Case Report Detection of mixed infections with *Mycobacterium lentiflavum* and *Mycobacterium avium* by molecular genotyping methods

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Three mycobacterial isolates, one from the blood of an HIV-infected patient and two consecutive isolates from a woman with unknown HIV status, had been identified as belonging to the *Mycobacterium avium* complex by conventional procedures. In both patients, using genetic analysis procedures such as PCR–restriction enzyme analysis (PRA) of the *hsp65* gene, a commercially available reverse hybridization-based assay (INNO-LiPA MYCOBACTERIA) and/or sequencing analysis of the 16S–23S internal transcribed spacer (ITS), the presence of *Mycobacterium lentiflavum* was also demonstrated. At the time of detection, both cases were also infected with *M. avium*, suggesting an underestimation of infection with *M. lentiflavum* and co-infection with different *Mycobacterium* species.

**Introduction**

*Mycobacterium lentiflavum* is a slowly growing acid-fast bacillus (AFB) that has biochemical characteristics identical to those of organisms belonging to the *Mycobacterium avium* complex (MAC) and mycolic acid and fatty acid chromatography patterns very similar to those of *Mycobacterium simiae*, so genetic analysis is necessary for conclusive identification (Springer et al., 1996). This organism has been isolated from sterile clinical samples in Italy, Switzerland, Germany, France and Spain (Springer et al., 1996; Tortoli et al., 1997; Niobe et al., 2001; Ibanez et al., 2002) and from sputum samples in Brazil (da Silva Rocha et al., 1999) and Italy (Molteni et al., 2005) and, recently, cases of human disease have been reported, including chronic pulmonary disease (Molteni et al., 2005), cervical lymphadenitis (Cabria et al., 2002), liver abscess (Tortoli et al., 2002) and fatal disseminated infection (Ibanez et al., 2002). The main reservoir in the environment has not been firmly established, but organisms with *M. lentiflavum*-like 16S rRNA gene sequences were detected in soil samples from the UK and from France (Mendum et al., 2000) and the species seems to be frequently present in drinking water distribution systems in Finland (Torvinen et al., 2004). We here report the detection of a co-infection with *M. avium* and *M. lentiflavum* in the blood or lung of two different patients.

**Methods**

**Case descriptions**

**Case 1.** In December 1994, a 27-year-old Caucasian male was submitted to a renal biopsy at the Clementino Fraga Filho University Hospital in Rio de Janeiro and membranoproliferative glomerulonephritis type I was diagnosed. The individual was submitted to intravenous corticoid treatment and discharged from the hospital while continuing oral methylprednisolone treatment that was gradually reduced until interruption in December 1995. By that time, the patient had developed lymphopenia (as shown by CD4 lymphocyte...
counts of 500 cells mm$^{-3}$) that was held under control, but, in September 1996, he returned with weight loss, cough, fever and oral candidiasis. A chest X-ray revealed a diffuse reticulonodular infiltrate suggestive of active pulmonary disease. Sputum bacteriology showed no evidence of AFB, but pneumocystosis, a definitive marker of AIDS, was diagnosed and infection with HIV was confirmed. Treatment of pneumocystosis resulted in clinical improvement but, 3 weeks later, the patient returned with high fever and aqueous diarrhoea. A blood culture was performed and was positive for AFB. Upon treatment with streptomycin, sulphonamethoxazole/trimethoprim and corticoid, the patient improved and was discharged from the hospital in October 1996. Two weeks later he returned to the hospital and received zidovudine and didanosine and was discharged with the recommendation to return for regular re-evaluation. The patient died a few months later in another hospital and no data are available on the exact cause of death.

**Case 2.** In 1996, a 64-year-old woman was diagnosed with tuberculosis in the State of Mato Grosso. Despite treatment for tuberculosis since February 1997, she presented to Public Health Care in Votorantim, São Paulo, with cough, fever, coryza, weakness, lack of appetite, severe weight loss and dyspnoea. The X-ray showed bilateral thin-walled cavitations and sputum collection revealed AFB. She was therefore enrolled in 1998 at the ‘Núcleo de Gestão Assistencial’, a health care service. During the following 4 years, she was submitted to several treatment schemes for tuberculosis, including antibiotics such as clarithromycin, ethambutol, clofazimine, rifampicin and doxycycline. During this period, the patient did not show improvement but rather a gradual worsening of the clinical symptoms was observed with frequent positive bacilloscopy and mycobacterial cultures. In August 2002 she died of uterine cancer at 26 kg in weight.

**Culture, conventional identification and drug susceptibility testing.** AFB staining was performed by the Ziehl–Neelsen method. For case 1, a blood culture was performed using the lysis-centrifugation method (Fandinho et al., 1997) and colonies of AFB were grown by incubation on Löwenstein–Jensen (LJ) medium. For case 2, sputum culture on LJ medium was performed after decontamination using the Petroff method and centrifugation (Kent & Kubica, 1985). Subculture on LJ medium was performed after decontamination using conventional biochemical methods (negative for Tween hydrolysis, nitrate reduction and urease and positive for catalase and tellurite reduction). Part of the sample was treated by heat shock and submitted to genetic characterization by PRA of part of the hsp65 gene (Telenti et al., 1993; da Silva Rocha et al., 2002): no digestion with BsrEII and 145/125 bp fragments with HaeIII were obtained (Fig. 1a). According to the literature, this pattern is identical to M. lentiflavum I (Springer et al., 1996), but this pattern has also been described for M. simiae (da Silva Rocha et al., 2002). The isolate was submitted to INNO-LiPA MYCOBACTERIA and hybridized with the Mycobacterium species probe but not with the probes specific for MAC, confirming that the isolate did not belong to this complex. Since the INNO-LiPA assay does not contain probes specific for M. lentiflavum or M. simiae, sequencing of the 16S–23S ITS was performed and the isolate was confirmed to be M. lentiflavum.

A subculture obtained from a small amount of the original bacterial mass in the tube containing LJ medium before submitting it to heat shock was grown in Middlebrook 7H9 and reanalysed by PRA. On this occasion, the M. avium II restriction digest was observed and no (not even weak) bands corresponding to the M. lentiflavum pattern were found.

**Case 2**

Among the 15 Mycobacterium cultures obtained from 1997 to 2001 on LJ medium, 12 were identified as MAC and 3 as M. gordonae using conventional biochemical identification procedures (data not shown). Among these, two cultures, one obtained in June 1998 and the other in September 2000 and both identified as MAC, were submitted to molecular identification procedures. Both cultures were identified as M. intracellulare I by PRA; however, amplification results using primers from the M. intracellulare-specific DT1 fragment and the M. avium-specific DT6 and IS1245 fragments were contradictory. The first isolate was negative in the three PCR systems, while the more recent isolate was positive upon amplification of DT6 and IS1245; both results were therefore inconsistent with the identification as M. intracellulare.

For that reason, subcultures were prepared on 7H10-OADC plates and the molecular tests were repeated on isolated M. intracellulare and M. avium, respectively, according to Thierry et al. (1993), while the presence of the insertion sequence IS1245 is indicative of M. avium (Guerrero et al., 1995). Because the two cases were investigated independently by different research groups, the methodologies performed on the isolates from the two patients were not identical.

**Results**

**Case 1**

Blood culture yielded small, pale-yellow, smooth-domed colonies of AFB after 28 days of incubation at 37°C in LJ medium and the culture was identified as MAC by conventional biochemical methods (negative for Tween hydrolysis, nitrate reduction and urease and positive for catalase and tellurite reduction). Part of the sample was treated by heat shock and submitted to genetic characterization by PRA of part of the hsp65 gene (Telenti et al., 1993; da Silva Rocha et al., 2002): no digestion with BsrEII and 145/125 bp fragments with HaeIII were obtained (Fig. 1a). According to the literature, this pattern is identical to M. lentiflavum I (Springer et al., 1996), but this pattern has also been described for M. simiae (da Silva Rocha et al., 2002). The isolate was submitted to INNO-LiPA MYCOBACTERIA and hybridized with the Mycobacterium species probe but not with the probes specific for MAC, confirming that the isolate did not belong to this complex. Since the INNO-LiPA assay does not contain probes specific for M. lentiflavum or M. simiae, sequencing of the 16S–23S ITS was performed and the isolate was confirmed to be M. lentiflavum.

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colonies. In the second isolate, a mixed population containing colonies with two different morphologies was observed; PRA analysis resulted in the M. lentiflavum III pattern for the small yellow colonies, while the pale colonies were identified as M. avium II. This confirms the presence of a mixed infection with two different species and explains the earlier results obtained using amplification systems for DT1, DT6 and IS1245. On the other hand, analysis of the earlier isolated culture yielded small yellow colonies only and PRA patterns were all M. lentiflavum III.

**Discussion**

In contrast to M. avium, a species isolated frequently from the blood of HIV-infected individuals, isolation of M. lentiflavum from blood was described only recently (Niobe et al., 2001). Previous reports describe isolates from contaminated bronchoscope, gastric juice and urine samples (Springer et al., 1996), lymph nodes (Tortoli et al., 1997; Haase et al., 1997), bronchoalveolar lavage fluid and, very recently, sputum (Molteni et al., 2005); the present report is to our knowledge the second to demonstrate detection of M. lentiflavum in Brazil. Infection with MAC is frequent in Brazilian AIDS patients (Barreto et al., 1993) and because routine identification procedures do not differentiate some Mycobacterium species (including M. lentiflavum) from MAC, use of genetic methods for identification on a more routine basis would give a better idea of the prevalence of such species in this country.

Niobe et al. (2001) published the ITS sequences of a clinical isolate of M. lentiflavum and of the type strain ATCC 51985 and, although the 16S rRNA gene sequence of the clinical isolate had 100% identity to the sequence of the type strain, the ITS sequence of the clinical isolate had only 92.6% identity to that of strain ATCC 51985, suggesting the need to study ITS variability in this species. The ITS sequence of one M. lentiflavum isolate described here was identical to that published by Niobe et al. (2001), as was the case for another isolate obtained from a sputum sample of an HIV-positive individual from Rio de Janeiro (data not shown). This suggests that the ITS sequence variability, at least in Brazil, is limited or non-existent while, interestingly, the isolates presented different PRA patterns (Springer et al., 1996). Bearing in mind that the whole ITS sequence was evaluated while restriction enzyme analysis only demonstrates creation or destruction of restriction sites, this finding suggests that mutation in the two genes seems to occur at different rates.

In both patients, mixed mycobacterial populations were present upon genetic analysis. Although an M. lentiflavum pattern was observed in the original sample from the first patient, M. avium was observed exclusively in the sample that was obtained after culturing of a fraction of that sample, suggesting the selection of M. avium either by fractionating the sample during collection or because of the faster growth of M. avium; M. lentiflavum has been reported to be less virulent than M. intracellulare in mice (Saito et al., 2000), and this needs to be further investigated. This suggests the importance of submitting identical fractions to different identification procedures and considering analysis of isolated colonies, as confirmed by the results of characterization of separate colonies of the second isolate of case 2. Besides observing different colony morphology using this strategy, two genotypes belonging to different species were observed.

In the initial identification, both isolates of the second patient were identified as M. intracellulare by PRA. Comparing PRA patterns of M. intracellulare and M. lentiflavum III, the BstEII fragments are indistinguishable and there is a one-band difference upon HaellII digestion, a 60 bp band in M. intracellulare I that is absent from M. lentiflavum III. Failure to observe the 60 bp band or the appearance of the 60 bp band from M. avium could have led to this
misinterpretation (Fig. 1b); the influence of such bands on correct pattern interpretation has been observed before (da Silva Rocha et al., 1999; Léaño et al., 2005).

Sequencing also confirmed that the isolates were actually M. lentiflavum rather than M. intracellulare. In our earlier study, the PRA pattern M. lentiflavum III was also observed in about half of the M. intracellulare isolates, adding one more identifying pattern for the latter species (da Silva Rocha et al., 1999). The fact that these two species that are hard to separate by conventional identification and have the same PRA type co-exist in Brazil demonstrates the need to use different genotype assays for some organisms. Also, M. lentiflavum was present in cultures from material taken with a 2 year interval, showing that this species is more than a mere colonizer.

Prior to the HIV era, mixed mycobacterial infections consisted mainly of M. tuberculosis and some atypical mycobacteria. However due to immune suppression, simultaneous infection with different atypical Mycobacterium species is now more frequent; polyclonal infection of M. avium strains has been reported in AIDS patients in Brazil (Oliveira et al., 2000; Saad et al., 2000). So far, simultaneous infection of M. avium and M. lentiflavum has not been reported, probably because the two species are phenotypically indistinguishable. Although we suspect that Case 2 could initially have been infected with M. avium (and M. gordonae), superinfection with M. lentiflavum probably occurred when the patient was being treated for cancer. Infection with M. lentiflavum has been diagnosed in the lung of a woman that had been treated with corticoids because of suspicion of lung cancer (Galarraga et al., 2002), but this association is difficult to confirm here because not all isolates have been submitted to genetic analysis. Because of the lack of clinical data and the presence of different mycobacterial species, it was not possible to associate the presence of M. lentiflavum with the pathological states of the patients, but both disseminated disease (Niobe et al., 2001) and chronic pulmonary disease (Oliveira et al., 2000) caused by M. lentiflavum have been reported. Although M. lentiflavum has been reported to be susceptible to several antibiotics used for treatment of infection with mycobacteria other than M. tuberculosis (MOTT) (Niobe et al., 2001; Molteni et al., 2005), the clinical significance of susceptibility testing of these organisms has not been fully validated and complicates decisions on proper treatment of infection with M. lentiflavum.

The fact that M. lentiflavum has been reported in particular situations as one of the more frequently isolated mycobacteria not associated with disease (Idigoras et al., 2004), has been isolated from drinking water (Torvinen et al., 2004) and can lead to fatal disseminated disease highlights the importance of the correct identification of this species. Molecular identification tools can aid in characterization and thus in better understanding of the epidemiology of this species.

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References


