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The spiral CT examination of the maxillary sinuses – virtual endoscopy and VRT reformations

Inflammatory disease of the paranasal sinuses is a common and serious health problem. CT is a well established technique in diagnosing sinusitis and tumors in the paranasal sinuses (1,2). Fiberooptic Endoscopic sinus surgery is an effective technique which is increasingly employed in the treatment of sinus disease. Such surgery is not without hazards, particularly if anatomical variations are present. High quality CT scans are essential to delineate the relevant anatomical structures and the extent of mucosal disease (2,6,7).

The processing of the spiral CT images has allowed the development of virtual endoscopy, a new method capable of simulating the endoscopic view obtained with fiberooptic instruments. It can be applied to different body regions, such as colon, vascular system, and the urinary system, or upper airways (3,4,8,10).

The aim of the study is presenting the usage of CT examination with virtual endoscopy and VRT reformation in assessment of the maxillary sinuses.

MATERIAL AND METHODS

Material comprises a group of 11 patients in whom CT examination due to suspected pathologies of maxillary sinuses was performed. In each patient CT examination was performed in 2 mm thick axial sections. The coronal MPR reconstructions were performed after examination. The sinuses were also assessed on VRT spatial images. Virtual endoscopy of maxillary sinuses was performed using dedicated software, and images of evident pathology were recorded.

RESULTS

In seven patients the pathology of the maxillary sinuses was found. In five of them there were polyps. Inflammatory mucosa thickening was seen in six and in two cysts were found. The cysts were easily seen on axial images (Fig. 1). The coronal reconstructed images reveal the pathology relation to the maxillary floor (Fig. 2). The cysts were clearly seen on VRT spatial images, cut across the middle of the maxillary sinuses (Fig. 3). The cysts were precisely depicted on virtual endoscopy images (Fig. 4). The virtual images of polyps were very similar to the images of cysts (Fig. 5). Virtual images provide information about mutual relation of the examined structures. The differentiation of cysts and polyps is based on density measurements on axial images.

Fig. 1. Large maxillary cyst (big arrow) on the right and smaller one on the left (small arrows) on axial CT section

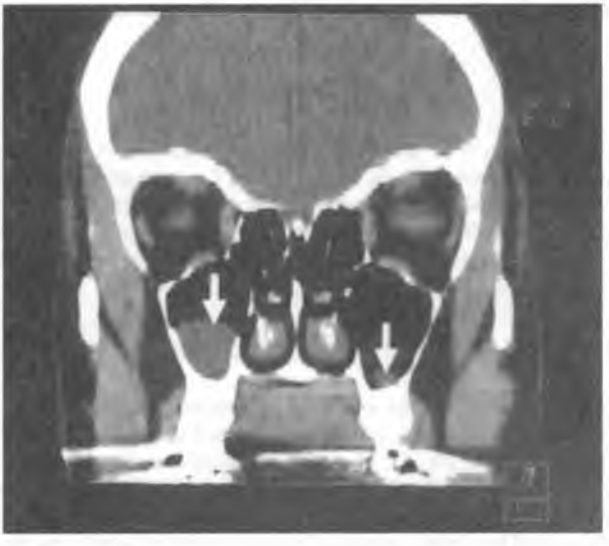

Fig. 2. Bilateral maxillary cysts on coronal CT reformation (arrows)

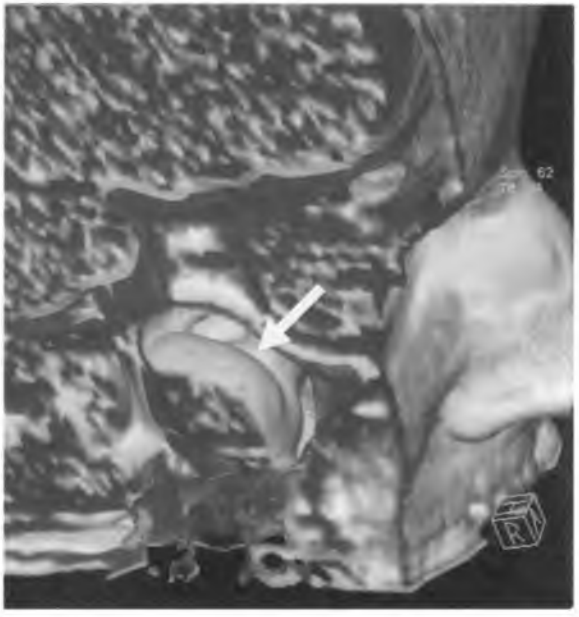

Fig. 3. The cyst in right maxilla on VRT spatial CT image (arrow)

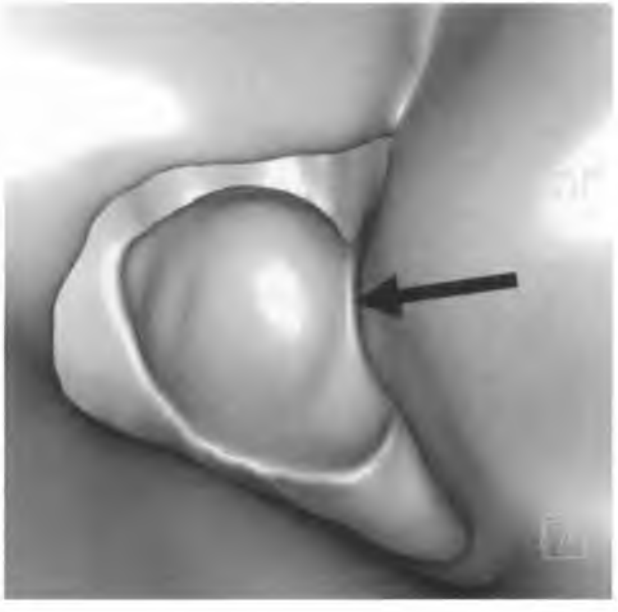

Fig. 4. Large maxillary cyst in virtual sinuscopy (arrow)

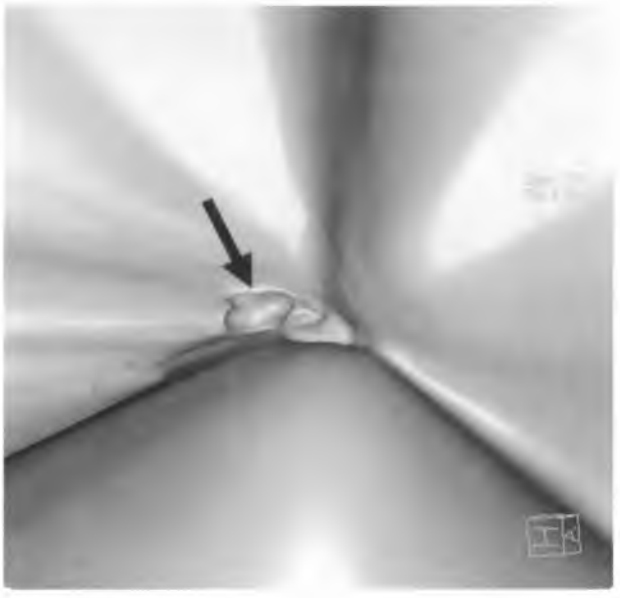

Fig. 5. Small polyps on the maxillary floor in virtual sinuscopy (arrow)

DISCUSSION

Sinus pathologies, especially maxillary sinus pathologies are often related to problem originating in the upper dental arch, given their close anatomical relations. Some 10–15% of sinusites have dental causes. Acute sinusites may occur after inflammatory processes involving the root apex of the tooth (2,3). The anatomical characteristics of the rhino-sinusal region given its natural air content appear ideal for virtual sinuscopy. The principles and the technique of virtual endoscopy may be applied to the study of sinus diseases of dental origin using the data acquired through a CT scan of the upper dental arch (3).

The study of sinus cavities for virtual sinuscopy may be performed with conventional techniques, by setting a specific scan series for paranasal sinuses, or extending cranially the series set for dentascan CT. The latter has the advantage of requiring one scan only, resulting in lower dose and shorted scan time, and provides in addition to the data needed for the virtual navigation all the information afforded by multiplanar nature of dentascan (2,3,5). The examination is preferably carried out with a single-slice of multi-slice spiral CT scanner so as to reduce scan time and suppress any motion artifacts. The conventional acquisition technique with single-slice spiral scanners includes axial scans with 3 mm collimation and 3 mm table feed (pitch-1), and 1 mm reconstruction index. The standard acquisition technique with multi-slice spiral scanners includes a series of spiral scans with cranio-caudal extensions of 7 cm at the level of the maxillary region, 512x512 matrix, 1.25 mm thickness (3,5,9).

The main technique enabling virtual navigation is perspective volume rendering. It allows the 3D and perspective view of the walls of the structures but with the added advantage of permitting view from the inside when hollow organs is being examined. The images are projected from a source, as it were, towards an infinite distance, thereby simulating human vision (3). After selecting the 3D processing protocol, which assigns different opacity and color values to anatomical structures under examination, one needs to choose the modality for the manual editing of some of the protocol's parameters, for carrying out measurements, for recording cine loop sequences and for choosing the viewing mode (3). As regards viewing mode, two different types of display can

be selected: the fly-around display, which allows one to fly around the anatomical segment by rotating it around its center; the fly-through, which enable navigation by following a path within the volume, in the form of kinematic sequences, or by visualizing the single images selecting the viewpoint each time (3). In most cases the threshold between –300 and – 800 Hounsfiel units is applied, which is ideal for navigating inside air-containing structures and supplies images similar the those obtained with conventional endoscopy (3). In the event of maxillary sinuses partially or entirely filled with inflammatory material, virtual navigation is possible thanks to the high density differences between the bone walls of the maxillary sinuses and the inflammatory tissue.This is allowed by electronic removal of any obstacle impeding visualization of the maxillary sinus walls and of the odontoid problem causing the sinusopathy (3). The main tooth-related condition involving the maxillary sinus include odontogenic cysts, "endo-antral syndrome", mucous pseudopolyps (1, 3). The sensitivity achieved by virtual endoscopy in reproducing the anatomy and identifying the lesions is now extending its clinical use (3). The most important advantages of virtual endoscopy over traditional endoscopy are non-invasiveness, especially in the study of paranasal sinuses, which canned otherwise be assessed in a non-invasive manner with fiberooptic techniques, fast scan time, and depiction of extraluminal extension of lesion on axial images. Its greatest limits lie in its inability to directly assess the appearance of the mucosa, to permit biopsy, and the difficulty with examining flat lesions (3).

CONCLUSIONS

The CT examination of paranasal sinuses is a well established technique. The axial and coronal sections reveal precisely the sinusal anatomy and pathology. Modern technical CT modification such as multiplanar reconstructions, VRT spatial images or virtual endoscopy may also be useful in evaluation of sinuses. The most common pathological structure, polyps and cyst are clearly seen on both VRT and virtual sinuscopy images.

REFERENCES

1. Bernhardt T.M. et al.: CT scanning of the paranasal sinuses: axial helical CT with reconstruction in the coronal direction versus coronal helical CT. Br. J. Radiol., 71, 846, 1998.
2. Elias R. Melhem E.R. et al.: Optimal CT evaluation for functional endoscopic sinus surgery. Am. J. Neuroradiol., 17, 181, 1996.
3. Fanucci E. et al.: Virtual endoscopy in odontogenic sinus disease. Study technique and main pathological findings. Radiol. Med., 108, 225, 2004.
4. Fenlon H. M. et al.: Colorectal neoplasm detection using virtual colonoscopy: a feasibility study. Gut, 43, 806, 1998.
5. Hoeffner E. G. et al.: Development of a protocol for coronal reconstruction of the maxillofacial region from axial helical CT data. Br. J. Radiol., 74, 323, 2001.
6. Kearney S. E. et al.: CT scanning of the paranasal sinuses – the effect of reducing mAs. Br. J. Radiol., 70. 1071, 1997.
7. Sohaib S.A. et al.: The effect of decreasing mAs on image quality and patient dose in sinus CT. Br. J. Radiol., 74, 157, 2001.
8. Song J.H. et al.: Bladder tumor detection at virtual cystoscopy. Radiology, 218, 95, 2001.
9. Suojanen J.N., Regan F.: Spiral CT scanning of the paranasal sinuses. Am. J. Neuroradiol., 16, 787, 1995.
10. Vining D.J. et al: Virtual bronchoscopy. Relationships of virtual reality endobronchial simulations to actual bronchoscopic findings. Chest, 109, 549, 1996.

SUMMARY

The aim of the study is presenting the usage of CT examination with virtual endoscopy and VRT reformation in assessment of the maxillary sinuses. Material comprises a group of 11 patients in whom CT examination due to suspected pathologies of maxillary sinuses was performed. In each patient CT examination was performed in 2 mm thick axial sections. The coronal MPR reconstructions were performed after examination. The sinuses were also assessed on VRT spatial images. Virtual endoscopy of maxillary sinuses was performed using dedicated software, and images of evident pathology were recorded. In seven patients the pathology of the maxillary sinuses was found. In five of them there were polyps. Inflammatory mucosa thickening was seen in six and in two pseudo cyst were found. The cysts were easily seen on axial images. The coronal reconstructed images reveal the pathology relation to the maxillary floor. The cysts were clearly seen on VRT spatial images, cut across the middle of the maxillary sinuses. The cysts were precisely depicted on virtual endoscopy images. The virtual images of polyps were very similar to the images of cysts. Virtual images provide information about mutual relation of the examined structures. The differentiation of cysts and polyps is based on density measurements on axial images. The CT examination of paranasal sinuses is a well established technique. The axial and coronal sections reveal precisely the sinusal anatomy and pathology. Modern technical CT modification such as multiplanar reconstructions, VRT spatial images or virtual endoscopy may also be useful in evaluation of sinuses. The most common pathological structure, polyps and cyst are clearly seen on both VRT and virtual sinuscopy images.

Spiralna tomografia komputerowa zatok szczękowych – endoskopia wirtualna i rekonstrukcje VRT

Celem pracy jest przedstawienie zastosowania badania TK z wykorzystaniem endoskopii wirtualnej i rekonstrukcji VRT w ocenie zatok szczękowych. Materiał stanowi grupa 11 pacjentów, u których wykonano badanie TK z powodu podejrzenia patologii zatok szczękowych. U każdego pacjenta wykonano badanie TK w 2 mm przekrojach osiowych. Rekonstrukcje czołowe były wykonywane po badaniu. Zatoki szczękowe oceniono również na obrazach przestrzennych VRT. Wirtualna endoskopia zatok była wykonywana przy wykorzystaniu specjalnego oprogramowania, a obrazy ewidentnych patologii były zapisywane. U siedmiu pacjentów stwierdzono patologię zatok przynosowych. U pieciu z nich były to polipy. Zapalne zgrubienia błony śluzowej stwierdzono u szesciu pacjentów, a u dwu znaleziono torbiele. Torbiele były widoczne na przekrojach osiowych oraz czołowych. Były one również wyraźnie widoczne na obrazach przestrzennych VRT po przecięciu przez środek zatoki szczękowej. Wirtualna endoskopia precyzyjnie uwidacznia również torbiele i polipy, dostarczając informacji o przestrzennych zależnościach miedzy strukturami patologicznymi i anatomicznymi. Różnicowanie między torbielami a polipami opiera się na ocenie obrazów osiowych i czołowych i pomiarach densyjności. Badanie TK zatok przynosowych jest uznaną metodą diagnostyczną. Przekroje osiowe i czołowe umożliwiają precyzyjną ocenę anatomii zatok i ich patologii. Współczesne modyfikacje techniczne TK, jak rekonstrukcje wielopłaszczyznowe, obrazy przestrzenne VRT oraz wirtualna endoskopia, mogą również być użyteczne w ocenie zatok. Najczęściej spotykane struktury patologiczne, polipy i torbiele są dokładnie widoczne zarówno w obrazach przestrzennych VRT, jak i obrazach wirtualnej sinuskopii.