In vitro activity of an antistaphylococcal phage lysate against planktonic and biofilm Staphylococcus aureus

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Background: The increase of the antibiotic resistance and the ability of bacteria to form biofilm on orthopedic implants spur the scientists to look for strategies alternative to antibiotics. Virulent bacteriophages are effective against planktonic and biofilm bacteria. We evaluated the killing activity of an antistaphylococcal phage lysate (ASPL), available in the Czech Republic for topical application, against planktonic and biofilm-embedded Staphylococcus aureus strains, isolated in orthopedic infections, by microcalorimetry.

Materials/methods: The susceptibility to ASPL of 23 methicillin-resistant S. aureus (MRSA) and 18 methicillin-susceptible S. aureus (MSSA) isolates, and two laboratory MRSA strains (ATCC 43300 and ATCC 33591) was evaluated by spot assay. The activity of different ASPL titers (from 10² to 10⁵ PFU/ml) against planktonic cells (10⁶ CFU/ml) and 24h-old biofilm of MRSA ATCC 43300 was evaluated in real-time by isothermal microcalorimetry for 24h at 37°C. The minimum heat inhibitory concentrations (MHIC) was defined as the lowest phage titer leading to the lack of heat flow production after 24h for both planktonic and biofilm-embedded cells. The viability of bacterial cells was assessed by plating and colony counting.

Results: 32 of 41 S. aureus strains, including 15 MRSA and 17 MSSA strains, were susceptible to the ASPL. A low phage titer (MHIC=10⁴ PFU/ml) was able to inhibit the heat production of planktonic MRSA ATCC43300. A complete killing of 10⁶ CFU/ml MRSA was already possible with 10⁵ PFU/ml ASPL. The same ASPL titer was also able to strongly suppress the heat produced by biofilm-embedded cells, although a complete MRSA biofilm eradication, after 24h incubation with 10⁵ PFU/ml ASPL, was not observed (Figure 1).

Conclusions: ASPL showed a broad host spectrum among MRSA and MSSA isolates from patients with implant-associated infections. ASPL exhibits a lytic activity against planktonic and biofilm MRSA, but higher titers of phage are needed for the complete eradication of MRSA biofilm. The ASPL shows a potential option of treatment for S. aureus implant-related infections alone and in a combination antibiotic therapy.

Figure 1. Percentage of MRSA and MSSA strains susceptible to ASPL (a) and evaluation of ASPL activity versus planktonic cells (b) and biofilms (c) of ATCC 43300 by isothermal microcalorimetry.