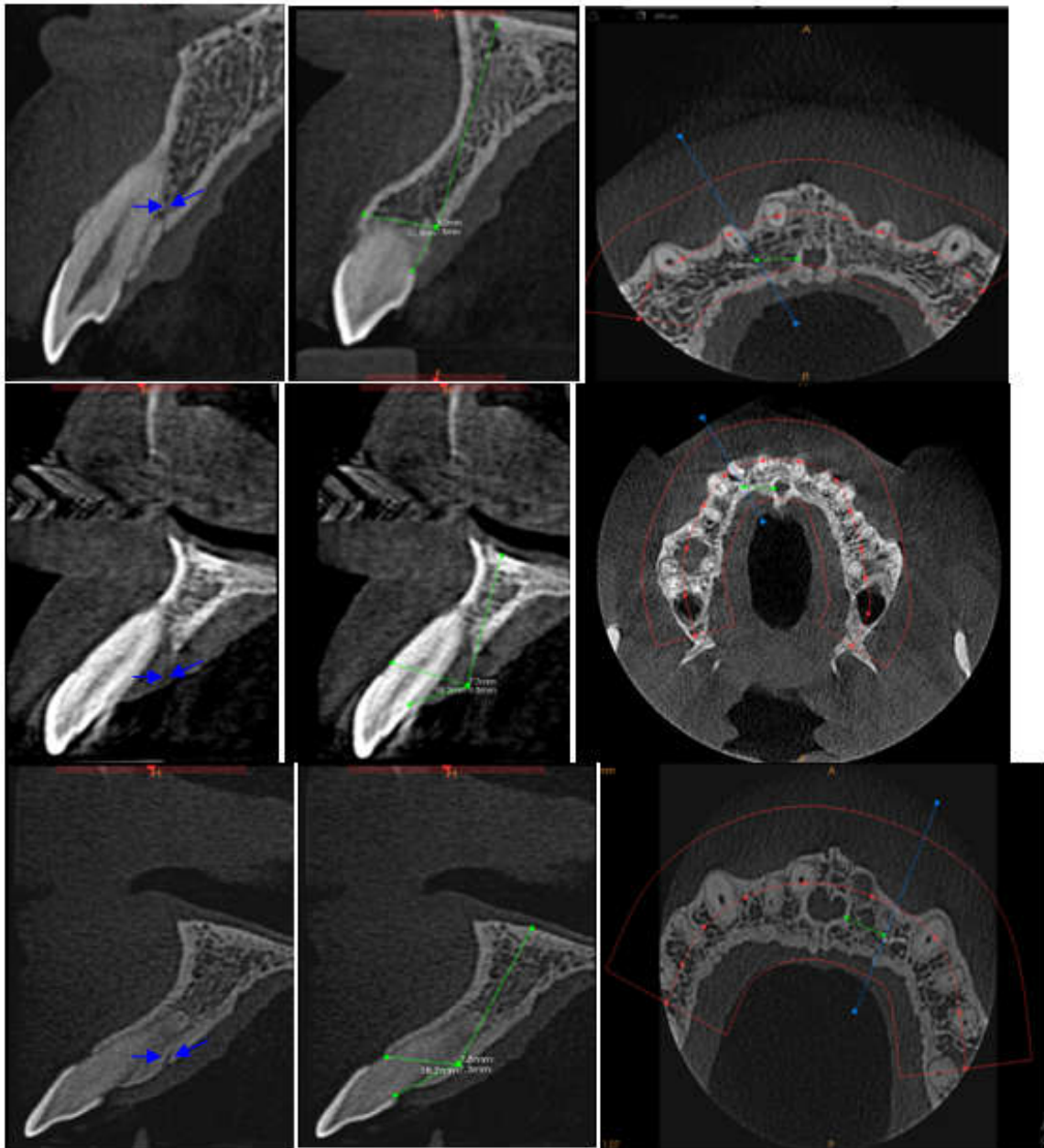


Figure 1. Examples of CS presence in CBCT sagittal and axial sections

The unilateral and bilateral occurrences were 30.2% and 9.5% respectively. Left side has a greater predilection with 22.2%. Position of Canalis sinuosus was greater near lateral incisor region with 12.7% and 20.6% on right and left side respectively. The following p-values were obtained for the NC, BC, RC, IC were 0.9, 0.95, 0.62, 0.52 respectively. Oliveira-Santos et al assessed CBCT scans of 178 subjects and found that 28 (15.7%) had an additional foramen on the palate, with a total of 34 additional foramina being recorded.<sup>13</sup> There were no statistical differences between the patients either with or without an additional foramen on the palate when compared by gender or age, which is not in agreement with the findings of the present study because this includes only mixed group and CS was present in 39.7% of scans. Manhães Junior LR et al assessed 500 CBCT scans and found that there was a variation between the right and left sides regarding the distances between the CS and the alveolar bone crest and between the CS and the buccal cortical bone which is not in agreement with present study because there was no significant

difference in the mean distance of NC, BC, RC, IC on the left and right sides in the present study (Manhães Júnior, 2016). Manhães Júnior LR et al concluded that the CS position is going to be located by the upper lateral incisor palatine which is agreement with the present study. Wanzeler et al assessed 100 CBCT images and found CS was present in 88% of the total sample (Wanzeler, 2015). There were no statistically significant changes in the presence of the CS related to gender, age, and course direction. The authors concluded that the CS was frequent similar in both genders, with a distant course to the alveolar bone crest ending in different locations, which is not agreement with the present study, suggesting that the CS should be analyzed using CBCT before performing surgical procedures. von Arx et al evaluated 176 CBCT images and found the CS in 49 patients (27.8%) (von Arx, 2013). The greatest canal frequency was observed more often in male (33.0%) than in female (22.7%;  $p = 0.130$ ) subjects, though gender and age did not significantly influence CS diameter. The authors concluded that, from a clinical perspective, further

studies are needed to determine the content of these canals. The results of this paper are in agreement with those of previous studies suggesting CBCT is necessary for identifying anatomical variations for proper treatment.

### Glossary of abbreviations

- 1) ABSENT – A
- 2) BILATERAL - BL
- 3) BOTH – B
- 4) BUCCAL CORTICAL BONE RIDGE - B
- 5) CANALIS SINUOSUS – CS
- 6) CANINE – C
- 7) CENTRAL INCISOR - CI
- 8) CONE BEAM COMPUTED TOMOGRAPHY – CBCT
- 9) CREST OF ALVEOLAR RIDGE - RC
- 10) INCISIVE FORAMEN – IC
- 11) LATERAL INCISOR – LI
- 12) LEFT – L
- 13) NASAL CAVITY FLOOR – NC
- 14) PRESENT - P
- 15) RIGHT – R
- 16) UNILATERAL - UL

### Conclusion

According to the results obtained, it may be concluded that CS is not a rare anatomical variation hence clinicians should evaluate before surgical interventions. It's occurrence is mostly unilateral with left side predilection and positioned near lateral incisor region. CBCT is necessary for imaging these anatomical variations for better treatment plan and prognosis. Further studies with large sample size is needed for better evaluation.

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