Intracellular activities of roxithromycin used alone and in association with other drugs against Mycobacterium avium complex in human macrophages.

N. Rastogi, V. Labrousse, A. Bryskier

To cite this version:
N. Rastogi, V. Labrousse, A. Bryskier. Intracellular activities of roxithromycin used alone and in association with other drugs against Mycobacterium avium complex in human macrophages.. Antimicrobial Agents and Chemotherapy, American Society for Microbiology, 1995, 39 (4), pp.976-8. <pasteur-00925375>

HAL Id: pasteur-00925375
https://hal-riip.archives-ouvertes.fr/pasteur-00925375
Submitted on 8 Jan 2014

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Intracellular activities of roxithromycin used alone and in association with other drugs against Mycobacterium avium complex in human macrophages.

N Rastogi, V Labrousse and A Bryskier

NOTES

Intracellular Activities of Roxithromycin Used Alone and in Association with Other Drugs against Mycobacterium avium Complex in Human Macrophages

NALIN RASTOGI,1* VALÉRIE LABROUSSE,1 AND ANDRÉ BRYSKIER2,3

Unité de la Tuberculose et des Mycobactéries, Institut Pasteur, Pointe-à-Pitre, Guadeloupe, French West Indies,1 and Domaine Antibiothérapie, Roussel-Uclaf, 93230 Romainville,2 and Laboratoire de Microbiologie, Centre Hospitalier Victor Dupouy, 95107 Argenteuil Cedex,3 France

Received 16 September 1994/Returned for modification 21 December 1994/Accepted 23 January 1995

Recent reports have shown that roxithromycin possesses significant activity against atypical mycobacteria, including the Mycobacterium avium complex (MAC), and that its extracellular anti-MAC activity is further enhanced in two- or three-drug combinations with ethambutol, rifampin, amikacin, ofloxacin, and clofazimine. In accordance with the above data, the anti-MAC potential of roxithromycin used alone and in combination with the above-mentioned antituberculous drugs was screened intracellularly against five clinical MAC isolates (from both human immunodeficiency virus-positive and human immunodeficiency virus-negative patients), phagocytized by human monocyte-derived macrophages. The results showed that roxithromycin used alone and within clinically achievable levels was active against all of the MAC isolates tested. Screening of two-drug combinations showed that both rifampin and clofazimine further increased the intracellular activity of roxithromycin against all five isolates by 35 to 80% (ethambutol, ofloxacin, and amikacin resulted in increased intracellular activity against one, two, and four isolates, respectively). For the three-drug combinations, the combination of roxithromycin plus ethambutol used with rifampin or clofazimine was the most uniformly active against all five MAC isolates, with activity increases of 42 to 90%, followed by roxithromycin plus ethambutol used with amikacin, which resulted in activity increases of 15 to 90%. The overall level of intracellular killing after 5 days of drug addition, in comparison with growth in untreated controls, varied from 1 to 3 log units depending on the individual MAC isolate and/or drug combination used.

With the advent of the global AIDS pandemic, disseminated Mycobacterium avium complex (MAC) disease has emerged as one of the most difficult-to-treat complications among terminally ill patients, considerably affecting the quality of life and resulting in increased morbidity and mortality (13). One of the major clinical aims in the management of AIDS patients is the prevention and treatment of MAC infections. This opportunistic pathogen poses one of the most formidable challenges to clinicians and scientists alike, not only because of its multiple drug resistance (12) but also because our understanding of MAC pathogenicity is limited (13). Furthermore, recent reports have shown that AIDS patients with MAC infection not only were highly immunosuppressed but also consistently showed much lower levels of oral antimycobacterial agents in serum than expected (7, 13), two factors which further complicate the efficacy of MAC therapeutic regimens (3).

Resistance in M. avium is apparently associated with the cell envelope and its refractoriness toward drug penetration (12, 14). We have previously attempted to circumvent this problem by breaking the MAC permeability barrier using combined drug treatment, which resulted in increased bactericidal activity against both extracellular and intracellular organisms (17). We have recently shown that roxithromycin possessed significant in vitro activity against atypical mycobacteria (15). Moreover, its extracellular anti-MAC activity was further enhanced in two- or three-drug combinations with ethambutol, rifampin, amikacin, ofloxacin, and clofazimine (16), all of which have been previously included in various therapeutic regimens to treat MAC infections (1, 2, 10, 13, 20). In the present investigation, we decided to screen the intracellular activity of roxithromycin used alone and in combination with above-mentioned potential anti-MAC drugs against clinical isolates from human immunodeficiency virus-positive (HIV+) and HIV-negative (HIV−) patients in a human macrophage system.

MAC strains used in this investigation (MAC1 through MAC3 from patients with HIV+ serology and MAC4 and MAC5 from patients with HIV− serology) were from our own culture collection. Bacteria were grown in complete 7H9 broth (supplemented with Middlebrook ADC enrichment; Difco Laboratories, Detroit, Mich.), containing 0.05% (vol/vol) Tween 80 to avoid clumping, at 37°C and were harvested in their mid-logarithmic phase at an optical density of 0.15 (measured at 650 nm with a Coleman Junior II spectrophotometer), which corresponded to about 10⁸ CFU/ml (15–17).

Cultures of human macrophages were prepared from adherent peripheral blood monocytes (from healthy donors) and infected with various MAC strains as reported previously (19). The monolayers (about 1 million macrophages per well) were allowed to phagocytize bacteria for 4 h at 37°C, after which all the extracellular bacilli were thoroughly washed away with

* Corresponding author. Phone: (590) 89 38 81. Fax: (590) 89 38 80.
TABLE 1. Intracellular activities of roxithromycin used alone and in combination with other antituberculous drugs against MAC isolates from HIV+ and HIV− patients

<table>
<thead>
<tr>
<th>Experimental conditions</th>
<th>HIV+ patients</th>
<th>HIV− patients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MAC1</td>
<td>MAC2</td>
</tr>
<tr>
<td>Control D0</td>
<td>1.000 ± 0.120</td>
<td>0.580 ± 0.140</td>
</tr>
<tr>
<td>Control D5</td>
<td>10.000 ± 1.000</td>
<td>3.900 ± 0.500</td>
</tr>
<tr>
<td>EMB 6</td>
<td>0.232 ± 0.015</td>
<td>1.130 ± 0.230</td>
</tr>
<tr>
<td>OFLO 5</td>
<td>0.047 ± 0.010</td>
<td>0.575 ± 0.073</td>
</tr>
<tr>
<td>RIF 15</td>
<td>0.019 ± 0.005</td>
<td>0.270 ± 0.050</td>
</tr>
<tr>
<td>AMIK 20</td>
<td>0.044 ± 0.016</td>
<td>0.096 ± 0.010</td>
</tr>
<tr>
<td>ROX 10</td>
<td>0.055 ± 0.010</td>
<td>0.160 ± 0.010</td>
</tr>
<tr>
<td>CLOFA 2.5</td>
<td>0.057 ± 0.010</td>
<td>0.035 ± 0.004</td>
</tr>
<tr>
<td>ROX + EMB</td>
<td>0.127 ± 0.014</td>
<td>0.140 ± 0.023</td>
</tr>
<tr>
<td>ROX + OFLO</td>
<td>0.100 ± 0.010</td>
<td>0.125 ± 0.010</td>
</tr>
<tr>
<td>ROX + RIF</td>
<td>0.013 ± 0.002</td>
<td>0.040 ± 0.004</td>
</tr>
<tr>
<td>ROX + AMIK</td>
<td>0.033 ± 0.005</td>
<td>0.084 ± 0.014</td>
</tr>
<tr>
<td>ROX + CLOFA</td>
<td>0.036 ± 0.010</td>
<td>0.012 ± 0.001</td>
</tr>
<tr>
<td>ROX + EMB + OFLO</td>
<td>0.113 ± 0.022</td>
<td>0.120 ± 0.012</td>
</tr>
<tr>
<td>ROX + EMB + RIF</td>
<td>0.011 ± 0.002</td>
<td>0.031 ± 0.002</td>
</tr>
<tr>
<td>ROX + EMB + AMIK</td>
<td>0.038 ± 0.008</td>
<td>0.044 ± 0.008</td>
</tr>
<tr>
<td>ROX + EMB + CLOFA</td>
<td>0.029 ± 0.005</td>
<td>0.013 ± 0.004</td>
</tr>
</tbody>
</table>

a Results are expressed as viable counts ± standard errors (in millions).

b For control D0 (control at day 0), the number of bacteria initially phagocytized at day 0 was determined; for control D5, growth in the control after 5 days of incubation was determined. EMB 6, ethambutol at 6 μg/mL; OFLO 5, ofloxacin at 5 μg/mL; RIF 15, rifampin at 15 μg/mL; AMIK 20, amikacin at 20 μg/mL; ROX 10, roxithromycin at 10 μg/mL; CLOFA 2.5, clofazimine at 2.5 μg/mL. The same concentrations were used for drug combinations.

In accordance with our experimental model for determining the intracellular action of drugs (17–19), all drugs were used at their reported maximum concentrations in serum in humans as follows: roxithromycin, 10 μg/mL (4); ethambutol, 6 μg/mL (11); ofloxacin, 5 μg/mL (21); rifampin, 15 μg/mL (11); amikacin, 20 μg/mL (5); and clofazimine, 2.5 μg/mL (9). Roxithromycin and ofloxacin (Roussel-Uclaf), ethambutol (Lederle), amikacin (Bristol-Myers Squibb), and clofazimine (Ciba-Geigy) were kindly provided by their manufacturers, whereas rifampin was purchased from Sigma Chemical Co., St. Louis, Mo.

The results obtained in this investigation are summarized in Table 1. During 5 days of incubation, the M. avium isolates grew from a low of 5.8 × 10^5 ± 1.4 × 10^5 to 3.9 × 10^6 ± 0.5 × 10^6 CFU per macrophage monolayer (strain MAC2) to a high of 9.4 × 10^5 ± 1.0 × 10^5 to 2.3 × 10^7 ± 0.2 × 10^7 CFU per macrophage monolayer (strain MAC5). In general, all organisms grew by about 1 log unit during 5 days of intracellular growth. Roxithromycin used alone and within the clinically achievable level of 10 μg/mL was active against all five MAC isolates, although to a somewhat lesser extent with strain MAC3 (Table 1). Both rifampin and clofazimine further increased the intracellular activity of roxithromycin against all five isolates by an order of 35 to 80% (Table 1; Fig. 1), in comparison with amikacin, which resulted in about a 13 to 64% increase against four of five strains. Both clofazimine and amikacin have been previously included in MAC treatment regimens with rifamycins and/or macrolide drugs, yielding favorable results (1, 13, 20). On the other hand, addition of ethambutol and ofloxacin resulted in increased intracellular killing of only one and two isolates, respectively.

For three-drug combinations, roxithromycin plus ethambutol used with rifampin or clofazimine was the most uniformly active combination against all five MAC isolates, with an overall activity increase of 42 to 90% in comparison with the activity of any of the drugs used alone at its peak concentration in serum (Table 1; Fig. 1). The combination of roxithromycin, ethambutol, and amikacin resulted in activity increases of 15 to 90% in comparison with the activity of any of the drugs used alone. On the other hand, no significant enhancement of the intracellular activity by ofloxacin in three-drug combinations was noticed against any of the five clinical isolates (Fig. 1).

When our viable-count data are compared with published evidence about the refractoriness of MAC isolates to most antimicrobial agents (3, 12–14), it is noteworthy that the combination of roxithromycin plus ethambutol used with rifampin, clofazimine, or amikacin resulted in overall inhibition of some of the MAC isolates of 1 to 3 log units in comparison with their growth in untreated controls at day 5 (Table 1). However, despite an increase in intracellular bactericidal activity of up to 1 log unit with certain two- or three-drug combinations over the level achieved with individual drugs (Fig. 1), it is not possible to choose one particular combination over others because...
FIG. 1. Percent enhancement of intracellular bactericidal activity of various drug combinations against MAC organisms inside human macrophages. The increase in intracellular bactericidal activity of drug combinations in comparison with activity of the drugs used alone was calculated by the following equation (18):

\[
\text{increase} = \left(1 - \frac{\text{CFU with drug combination}}{\text{lowest CFU with either drug used alone}}\right) \times 100
\]

EMB, ethambutol; OFLO, ofloxacin; RIF, rifampin; AMIK, amikacin; ROX, roxithromycin; CLOFA, clofazimine.

doing wide strain-to-strain variations in the drug susceptibility of MAC isolates (12, 16, 19). Overall, the results obtained in this investigation are comparable to those reported previously for another macrolide drug, clarithromycin, against MAC organisms growing intracellularly in murine (17) or human (18) macrophages.

On the basis of the significant anti-M. avium activity of roxithromycin in human macrophages (this paper), as well as its favorable pharmacokinetic properties (4, 6, 8), we conclude that this drug warrants further assessment in controlled clinical trials. We suggest that the three-drug combination of roxithromycin, ethambutol, and rifampin may be successfully used in combination with other drugs, which may include either clofazimine or amikacin, in future attempts to treat M. avium infections.

REFERENCES