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The occurrence of sinusitis in HIV-infected patients with fever*

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SUMMARY

Sinusitis is commonly occurring in patients infected with Human Immunodeficiency Virus I (HIV), but the occurrence and etiology have not been established. The purpose of this study was prospectively to determine the occurrence, site and type of paranasal sinus abnormalities seen on MRI in HIV-infected patients with fever, to relate the abnormalities to clinical and immunological parameters, and to determine the microbiological agents found in the sinus aspirates. MRI was performed in 54 HIV-infected patients with 70 evaluable episodes of fever. Patients receiving antibiotics were excluded. Bactrim was permitted, when given as prophylaxis of Pneumocystis carinii pneumonia. If abnormalities were found on MRI, sinus aspiration was performed and the aspirate investigated. MRI abnormalities were found in 54.3% of the patients with a significantly higher occurrence of pathological changes in AIDS patients compared with HIV-infected without AIDS. In approximately 2/3 of the aspirates a probable, etiologic agent was found. However, 1/3 of these agents were atypical such as cytomegalovirus and mycobacteriae; in one patient Non-Hodgkin's lymphoma was found.

The high occurrence of sinusitis in HIV-infected patients and the atypical findings in the sinus aspirates stress the importance of searching for sinusitis and the etiology to ensure the correct treatment.

Key words: HIV/AIDS, MRI, sinusitis, etiology, Non-Hodgkin's lymphoma (NHL)

INTRODUCTION

Sinusitis is commonly occurring in patients infected with Human Immunodeficiency Virus I (HIV), but the true prevalence has not been established. Retrospective studies have found prevalences between 4.4% and 16% (Lamprecht and Wiedbrauck, 1988; Del Borgo et al., 1997), while prospective studies suggest rates between 30% and 68% (Lamprecht and Wiedbrauck, 1988; Sample et al., 1989). The great discrepancies between the prevalences may partly be explained by a great number of asymptomatic cases of sinusitis, 25-33% (Zurlo et al., 1992; Godofsky et al., 1992). These asymptomatic cases are missed in retrospective studies in which the diagnosis often is based on clinical criteria. The use of different diagnostic techniques as plain radiographs, computed tomography (CT) or magnetic resonance imaging (MRI) and the different definitions of normal or abnormal conditions of the paranasal sinuses may also contribute to the discrepancies observed.

In most cases the etiologic agents are the same as found in immunocompetent patients: *Streptococcus pneumoniae, Haemophilus influenzae* and *Staphylococcus aureus,* but atypical organisms as *Legionella pneumophila, Mycobacterium avium,* fungi, viruses and parasites have been reported (Schlanger et al., 1984; Naguib et al., 1994; Dunand et al., 1997; Iwen et al., 1997; Yoskovitch and Cantrell, 1998).

The purpose of this study was 1) prospectively to determine the occurrence, site and type of paranasal sinus abnormalities seen on MRI in HIV-infected patients with fever, 2) to relate the demonstrated abnormalities of the paranasal sinuses to clinical and immunological parameters, and 3) to determine the microbiological agents found in the sinus aspirates.

MATERIALS AND METHODS

This prospective study was performed at the Department of Infectious Diseases, Marselisborg Hospital, Aarhus University Hospital, Denmark during the period from May 1996 to June 1998. The criteria for inclusion was: HIV-infected/AIDS patients (≥18 years) admitted to the department with fever (temperature ≥37.5°C). Patients fulfilling the criteria more than once

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during the study period were included if at least three months had passed since the last episode of fever. Excluded were patients with problems of compliance and patients receiving or having received treatment with antibiotics within the last three days before participating in the study. Trimethoprim/sulfamethoxazole (TMS), was permitted, when given as prophylaxis of *Pneumocystis carinii* pneumonia (PCP) in a dose of 160/800 mg/kg twice/day three times/week. A total of 81 patients fulfilled the inclusion criteria but 3 did not want to participate, 2 suffered from claustrophobia and 6 were severely ill making MRI impossible to perform. At inclusion the patients completed a questionnaire commenting on the presence of (1) allergy, (2) current symptoms of sinusitis, (3) previous events of sinusitis, (4) cold more than twice annually and (5) smoking habits. Clinical examination was performed and the blood samples were drawn and immediately analyzed. The clinical examination was a routine examination including tapping of the sinuses and otoscopy. The blood samples included: erythrocyte sedimentation rate (ESR), hemoglobin, leucocyte count with differentiating into subtypes, platelet count, eosinophilics (total number), creatinine, sodium, potassium, albumin, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, bilirubin, IgG, IgM, IgA, IgE, CD3, CD4, CD8 counts, cryptococcus antigen, HIV-1 viral load, and blood cultures.

MRI scans were performed within 24 hours after inclusion and performed on a 1.5 Tesla magnet. In all patients an axial, double spin-echo and a T1-weighted, coronal spin-echo of the sinuses and cerebrum were performed. All the MRI examinations were reviewed by the same radiologist who was blinded with regard to the results of the questionnaire. Eight anatomic areas (4 on each side) were examined separately: the frontal, maxillary, sphenoid and ethmoid sinuses. The three first mentioned paranasal sinuses were classified in grades 0-6 (Table 1). Due to the normal physiological cyclical changes that occurs in the ethmoids (Kennedy et al., 1988) a special classification (grades 0, 1, 4) was made for this sinus group (Table 2). If one sinus showed more than one abnormality, only the most pronounced abnormality was recorded.

In patients with changes on MRI classified as grade 2, 3 or 4, sinus aspiration from the maxillary sinus was performed as follows: a gauze tampon moistened with a solution of 5% lidocaine was applied to the area below the inferior turbinate. After a period of 5 minutes the gauze was removed and a topical anaesthesia with a 10% lidocaine *cum* adrenaline was applied to the mucosa of the puncture site. With a SinuJect™ (Atos Medical AB, Sweden) a small sterile drainage tube was introduced into the maxillary sinus simultaneously with the puncture. Aspiration was performed with a 20 ml syringe and sent for analysis. If the aspirate was purulent, the sinus was washed with 50-100 ml of 0.9% NaCl and the drainage tube stayed in position. Lavage with 50-100 ml of 0.9% NaCl was then performed through the tube every day (typically 2 days) until the obtained fluid was clear. If no fluid was obtained, one more drainage tube was introduced and 5 ml of 0.9% NaCl was instilled and aspirated. As obtaining biopsies from the sinuses is a very painful surgical intervention, biopsies were only obtained if malignancy was suspected.

Table 1. Classification of MRI signals in the frontal, maxillary and sphenoid sinuses.

Grade	Definition
0	Absence of signal: normal
1	Visible thickening of the mucous membrane < 5 mm: normal
2	Thickening of the mucous membrane ≥ 5 mm, < 10 mm: pathological
3	Thickening of the mucous membrane ≥ 10 mm: pathological
4	Total sinus opacification or fluid level: pathological
5	Polyp or retention cyst: pathological
6	Other abnormalities due to previous surgery, hypo- or aplasia: pathological

Table 2. Classification of MRI signals in the ethmoids.

Grade	Definition
0	Absence of signal: normal
1	Minimal or moderate sinus reaction: normal
4	Marked or total sinus reaction: pathological

The sinus aspirate was rutinely cultured for ordinary aerobic and anaerobic bacteria, fungi, legionella species, *Herpes simplex, Cytomegalovirus* (CMV), and mycobacteriae. Quantification was performed and isolates in numbers ≥10^6 cfu/ml was regarded as threshold for antibiotic treatment. Samples were cultured for *Mycoplasma pneumoniae* and examined with the polymerase chain reaction (Jensen et al., 1989). Antigen detection was performed for influenza-, parainfluenza-, adeno-, *Respiratorial syncytial virus* (RSV) and *Cryptococcus neoformans* (CN). Detection of *Pneumocystis carinii* (PC) was performed by use of immunofluorescence and Gomori methenamine silver stain at the Laboratory of Parasitology and at the Department of Pathology, Aarhus University Hospital. The pathologists examined for eosinophilic and tumour cells too. The examinations for Legionella species, mycobacteriae and *Mycoplasma pneumoniae* were performed at Statens Serum Institut, Copenhagen, Denmark. Antigen detection of CN was performed at Department of Microbiology, Aarhus University. The remaining microbiological examinations were performed at the Department of Clinical Microbiology, Aarhus University Hospital, Aarhus, Denmark.

Statistical analysis

Each episode counted as if it represented a new patient. In case of persistent changes as e.g. polyps in the sinuses, these changes were only counted when the patient was included for the first time.

The statistical programme used was SPSS package for personal computers. Univariate analysis was calculated by using odds ratios and the χ^2 test. Level of significance was 5%.

Table 3. The microbiological agents detected in 14 sinus aspirates.

Organism	Number of isolates	Quantity (cfu/ml)
Streptococcus pneumoniae	5	10^6 - 10^9
Haemophilus influenzae	3	10^4-10^5
Mycobacterium avium	1	$>10^4$
Cytomegalovirus	1	200 virus/ml
Streptococcus spp. (nonhemolytic)	2	10^5
Neisseria species	1	10^4

Ethics

The study was approved by the local ethical commitee.

RESULTS

Fifty-four patients with 70 evaluable episodes of fever were consecutively included with an even distribution in each of the four seasons (between 15 and 20 patients/season). Thirty-nine of the 54 patients were included once, 14 were included twice, and one was included three times. Fifty-eight (83%) were men and 12 women with a median age of 37 years (range 19-63). The median CD4 cell count was 245 x 10^6/l (range 10-1140). The median HIV-1 viral load was 23370 copies/ml (range 0-1166954). The median length of time since the diagnosis of HIV infection was 7.5 years (range 1 month to 12.1 years). Thirty-two (45.7%) of the patients met the criteria for the diagnosis of AIDS.

In accordance with the criteria of classification (Table 1 and 2) 38 (54.3%) of the MRI s from the 70 cases showed abnormalities > grade 1 in one or more of the 8 paranasal sinuses. With the exception of polyps, none of the 15 patients, who were included more than once, had morphological abnormalities on the second or third MRI classified > grade 1. The final diagnosis of these 15 patients were pneumonia (10), cystitis (1), toxoplasmosis (1) and in the remaining three patients the fever disappeared spontaneously. Abnormalities were most commonly seen in the maxillary sinuses followed by the sphenoid, the ethmoid, and the frontal sinuses. No significant left-right variation was observed. Twenty-three of the 38 patients had abnormalities in one or more sinuses classified as grade 4, i.e. showing morphological changes compatible with the radiological definition of acute sinusitis (Lindbæk et al., 1996; Del Borgo et al., 1997). Mucosal polyps or cysts were seen in 9 cases and in 7/38 (18.4%) of the cases polyps were the only pathological change detected. Aplasia was not seen.

Pathological changes were significantly more common in patients with the AIDS diagnosis, 22/32 cases compared with 16/38 in HIV infected without AIDS ($\chi^2 = 4.970$, df = 1, $p < 0.026$). The occurrence of morphological changes increased with decreasing CD4 count, decreasing CD4:CD8 ratios, and with increasing length of time since the diagnosis of HIV infection, but the occurrence was not significantly higher in patients with CD4 count < 200 x 10^6/l, CD4:CD8 ratios < 0.5, or in patients with known HIV infection for ≥ 5 years.

Facial tenderness/pain localized over the sinuses and cough were the only symptoms significantly associated with paranasal sinus abnormalities ($\chi^2 = 5.748$, df = 1, $p < 0.017$) and ($\chi^2 = 5.005$, df=1, $p < 0.025$), respectively. Facial tenderness/pain localized over the sinuses was present in 22/38 of the patients with abnormalities on MRI versus 9/31 in patients with normal MRI's. The corresponding numbers for cough were 35/38 versus 23/32. We did not find any difference in the duration of symptoms between the group with and without morphological changes and there was no association between previous events of sinusitis, suffering from allergy and/or asthma, suffering from cold more than twice annually, having elevation of IgE (> 150 KIU/l), eosinophilia (> 0.4 x 10^9/l), elevated erythrocyte sedimentation rate (ESR) (> 20mm/h), and the actual abnormality seen. Nor was there any significant difference between smokers, irrespective of the tobacco consumption, non-smokers and the presence of abnormality.

Forty-four of the 70 patients were treated with one or more antiretroviral drugs. Twenty-nine patients received prophylaxis of PCP; 10 received pentamidine; 19 TMS. Treatment with antiretrovirals and/or PCP-prophylaxis did not have any influence on the prevalence or severity of morphological changes observed.

Abnormalities were apparent on the MRI's of 56.9% of the men compared with 41.7% of women, but the difference was not significant and there was no age or seasonal dependency.

In 20 patients sinus aspiration was performed. Eighteen of the aspirates were from patients with acute sinusitis (grade 4), the remaining 2 patients had changes classified as grade 3. As none of the patients had more than one episode of sinusitis the 20 aspirates represented 20 different patients. Fourteeen patients had positive cultures; one had two isolates (*Streptococcus viridans* and Neisseria species) (Table 3). All of these 14 patients had morphological changes classified as grade 4. No microorganisms were detected in the remaining 6 aspirates. Eosinophilic cells were not detected in the sinus aspirates.

In one patient it was indicated to obtain a biopsy as the patient was complaining of vertigo and diplopia. At clinical examination ptosis and protrusion of the right eye were found. MRI showed total opacification of the left sphenoid while the other sinuses were clean. *Streptococcus pneumoniae* were cultured from the sinus aspirate and histopathology of a biopsy from the sinus concerned confirmed the diagnosis of a high-grade malignant Non-Hodgkin's lymphoma (NHL) of B cell origin (Burkitt-like type).

DISCUSSION

The prevalence of paranasal sinus abnormalities reported in the literature in patients infected with HIV- I/AIDS varies between 4.4% and 94.6% (Chong et al., 1993; Del Borgo et al., 1997), and is generally stated to be higher than in immunocompetent patients (Rubin and Honigberg, 1990). We found paranasal sinus abnormalities on MRI in 54.3% of our study population. This occurrence is higher than the prevalence of 38.5% found in 153 HIV-negative patients, who were complaining of symptoms consistent with sinusitis. These 153 patients were part of a prospective study performed on 404 HIV-negative patients who were comparable to the HIV-positive patients concerning age, area of origin (same climate), and the way of classification of the

MRI's (Tarp et al., 2000). Our present results are in accordance with a prospective study of Small et al. (1993) who found that 59% of 37 HIV-infected patients had symptoms and 41% radiographic evidence of sinusitis; with a retrospective study of Zurlo et al. (1992) in which 54% of 139 HIV-infected patients had radiographic evidence of sinusitis, and relatively well with the prospective part of Lamprecht & Wiedbrauck's (1988) study, who found 68% of 28 HIV-infected patients with radiologic signs of sinusitis. Our results differ markedly from retrospective studies of Del Borgo et al. (1997) and Grant et al. (1993) who found prevalences of 4.4% and 6.3%, respectively. The great discrepancies may be explained by use of different diagnostic techniques or different study populations, but the most important explanation is probably the different ways of classification of the morphological changes observed. In some studies even minimal mucosal thickening is classified as sinusitis or at least as abnormal (Cooke and Hadley, 1991; Chong et al., 1993); some studies do not include polyps and retention cysts as abnormalities (Gordts et al., 1997), and some ignore the ethmoids (Chong et al., 1993). The arguments for having chosen MRI as the diagnostic imaging technique and the classification shown in Table 1 and 2 appear from our previous study (Tarp et al., 2000). Similarly to what is previously observed, the maxillary sinuses were the most frequently involved (Zurlo et al., 1992; Mofenson et al., 1995; Kankam and Sallis, 1997; Tarp et al., 2000).

We found pathological changes significantly more common in patients with the AIDS diagnosis. This is in accordance with a study of Small et al. (1993). Porter et al. (1999), however, stressed that patients with AIDS did not have more severe sinonasal symptoms than HIV-positive patients. As the prevalence and severity in Porters' study were assessed by self-reported symptoms the explanation may be that patients with AIDS have a lot of other and maybe more serious symptoms, so that they simply ignore more "banal" symptoms as e.g. symptoms of sinonasal disease.

Symptoms specific of sinusitis are very difficult to state as 25-33% of cases with sinusitis are asymptomatic (Zurlo et al., 1992; Godofsky et al., 1992; Tarp et al., 2000). We found, in accordance with other studies (Hansen et al., 1995; Kankam and Sallis, 1997), tenderness/pain localized to the sinuses and cough (Wong et al., 1998) to be significantly associated to sinusitis.

We have not been able to show any effect on the occurrence or severity of morphological changes in the patients receiving PCP-prophylaxis and/or antiretrovirals. Mofenson et al. (1995) neither could prevent sinusitis with intravenous immunoglobulin nor with TMS PCP-prophylaxis. Concerning the possibility of an allergic factor, we did not find any association between suffering from allergy, asthma, elevated IgE or eosinophilia and sinusitis like we did not find any sign of eosinophilia in the sinus aspirate. Small et al. (1993) and Tarp et al. (2000) did not find any correlation between sinusitis and an allergy history but Small et al. (1993) found that an increase in IgE levels was significantly associated with sinusitis in HIV infected patients. That hypothesis has even been advanced, that increased IgE may be a secondary marker for a worsening of immunodeficiency and may be a marker of poor prognosis in HIV-infected individuals (Carini et al., 1988; Grieco MH, 1989; Israël-Biet et al., 1992).

In accordance with our previous study of a general population (Tarp et al., 2000), we have not found any sex or age dependency, but unlike the abovementioned study, we here observed an equal distribution of sinusitis cases during the year. In the Danish climate, it is expected to find more infections in the cold and wet winter period as seen in our first study (Tarp et al., 2000). The lack of this seasonal variation in the HIV-infected population may reflect that the immunodeficiency predisposes to chronical infections and by that to acute exacerbations, and that the state of constant immunosuppression is more predominant than the influence of the climate.

Approximately 2/3 of the findings in the sinus aspirates were similar to those reported in the general population (Godofsky et al., 1992), but the remaining 1/3 were more atypical findings. Thus, in 20 sinus aspirates we found CMV in two, *Mycobacterium avium* in two, and NHL in one. The two last mentioned phenomenons have previously only been casuistically described (Naguib et al., 1994; Juman et al., 1994; Pomilla et al., 1995; Ferguson et al., 1997; Del Forno et al., 1998). In 30% of the aspirates no agents were demonstrable. In comparable studies performed on BAL-fluids from HIV-infected patients the number of "sterile" cases was about 35% (Mundy et al., 1995; Tarp et al., 1999). If we routinely had obtained biopsies from the sinuses, we could have looked for more microorganisms such as microsporidia and different types of fungi, or we may have detected more cases with CMV. However, for ethical reasons we desisted from this intervention.

From the literature and from our everyday experience it appears that very often antibiotic treatment is initiated only on the basis of symptoms and/or radiologic investigations but without a preceding sinus aspiration. Sometimes the sinus aspiration is avoided in order to spare the patient. With the technique applied in the present study using the SinuJect™, the surgical intervention is associated with a minimum of trauma, hardly any pain, a low tendency to bleeding (Wenig et al., 1995), and a low risk of contamination of the sinus aspirate with microorganisms from the nasal cavity. Due to the introduction of a drainage tube and thereby the possibility of performing lavage, this technique may make up the main treatment. In this way antibiotics may be avoided.

A threshold for antibiotic treatment based on quantification of the bacterial growth in sinus aspirates is previously not described. In studies performed on bronchoalveolar lavage, which in several ways are comparable with sinus aspirates, the threshold for diagnosis of infection varies between $\geq 10^3$ and $\geq 10^4$ cfu/ml (Cantral et al., 1993; Meduri et al., 1998). Due to the therapeutic effect of the sinus puncture in itself and in order to obtaine a high specificity we have chosen a relatively high cut off value of $\geq 10^6$ cfu/ml.

In conclusion, we found a higher occurrence of sinusitis in HIV-infected patients than in the general population, 54.3% versus

38.5%. If the patients had met the criteria of AIDS, the occurrence was significantly higher than in HIV infected without this diagnosis. The only symptoms significantly associated to paranasal sinus abnormalities were facial tenderness/pain and cough. In 70% of the sinus aspirates one or more probable, etiologic agents were found. Approximately 2/3 of the microorganisms found were similar to those reported in immunocompetent patients (Godofsky et al., 1992), but in 1/3 atypical agents such as CMV and *Mycobacterium avium* were found. In one case malignant cells (NHL) were seen. In 30% of the aspirates no agents were demonstrable. These findings stress the importance of performing sinus aspiration and analyses before initiating antibiotic treatment in order to choose the correct treatment.

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REFERENCES

1. Cantral DE, Tape TG, Reed EC, Spurzem JR, Rennard SI, Thompson AB (1993) Quantitative culture of bronchoalveolar lavage fluid for the diagnosis of bacterial pneumonia. Am J Med 95: 601-607.
2. Carini C, Margolick J, Yodoi J, Ishizaka K (1988) Formation of IgE-binding factors by T cells of patients infected with human immunodeficiency virus type 1. Proc Natl Acad Sci USA 85: 9214-9218.
3. Chong WK, Hall-Craggs MA, Wilkinson ID, Paley M, Grant A, Miller R, Harrison MJG (1993) The prevalence of paranasal sinus disease in HIV infection and AIDS on cranial MR Imaging. Clin Radiol 47: 166-169.
4. Cooke LD, Hadley DM (1991) MRI of the paranasal sinuses: incidental abnormalities and their relationship to symptoms. J Laryngol Otol 105: 278-281.
5. Del Borgo C, del Forno A, Ottaviani F, Fantoni M (1997) Sinusitis in HIV-infected patients. J Chemotherapy 9: 83-88.
6. Del Forno A, del Borgo C, Turriziani A, Ottaviani F, Antinori A, Fantoni M (1998) Non-Hodgkin's lymphoma of the maxillary sinus in a patient with acquired immunodeficiency syndrome. J Laryngol Otol 112: 982-985.
7. Dunand VA, Hammer SM, Rossi R, Poulin M, Albrecht MA, Doweiko JP, DeGirolami PC, Coakley E, Piessens E, Wanke CA (1997) Parasitic sinusitis and otitis in patients infected with Human Immunodeficiency Virus: Report of five cases and review. Clin Infect Dis 25: 267-272.
8. Ferguson BJ, Kapadia SB, Carrau RL (1997) Mycobacterium avium complex infection in the paranasal sinuses. Otolaryngol Head Neck Surg 117: 160-162.
9. Godofsky EW, Zinreich J, Armstrong M, Leslie JM, Weikel CS (1992) Sinusitis in HIV-infected patients: A clinical and radiographic review. Am J Med 93: 163-170.
10. Gordts F, Clement PAR, Destryker A, Desprechins B, Kaufman L (1997) Prevalence of sinusitis signs on MRI in a non-ENT paediatric population. Rhinology 35: 154-157.
11. Grant A, von Schoenberg M, Grant HR, Miller RF (1993) Paranasal sinus disease in HIV antibody positive patients. Genitourin Med 69: 208-212.
12. Grieco MH (1989) Immunoglobulins and hypersensitivity in human immunodeficiency virus (HIV) infection. J Allergy Clin Immunol 84: 1-3.
13. Hansen JG, Schmidt H, Rosborg J, Lund E (1995) Predicting acute maxillary sinusitis in a general practice population. BMJ 311: 233-236.
14. Israël-Biet D, Labrousse F, Tourani JM, Sors H, Andrieu JM, Even P (1992) Elevation of IgE in HIV-infected subjects: A marker of poor prognosis. J Allergy Clin Immunol 89: 68-75.
15. Iwen PC, Rupp ME, Hinrichs SH (1997) Invasive mold sinusitis: 17 cases in immunocompromised patients and review of the literature. Clin Infect Dis 24: 1178-1184.
16. Jensen JS, Søndergård-Andersen J, Uldum SA, Lind K (1989) Detection of Mycoplasma pneumoniae in simulated clinical samples by polymerase chain reaction. APMIS 97: 1046-1048.
17. Juman S, Robinson P, Balkissoon A, Kelly K (1994) B-cell non-Hodgkin's lymphoma of the paranasal sinuses. J Laryngol Otol 108: 263-265.
18. Kankam CG, Sallis R (1997) Acute sinusitis in adults. Postgrad Med 102: 253-258.
19. Kennedy DW, Zinreich JS, Rosenbaum AE, Kumar AJ, Johns ME (1988) Physiologic mucosal changes within the nose and ethmoid sinus: imaging of the nasal cycle by MRI. Laryngoscope 98: 928-933.
20. Lamprecht J, Wiedbrauck C (1988) Sinusitis und andere typische Erkrankungen im HNO-Bereich im Rahmen des erworbenen Immundefekt-Syndroms (AIDS). HNO 36: 489-492.
21. Lindbæk M, Johnsen U L-H, Kaastad E, Dølvik S, Møll P, Lærum E, Hjortdahl P (1996) CT findings in general practice patients with suspected acute sinusitis. Acta Radiol 37: 708-713.
22. Meduri GU, Reddy RC, Stanley T, El-Zeky F (1998) Pneumonia in acute respiratory distress syndrome. A prospective evaluation of bilateral bronchoscopic sampling. Am J Respir Crit Care Med 158: 870-875.
23. Mofenson LM, Korelitz J, Pelton S, Moye J, Nugent R, Bethel J (1995) Sinusitis in children infected with Human Immunodeficiency Virus: clinical characteristics, risk factors, and prophylaxis. Clin Infect Dis 21: 1175-1181.
24. Mundy LM, Auwaerter PG, Oldach D et al (1995) Community-acquired pneumonia: impact of immune status. Am J Respir Crit Care Med 152: 1309-1315.
25. Naguib MT, Byers JM, Slater LN (1994) Paranasal sinus infection due to atypical mycobacteria in two patients with AIDS. Clin Infect Dis 19: 789-791.
26. Pomilla PV, Morris AB, Laworek A (1995) Sinonasal non-Hodgkin's lymphoma in patients infected with Human Immunodeficiency Virus: report of three cases and review. Clin Infect Dis 21: 137-149.
27. Porter JP, Patel AA, Dewey CM, Stewart MG (1999) Prevalence of sinonasal symptoms in patients with HIV infection. Am J Rhinol 13: 203-208.
28. Rubin JS, Honigberg R (1990) Sinusitis in patients with the Acquired Immunodeficiency Syndrome. ENT-J 69: 460-463.
29. Sample S, Lenahan GA, Serwonska MH, Rangi S, Sherman JW, Chernoff DN, Hollander H, Goetzl EJ (1989) Allergic diseases and sinusitis in acquired immune deficiency syndrome. J Allerg Clin Immunol 83: 190.
30. Schlanger G, Lutwick LI, Kurzman M, Hoch B, Chandler FW (1984) Sinusitis caused by Legionella pneumophila in a patient with the Acquired Immune Deficiency Syndrome. Am J Med 77: 957-960.
31. Small CB, Kaufman A, Armenaka M, Rosenstreich DL (1993) Sinusitis and atopy in Human Immunodeficiency Virus infection. J Infect Dis 167: 283-290.
32. Tarp B, Jensen JS, Østergaard L, Andersen PL (1999) Search for agents causing atypical pneumonia in HIV-positive patients by inhibitor-controlled PCR assays. Eur Respir J 13: 175-179.
33. Tarp B, Fiirgaard B, Christensen T, Jensen JJ, Black FT (2000) The prevalence and significance of incidental paranasal sinus abnormalities on MRI. Rhinology 38: 33-38.

34. Wenig SP, Heppt WJ, Maier H (1995) Kieferhöhlenpunktion mit Sinoject. Laryngo-Rhino-Otol 74: 395-396.
35. Wong KH, Cooper DA, Pigott P, Marriott DJ (1998) Chronic cough in patients with HIV infection. Scand J Infect Dis 30: 227-229.
36. Yoskovitch A, Cantrell H (1998) Cytomegalovirus infection presenting as chronic sinusitis and nasal polyposis: A case report. ENT-J 77: 35-38.
37. Zurlo JJ, Feuerstein IM, Lebovics R, Lane HC (1992) Sinusitis in HIV-1 infection. Am J Med 93: 157-162.

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ANNOUNCEMENT