The Role of Chemical Substances in Classic and Modern Sialography

Technique and applications

DANISIA HABA[1#], CRISTIAN BUDACU[1]*, MIHAI CONSTANTIN[1], VICTOR VLAD COSTAN[1#], ALEXANDRU NEMTOI[2]

[1]Grigore T. Popa University of Medicine and Pharmacy, Department of Oral and Maxillofacial Surgey, 16 Universitatii Str., 700115, Iasi, Romania

[2]Grigore T. Popa University of Medicine and Pharmacy, Department of Morpho-Functional Sciences, 16 Universitatii Str., 700115, Iasi, Romania

The purpose of this study was to assess the role of a chemical contrast medium used in plain x ray and CBCT (cone beam computed tomography) sialography imaging in the detection of different changes associated with lesions of salivary glands. 20 subjects were recruited into this prospective clinical study over a 1 year time period. Sialography was performed by an oral and maxillofacial surgeon. A lateral skull plain image was then made and a three-dimensional scanning using a CBCT machine. The imaging volume was centred on the gland of interest. The lateral skull plain images represented the two-dimensional part of the study, and these were used for comparison with the three-dimensional investigation, the CBCT images.

Keywords: sialography, x rays, cone beam computed tomography, contrast media

Major salivary glands can present a variety of lesions, which can appear clinically as a swelling or diffuse glandular enlargement accompanied by symptoms of obstruction or inflammation. Radiographic examination is essential in diagnosing the lesions, and useful for planning further management, whether surgery or alternatives [1, 2].

Plain radiography, sialography, computed tomography (CT), cone-beam CT (CBCT), ultrasonography (US), magnetic resonance imaging (MRI), and nuclear scintigraphy/positron emission tomography (PET) all play roles in the diagnosis of salivary gland lesions [3].

Sialography requires injecting contrast media into the Stenon's or Wharton's duct of the major salivary glands to identify the outline of the ductal anatomy and any presence of sialoliths.

It creates excellent contrast resolution and allows small stones or strictures to be detected.

The invasiveness of the technique, use of chemical contrast media, and possible failure of the technique are limitations of sialography [2].

Sialography is a functional examination of the major salivary glands that involves the injection of a radiopaque chemical contrast agent into the ductal system of the gland prior to imaging [4]. There are many substances used as a chemical contrast agent in different sialography tehniques. Contrast media used in sialography were originally developed for radiologic examination other than the study of salivary glands [5]. The radiopaque materials in general use for sialography can be divided into oily media, water-soluble media, and suspensions [5].

It is the only examination that demonstrates the fine, delicate anatomy of the ductal system, and most accurately visualizes sialoliths and strictures, two of the most common causes of obstruction [6, 7]. These capabilities make sialography the most suitable examination for investigation of obstructive conditions of the parotid and submandibular salivary glands.

The capabilities of sialography are, however, restricted by the limitations of the imaging modalities to which it is coupled. Plain imaging has been used extensively with sialography; however the two-dimensional images that are generated may have limited diagnostic capability.

Sialography has also been combined with medical CT, but the anisotropic voxel resolution may not demonstrate the fine anatomy of the gland ductal structures [8]. Sialography has also been combined with fluoroscopy, but this modality delivers relatively significant doses of radiation to the patient [9, 10].

Recently, we and others have begun using cone beam CT (CBCT) as the imaging tool for sialography. CBCT overcomes many of the shortcomings of other imaging modalities and offers unique advantages such as isotropic voxel resolution and small voxel sizes associetd with better spatial resolution [11].

CBCT sialography has rarely been reported. Drage and Brown were pioneers in reporting cases of CBCT sialography [12]. They concluded that CBCT sialography was superior to conventional sialography and explained that 3D reconstruction could be performed and then viewed from any direction and in any slice thickness, and from which cross-sectional slices might be obtained in any direction.

In this study, further investigation of the potentials of a chemical contrast medium used in sialography was conducted. The role of CBCT sialography in diagnosing salivary gland lesions was also assessed.

Experimental part

Patient selection

20 subjects were recruited into this prospective clinical study over a 1 year time period from July 2016 to July 2017. Subject inclusion criteria were adults over 18 years of age with a suspected obstructive condition of a parotid or submandibular gland as determined by history and clinical examination.

Exclusion criteria included acute inflammation of the major salivary gland of interest, known or suspected allergy to iodinated contrast agents or an immediately anticipated thyroid function test. For each subject the following clinical data were collected prior to the sialography procedure:

* *email: cristibudacu@yahoo.com* *# Authors with equal contributions*

subject age, gender, medical history, chief complaint, subject self-assessment of pain presence and pain quality, swelling, abnormal taste, mouth dryness and provoking stimulus.

In addition, extra- and intraoral examinations were performed by a radiologist and a maxillo-facial surgeon to determine the presence of a swelling, and salivary quantity and quality (clear or cloudy).

Sialography performing

Sialography was performed by a radiologist and an oral and maxillofacial surgeon. The orifice of the primary duct of the salivary gland under examination was dilated with a series of metal probes, and this was followed by cannulation of the primary duct with a catheter. Between 1mL and 10 mL of Iopamiro 370® (Iopamidol) was injected slowly into the duct of the gland until the subject reported maximum tolerance to a feeling of pressure in the gland.

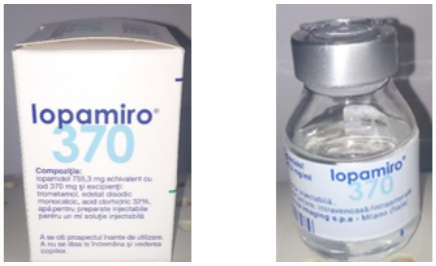

Fig. 1 The chemical substance, Iopamidol used as contras agent medium in sialography

Imaging protocols

A lateral skull plain image was then made using the Planmeca Panoramic x-ray machine, Helsinki, Finland (64–70 kVp, 7–14 mA, 16s) and a three-dimensional scanning using the Planmeca Promax 3D CBCT Mid machine, Helsinki, Finland, by selecting a 200 x 170 mm view field, and following the exposure parameters: 90 kV, 12 mA, 13.8 s and 0.4 x 0.4x 0.4 mm voxel size. The imaging volume was centred on the gland of interest. DICOM files were imported into Romexis 4.0.4 (Planmeca OY, Helsinki, Finland), a software capable of volume rendering. To achieve axial, coronal and sagittal sections, the CBCT reconstructions were established with a thickness of 1 mm, at a distance of 1 mm. If contrast fill was deemed inadequate, additional contrast was injected and another lateral skull plain image was made.

Five minutes following catheter removal, a second lateral skull plain image was made to evaluate contrast clearance from the gland. The lateral skull plain images represented the two-dimensional part of the study, and these were used for comparison with the CBCT images. This protocol allowed us to acquire and then compare the images of the same gland in the same subject using both modalities.

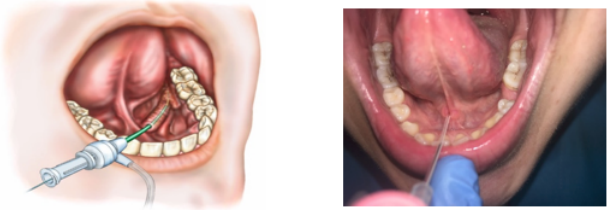

Fig. 2 The introduction of the chemical contrast agent medium into the duct of the submandibular gland with a catheter

Imaging evaluation

One radiologist and four maxillo-facial surgeon evaluated the images separately and scores were given for the interpretation of the images according to the following scoring systems. The presence of salivary stones or filling defects was rated as follows: 1=one sialolith, 2=two sialoliths, 3=three sialoliths, 4=four sialoliths, and 5=more than four sialoliths.

The presence of stenosis was also rated as follows: 0=not present, 1=the presence of stenosis, 2=the presence of stenosis in more than one area, and 3= intraglandular second-order branches. The above mentioned scoring system for evaluation was used by each physician to assess the interpretation criteria separately and then results were discussed with the others. Analysis of the resulting data was performed to evaluate the concordance among interpretations of the five physicians.

Results and discussions

The majority of the patients presented with ductal system problems, like presence of salivary calculus which cause the obstruction of the salivary ducts.

Among the patients in this study, three patients suffered from obstructive diseases due to stones in the parotid gland (3 cases) and in the submandibular gland (16 cases). One patient presented an accessory parotid gland in to the deep part of the cheek, during the course of the Stenon duct .

Four parotid gland and two submandibular gland cases showed the signs of filling defects, strictures in the main duct, and dilatation of the ducts distal to the filling defect. In addition, stones of various sizes, locations, and radiodensities were observed.

The detection rate of the presence of stones or filling defects, ductal stenosis and dilatation was 89% for CBCT sialography compared with conventional sialography. CBCT sialography was superior to conventional sialography in revealing stones, especially in the second and third order branches.

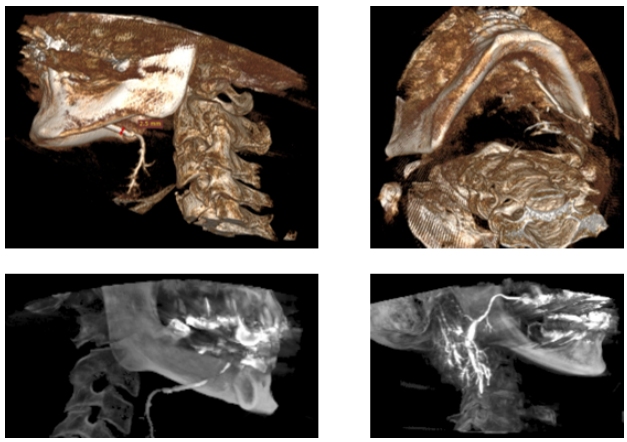

Fig. 3 The 3D reconstructions of the sialo - CBCT show stenosis with areas of strictures and dilatation through the glandular ductules

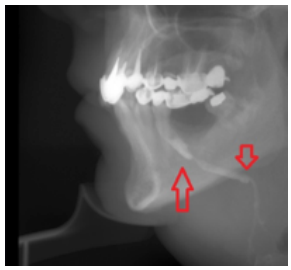

Fig. 4 The 2D sialography show stenosis with areas of strictures through the glandular duct (arrows)

The salivary glands are exocrine glands that are positioned in and around the oral cavity and secrete their salivary contents into the mouth to help keep the oral mucosa protected and lubricated as well as to help in the initial stages of digestion during mastication of food so that a food bolus is created and ready to be swallowed for further processing. The major salivary

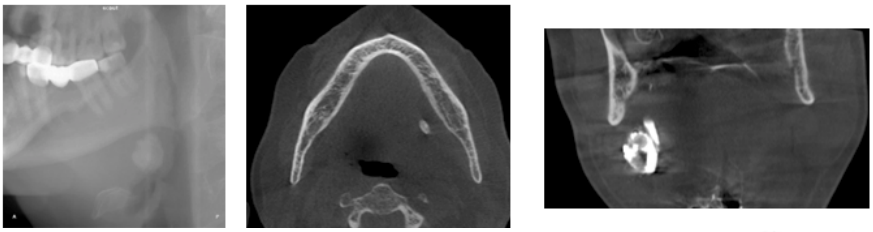

Fig. 5 Plain radiography (A), axial (B), and coronal (C) views of CBCT shows a large and small stones in the submandibular gland

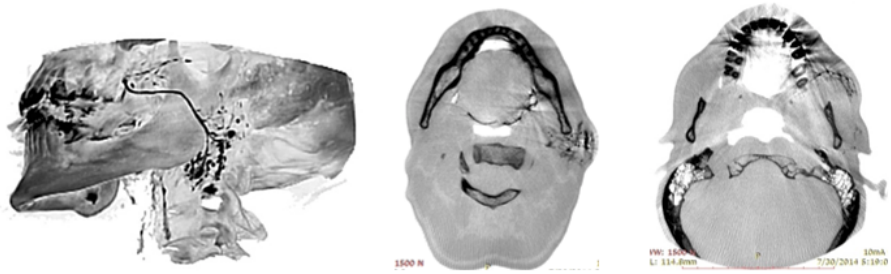

Fig. 6 3D sialo-CBCT reconstruction and axial views of sialo-CBCT showing the left parotid gland and the accessory parotid gland

glands are represented by the parotid, submandibular and sublingual glands.

Despite several limitations of sialography, it remains widely used for the diagnosis of salivary gland diseases, which affect the ductal system; in addition it provides the ability to assess the suitability for interventional procedures and radiolucent stones. Although CT and ultrasonography have been used, they have shown to be of limited value in visualizing the ductal system. However, a reliable technique that generates reproducible results similar to those of sialography has yet to emerge [1, 12-15].

CBCT has recently become widespread in maxillofacial radiology due to its high resolution and low radiation dose. It offers improvement in demonstration of the ductal system over conventional sialography [16].

Sialography was first performed in 1902, and is regarded as the gold standard for depicting the delicate ductal structures of the major salivary glands and identifying non-calcified sialoliths and ductal strictures [6, 7, 17-19].

The literature regarding the properties and the side effects of these media in the indicated fields of application is very extensive [5, 20, 21]. However, the conclusions concerning side effects are sometimes contradictory. The use of some of the media in sialography has resulted in many publications in which the conclusions on side effects are also controversial.

The literature is also incomplete, especially concerning some recently developed radiopaque materials. The ideal features of the chemicals contrast media agents are the follows:

- the iodine salt concentrations before and after dilution with saliva should be sufficiently high.

- the media should be eliminated rapidly from the healthy salivary gland after sialography. This property permits study of the glandular function and diminishes the risk of local side effects. It also makes possible the investigation of more than one gland during the same session.

- the contrast media should have no harmful effects on the salivary gland tissue.

- the media should be harmless in the event of spilling into the extraglandular tissues.

The chemical contrast medium substance used in our study was Iopamidol (INN, tradenames Iopamiro, Isovue, Iopamiron, and Niopam) which is a nonionic, low-osmolar iodinated contrast agent [22]. Each mL of Iopamiro-370 (Iopamidol Injection 76%) provides 755 mg iopamidol with 1 mg tromethamine and 0.48 mg edetate calcium disodium. The solution contains approximately 0.053 mg (0.002 mEq) sodium and 370 mg organically bound iodine per mL. The *p*H of Iopamiro-370 contrast media has been adjusted to 6.5-7.5 with hydrochloric acid and/or sodium hydroxide. Iopamidol is designated chemically as (S)-N,N'-bis[2-hydroxy-1-(hydroxymethyl)-ethyl]-2,4,6-triiodo-5-lactamidoisophthalamide [23].

Conclusions

In conclusion, in cases that have obstructive salivary gland diseases, it would be advisable to perform CBCT sialography with the help of different chemical contrast medium agents as the modality of choice in demonstrating the ductal system of the gland and as an alternative to conventional sialography.

References

1. JAGER L., MENAUER F., HOLZKNECHT N., SCHOLZ V., GREVERS G., REISER M., Radiology, **216**, 2000, p.665.
2. BURKE CJ., THOMAS RH., HOWLETT D., Br J Oral Maxillofac Surg, **49**, 2011, p.261.
3. LEVY DM., REMINE WH., DEVINE KD., JAMA, **181**, 1962, p.1115.
4. JADU FM., LAM EW.. Dentomaxillofac Radiol., **42**, 2013, p.20110319.
5. VERHOEVEN JW., Oral Surg Oral Med Oral Pathol., **57**, p.323.
6. NGU RK., BROWN JE., WHAITES EJ., DRAGE NA., NG SY., MAKDISSI J., Dentomaxillofac Radiol, **36**, 2007, p.63.
7. SOM PC., BRANDWEI-GENSLER MS., Head and neck imaging, 2011; p.1950.
8. SZOLAR DH., GROELL R., BRAUN H., PREIDLER K., STISKAL M., KERN R., Acta Otolaryngol, **116**, 1996, p.112.
9. MAHESH M., Radiographics, **21**, 2001, p.1033.
10. SORODOC V., SORODOC, L., UNGUREANU D., SAVA A., JABA I.M., International Journal Of Toxicology, **32,** 2013, p.351.
11. NEMTOI A. , CZINK C., HABA D., GAHLEITNER A. Dentomaxillofac Radiol, 42(8), 2013, p.
12. DRAGE NA., BROWN JE., Dentomaxillofac Radiol, **38**, 2009, p.301.
13. GRITZMANN N., Am J Roentgenol, **153**, 1989, p.161.
14. AVRAHAMI E., ENGLENDER M., CHEN E., SHABTAY D., KATZ R., HARELL M., Neuroradiology, **38**, 1996, p.287.
15. NGU RK., BROWN JE., WHAITES EJ., DRAGE NA., NG SY., MAKDISSI J., Dentomaxillofac Radiol, **36**, 2007, p.63.
16. SALERNO S., CANNIZZARO F., COMPARETTO A., SPECIALE R., LO CASTO A., Dentomaxillofac Radiol, **38**, 2009, p.550.
17. LI B., LONG X., CHENG Y., WANG S., Dentomaxillofac Radiol, **40**, 2011, p.519.
18. WHITE SC., Health Phys, **95**, 2008, p.628.
19. KATZ P., Ann Radiol, **34**, 1991, p.110.
20. HASSON O., J Oral Maxillofac Surg, **65**, 2007, p.300.
21. MARTU, C., GEORGESCU, M.G., MARTU, I., BUTNARU, C., PORUMB, V., RADULESCU, L. Mat. Plast., **53**, no. 2, 2016, p.321
22. SAVA A., DUMITRESCU G., HABA D., ET AL., Romanian Journal Of Morphology And Embryology, **54**, 2013, p. 195.
23. DILLMAN JR., AL-HAWARY M., ELLIS JH., COHAN RH., KAZA R., MYLES JD., KHALATBARI S., FRANCIS IR., Am J Roentgenol., **198**, 2012, p.392

Manuscript received: 8.07.2017