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Spoligotyping of *Mycobacterium tuberculosis* – comparing *in vitro* and *in silico* strategies

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INTRODUCTION

Since the 1990s, when molecular techniques became easily accessible to the mycobacteriologists, different tools for better understanding the epidemiology of tuberculosis (TB) have been developed. One of the most widely used methods for exploring the genetic diversity of *Mycobacterium tuberculosis* strains is spoligotyping.

The objective of this study was to compare the spoligotyping results for *M. tuberculosis* multidrug-resistant (MDR) and drug-susceptible (DS) clinical isolates, produced using both *in vitro* and *in silico* approaches.

METHODS

The study included 117 *M. tuberculosis* (57 MDR and 60 DS) isolates, recovered from as many patients from Poland (*n*=57) and Lithuania (*n*=60) between 2018 and 2019. Genomic DNA was extracted using PureLink Genomic DNA Mini Kit (Thremo Fisher Scientific, USA) or using a modified cetyltrimethylammonium bromide method. Spoligotyping *in vitro* was performed with a commercially available kit (Mapmygenome, India), as per manufacturer's instructions. Spoligotype shared types (ST) and phylogenetic clades were assigned according to the SITVIT2 database. Whole genome sequencing was done with Illumina NovaSeq 6000 sequencer in 2x150 bp paired-end mode. Phylogenetic clades of *M. tuberculosis* were assigned *in silico*, using three different spoligotyping tools, i.e. (i) *SpoTyping* (https://github.com/xiaeryu/SpoTyping-v2.0);
(ii) *SpolPred* www.pathogenseq.org/spolpred and
(iii) *lorikeet* (http://genomeview.org/jenkins/lorikeet

RESULTS

Upon *in vitro* spoligotyping, the isolates produced 37 different profiles split into 14 clusters (*n*=94, 80.3%, 2-33 isolates per cluster) and 23 (19.7%) unique patterns. Most isolates belonged to the Beijing family (*n*=40; 34.2%), followed by T (*n*=26; 22.2%), Ural (*n*=15; 12.8%), Haarlem (*n*=11; 9.4%), and LAM (*n*=10; 8.5%) clades. Fifteen (12.8%) isolates were designated as Unknown/Not defined. Among MDR *M. tuberculosis* isolates, the most abundant were Beijing (*n*=36; 63.1%) and Ural (*n*=11; 19.3%) lineages.

Spoligotypes inferred from the WGS data were congruent with *in vitro* generated profiles in 82.05%, when lorikeet and SpoTyping tools were applied, or 75.21% if SpolPred was used. Thus, either 21 isolates (11 spoligotypes) or 29 isolates (17 spoligotypes) were differently assigned, as compared with *in vitro* profiling.

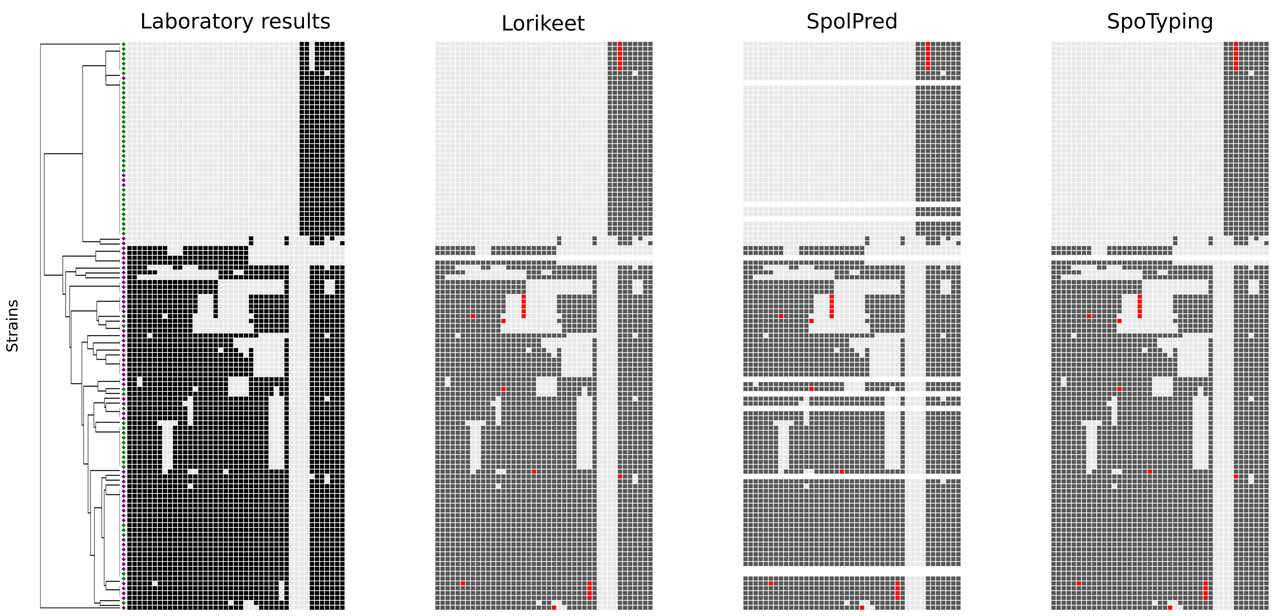

Figure 1. Spoligotype patterns of 117 *M. tuberculosis* isolates determined upon laboratory typing and WGS. Green and violet diamonds represent MDR and DS isolates, respectively. Probes differently assigned with *in vitro* and *in silico methods* are marked in red. If an assay gave inconclusive result, no pattern was drawn.

CONCLUSIONS

Given a relatively high (*ca*. 25%) discordance of the *in vitro* and *in silico* spoligotyping results, we advise to perform this genotyping as a conventional, PCR-reverse hybridization assay, at least unless more accurate tools are not available.

The spoligotype-based structure of the MDR *M. tuberculosis* population was conspicuously compact, since more than 80% of the isolates belonged to either of two lineages (Beijing and Ural). Among DS isolates, the T lineage predominated, comprising close to a third of the isolates.

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