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Microbial flora of nose and paranasal sinuses in chronic maxillary sinusitis

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SUMMARY

Nasal secretions, maxillary sinus aspirates and specimens of the maxillary sinus mucosa were collected in 44 patients aged between 25 and 60 affected by mono- or bilateral chronic maxillary sinusitis, in order to establish the best sampling technique for microbiological purposes, the most frequently involved bacteria and the physiopathological mechanism underlying chronic maxillary disease. The sinusal mucosa resulted to be the most reliable sample as it reduces contamination and microbial variability. Anaerobic bacteria were isolated in nasal swab (15.6%), in maxillary sinus aspirates (30.4%) and in maxillary sinus mucosa (36.4%) of maxillary sinusitis patients. In controls anaerobic bacteria were isolated only in one nasal swab (2.3%), while they could not be isolated in maxillary sinus aspirates and in maxillary sinus mucosa. The presence of anaerobic bacteria in chronic maxillary sinusitis patients and their absence in controls seem to confirm that anaerobic microorganisms represent the main pathogenetic agents of chronic maxillary sinusitis. The possible physiopathological mechanisms underlying chronic maxillary sinus disease are finally discussed.

Microbial agents in chronic maxillary sinusitis are extremely variable. Every kind of microorganism, whether aerobic or anaerobic, gram positive or gram negative, single or together with other agents is potentially able to cause inflammatory diseases of the paranasal sinuses. This variability is due to different sampling (Lystad et al., 1964; Catlin et al., 1965), transport and culturing techniques (Su et al., 1983) and to other variables, such as the patient's age (Maurizi and Ferraro, 1971) the socio-economical conditions and the geographical distribution (Axelsson and Brorson, 1972), the seasonal behaviour of the disease (Kinnman et al., 1967) and the uncontrolled assumption of antibiotics.

Anaerobic microorganisms have been isolated with increasing frequency in maxillary sinuses and especially in perisinusal complications. The increased knowledge of bacterial interference phenomena (Sanders, 1969; Tagg et al., 1976), could explain the individual aspecific resistance to infections; furthermore, microorganisms produce substances that can enhance or impair the host

defensive mechanisms (Dendry, 1974; Fox, 1974; Venezia and Robertson, 1975; Beachy and Ofek, 1977; Mulks et al., 1980).
The aim of the present paper is to establish the best sampling technique, the most frequently involved agents and the physiopathological mechanisms underlying chronic maxillary disease.

MATERIAL AND METHODS

Nasal secretion, a maxillary aspirate and specimens of the maxillary sinus mucosa were collected during Caldwell-Luc operations performed on 44 patients, 34 males and 10 females, aged between 15 and 60 ($M = 30 \pm 10$), affected by mono- or bilateral clinically and roentgenologically proven chronic maxillary sinusitis. Operations have been performed at the Institute of Otorhinolaryngology of the University of Perugia between January and December 1984. Controls were represented by seven patients, six males and one female, aged between 15 and 53 ($M = 25 \pm 3$), who underwent a Caldwell-Luc operation due to a non exposed fracture of the maxillary sinus. In 30 normal subjects, 20 males (age: 28 ± 3) and 10 females (age: 25 ± 4) a nasal sample was collected in order to increase observations. Local and or general antibiotic treatment had been interrupted at least 30 days before the sample collection.
Nasal secretions were obtained passing a sterile cotton swab along the middle meatus without touching the nasal vestibule. The swab was immediately introduced in the Stuart (Port A Cult BBL) transport Medium. The maxillary aspirate was obtained inserting through the anterior wall of the sinus a 10 ml syringe. When secretions were absent (controls), or very sticky and dense, 3 ml saline were previously injected. The aspirate was then introduced into a rubber stopped tube containing O_2 free gas prepared in an anaerobic chamber. The maxillary sinus mucosa was obtained by means of a Weill forceps after the surgical opening of the sinus and the sample was introduced in a rubber stopped tube containing thioglycholate medium. All samples were immediately sent to the Institute of Microbiology of the same University and introduced into selective mediums both in aerobic and anaerobic conditions (GAS-PACK-BBL) at 37 °C and examined after 24–48 hours. The media treated in anaerobic conditions were examined 49 and 96 hours later and the thioglycholate medium was cultured on for 5 days. All samples were stained by the Gram method and bacterial agents were identified by means of the Miniteck System.

RESULTS

Microbial agents found in each kind of sample in the two considered groups are represented in Tables 1, 2 and 3. In the nasal swab of patients with chronic maxillary sinus disease, 54 aerobic (84.4%)and 10 anaerobic bacteria (15.6%) were isolated. The most common aerobic agents were the Staphylococcus epidermidis,

the Micrococcus, the Streptococcus viridans, the Streptococcus pneumoniae and the Staphilococcus aureus. The most common anaerobius agent was the Peptostreptococcus anaerobius. The aerobic/anaerobic ratio was 5.4/1 (Table 4). Within the controls, out of 44 kinds of microbial agents, 43 (97.7%) were aerobic and only 1 (2.3%) anaerobic (Table 1). The aerobic/anaerobic ratio in controls was then 43/1 (Table 4).

From the maxillary aspirate of chronic sinusitis patients, 16 (69.6%) aerobic kinds of bacteria and 7 (30.4%) anaerobic were isolated. The Staphilococcus epidermidis was the most frequent aerobic agent, while the Peptostreptococcus anaerobius was the most frequent anaerobic one. The aerobic ratio was 2.2/1 (Table 4). Within controls, only 3 microbial agents were found, all being aerobic (Table 2).

Table 1. Nasal swab sample.

CHRONIC MAXILLARY SINUSITIS			
aerobic bacteria	N	anaerobic bacteria	N
Staphyl. epidermidis	14	Peptostrept. anaerobius	6
Micrococcus	12	Bact. melaninogenicus	1
Strept. viridans	7	Clostr. sfenoides	1
Dipht. bacillus	5	Peptococcus	1
Neisseria	5	Bact. ovatus	1
Strept. pneumoniae	3		
Staphyl. aureus	3		
Proteus mirabilis	2		
Bacillus sp.	2		
Strept. faecalis	1		
no growth	8		
total species	54	total species	10
aerobic bacteria	84.4%		
anaerobic bacteria	15.6%		
CONTROLS			
Micrococcus	13	Peptostrept. anaerobius	1
Dipht. bacillus	9		
Strept. viridans	8		
Neisseria	5		
Staphyl. epidermidis	5		
Staphyl. aureus	1		
Serratia	1		
Aspergillus a.	1		
no growth	1		
total species	43	total species	1
aerobic basteria	97.7%		
anaerobic bacteria	2.3%		

Table 2. Sinusal aspirate sample.

CHRONIC MAXILLARY SINUSITIS			
aerobic bacteria	N	anaerobic bacteria	N
Staphyl. epidermidis	6	Peptostrept. anaerobius	6
Strept. viridans	3	Clostr. sfenoides	1
Micrococcus	3		
Staphyl. aureus	2		
Neisseria	2		
no growth	28		
total species	16	total species	7
aerobic bacteria	69.6%		
anaerobic bacteria	30.4%		
CONTROLS			
Strept. viridans	1		
Micrococcus	1		
Corynebacterium	1		
no growth	3		
total species	3	total species	0
aerobic bacteria			100%

Table 3. Sinusal mucosa sample.

CHRONIC MAXILLARY SINUSITIS			
aerobic bacteria	N	anaerobic bacteria	N
Staphyl. epidermidis	6	Peptostrept. anaerobius	6
Micrococcus	4	Peptostrept. niger	2
Strept. viridans	4	Clostr. sfenoides	1
Staphyl. aureus	2	Peptococcus	1
Dipht. bacillus	2	Bact. melaninogenicus	1
Bacillus sp.	1	Bact. b	1
Strept. pneumoniae	1		
Neisseria	1		
no growth	21		
total species	21	total species	12
aerobic bacteria	63.6%		
anaerobic bacteria	36.4%		
CONTROLS			
Strept. viridans	2		
Micrococcus	1		
no growth	6		
total species	3	total species	0
aerobic bacteria	100%		

Table 4. Aerobic/anaerobic ratio within the 3 samples in chronic maxillary sinusitis (C.M.S.) and in controls (C).

			aerobic		anaerobic		
C.M.S.	N	total	N	%	N	%	a./an.
NSS	44	64	54	84.4	10	15.6	5.4/1
SAS	44	23	16	59.6	7	30.4	2.3/1
SMS	44	33	21	63.6	12	36.4	1.7/1
C.							
NSS	37	44	43	97.7	1	2.3	43 /1
SAS	7	3	3	100	0	0	3 /0
SMS	7	3	3	100	0	0	3 /0

NSS = Nasal swab sample;
SAS = Sinusal aspirate sample;
SMS = Sinusal mucosa sample.

Concerning maxillary sinus mucosa, 33 bacteria were isolated, 21 (63.6%) being aerobic and 12 (36.4%) anaerobic. The Staphylococcus epidermidis was the most common aerobic agent, while the Peptostreptococcus anaerobius the most common anaerobic one. The aerobic/anaerobic ratio was lower than in all other samples (Table 4). In controls, three bacteria were detected, all being aerobic (Table 3).

Anaerobic agents within the three samples, were always together with one or more aerobic agents. There was not any significant difference in the aerobic bacterial flora neither comparing the three different samples within the maxillary sinusitis group and the controls. A consistent difference could, instead, be detected comparing the anaerobic agents isolated in the third sample (maxillary mucosa) to those found in the first (nasal swab) in maxillary sinusitis group and controls.

DISCUSSION

Concerning sampling techniques, the direct collection during Caldwell-Luc operation has to be preferred to the transnasal approach to the sinus, which facilitates contamination (Palva et al., 1982; Kessler, 1968; Frederick and Braude, 1974; Evans et al., 1975; Karma et al., 1979). Furthermore the sinusal mucosa is the most reliable sample as it reduces contamination and microbial variability (Nostrand and Goodman, 1976; Lundberg and Engquist, 1984). In the present experiment Staphylococcus aureus and Streptococcus pneumoniae have been less frequently isolated if compared to literature data (Van Dishoeck and Franssen, 1957; Hohenwald, 1965; van Cauwenberge et al., 1976; Chapnick and Back, 1976; Carenfelt et al., 1978) but they are to be considered absolutely pathogenous, together with Diphteroid bacillus, as they have never been isolated in controls. Streptococcus viridans, instead, does not seem to be pathogenous as it has been found in controls and this finding is in contrast with those of Palva et al.

(1962) and Karma et al. (1979). The absence of a difference between the distribution of aerobic bacteria within maxillary sinusitis patients and controls, indicates that they represent the normal naso-sinusal bacterial flora (Su et al., 1983), and that they do not play a pathogenous role in the ethiopathogenesis of chronic maxillary sinusitis (Frederick and Braude, 1974).

The coexistence of anaerobic and aerobic bacteria is not surprising, as they often cooperate to the ethiopathogenesis of head and neck infections (Finegold, 1977).

The presence of anaerobic bacteria in chronic sinusitis mucosa (36.4%) and their absence in controls, confirm that anaerobic microorganisms represent the main pathogenetic agents of chronic maxillary sinusitis (Fredette et al., 1961; Frederick and Braude, 1974; van Cauwenberge et al., 1975; Su et al., 1983; Verschraegen, 1983). The way they reach the paranasal cavity is still unclear; they could populate in normal conditions the sinusal cavity (Brook, 1981) or they could reach it through the periosteal venous and lymphatic vessels (Su et al., 1983) or through the accessory ostia. This second hypothesis (Lundberg et al., 1979) is more reliable as anaerobic bacteria have not been detected in our control sinuses.

An impaired ventilation due to an anatomical and dynamical insufficiency of the antral ostium, and the following modifications of the endosinusal pO_2 and pCO_2 partial pressures and of the pH (Aust and Drettner, 1974) can determine the occurrence of a maxillary sinus inflammatory disease. The impaired mucociliary activity (Reimer and Toremalm, 1978), causing an inadequate drainage of the dense secretions produced by the affected mucosa, the reduced aspecific and specific local immune defensive mechanisms (Carenfelt and Lundberg, 1977), the oxigen reduction due to the presence of aerobic bacteria, create the ideal environmental conditions for the growth of anaerobic bacteria (Carenfelt, 1979).

Clinical implications of anaerobic sinusal infections concern their serious complications including periorbital cellulitis, cerebral abscesses, epi- and subdural empiema and cavernous sinus thrombosis (Himalstein, 1967; Quick and Paine, 1972; Yoshikava et al., 1975; Finegold, 1977; Grace, 1984).

RÉSUMÉ

Les auteurs ont étudié les sécrétions nasales, les aspirations des sinuses maxillaires et la muqueuse sinusale chez 44 sujets agés entre 25 et 60 ans, et atteints de sinusite chronique mono- ou bilateral, aufin de choisir la meilleure technique pour évaluer les bactères les plus souvent responsable de cette pathologie et les méchanisms physiopathologiques qui sont à la base des sinusites chroniques. Les données obténues ont montré que la muqueuse nasale répresente le substrate le plus fidèle, parce-que elle permet de réduire la contamination bactériologique et la variabilité des germes. On a isolé des bactères anaerobiques dans les sécretions nasales (15.6%), et dans les aspirations des sinuses maxillaires (36.4%) des sujects atteints de sinusite chronique; dans les controles, on contraire on les a trouvé

seulement dans un cas pour ce qui concerne les sécretions nasales, et en aucun pour ce qui concerne les aspirations maxillaire et la muqueuse. La présence de bactères anaérobiques dans les sujects atteints de sinusite maxillaire chronique et leur absence dans les sujects normaux pourrait confirmer que ces bactères représent les agents pathogénetiques les plus importantes dans cette pathologie. Finalement, les auteurs examinent les mechanisms physiopathogénetiques qui, vraisemblablement, sont à la base des sinusites maxillaires chroniques.

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