Molecular and Cellular Probes 31 (2017) 2–21

Contents lists available at ScienceDirect

Molecular and Cellular Probes

journal homepage: www.elsevier.com/locate/ymcpr

Serological approaches for the diagnosis of schistosomiasis – A review

Rebecca Hinz [a, b, *], Norbert G. Schwarz [c], Andreas Hahn [d], Hagen Frickmann [b, e]

[a] Institute of Medical Microbiology, Virology and Hygiene, University Medical Center Hamburg-Eppendorf, Germany
[b] Department of Tropical Medicine at the Bernhard Nocht Institute, German Armed Forces Hospital Hamburg, Germany
[c] Bernhard Nocht Institute for Tropical Medicine, Hamburg, Germany
[d] Takeda Pharma Vertrieb GmbH & Co. KG, Berlin, Germany
[e] Institute for Medical Microbiology, Virology and Hygiene, University Medicine Rostock, Germany

ARTICLE INFO

Article history:
Received 15 April 2016
Received in revised form
28 November 2016
Accepted 12 December 2016
Available online 13 December 2016

Keywords:
Serology
Schistosomiasis
Antibody detection
Test evaluation
Test comparison
Schistosoma spp.
Screening

ABSTRACT

Schistosomiasis is a common disease in endemic areas of Sub-Saharan Africa, South America and Asia. It is rare in Europe, mainly imported from endemic countries due to travelling or human migration. Available methods for the diagnosis of schistosomiasis comprise microscopic, molecular and serological approaches, with the latter detecting antigens or antibodies associated with *Schistosoma* spp. infection. The serological approach is a valuable screening tool in low-endemicity settings and for travel medicine, though the interpretation of any diagnostic results requires knowledge of test characteristics and a patient's history.

Specific antibody detection by most currently used assays is only possible in a relatively late stage of infection and does not allow for the differentiation of acute from previous infections for therapeutic control or the discrimination between persisting infection and re-infection. Throughout the last decades, new target antigens have been identified, and assays with improved performance and suitability for use in the field have been developed. For numerous assays, large-scale studies are still required to reliably characterise assay characteristics alone and in association with other available methods for the diagnosis of schistosomiasis. Apart from *S. mansoni, S. haematobium* and *S. japonicum,* for which most available tests were developed, other species of *Schistosoma* that occur less frequently need to be taken into account.

This narrative review describes and critically discusses the results of published studies on the evaluation of serological assays that detect antibodies against different *Schistosoma* species of humans. It provides insights into the diagnostic performance and an overview of available assays and their suitability for large-scale use or individual diagnosis, and thus sets the scene for serological diagnosis of schistosomiasis and the interpretation of results.

Contents

* Corresponding author. Institute of Medical Microbiology, Virology and Hygiene, University Medical Center Hamburg-Eppendorf, Germany.
E-mail address: r.hinz@uke.de (R. Hinz).

http://dx.doi.org/10.1016/j.mcp.2016.12.003

1. Introduction

Schistosomiasis is a disease caused by blood flukes of the genus *Schistosoma.* Transmission to humans and other mammalian hosts occurs via freshwater snails, which serve as intermediate hosts and vectors [1].

Schistosoma haematobium, S. mansoni and *S. japonicum* are the species most frequently causing human schistosomiasis. Whilst *S. mansoni* is endemic in the Americas and the Caribbean, *S. haematobium* and *S. bovis* also occur in the Middle East and Africa, and *S. guineensis, S. intercalatum* and *S. matthei* are associated with human disease in some African countries. *Schistosoma japonicum, S. mekongi* [1–3] and *S. malayensis* [4] are only found in Asia. However, the distribution of *Schistosoma* spp. underlies a certain dynamic, influenced by immigration from endemic areas and tourism [5], provided that an appropriate intermediate host is present.

The traditional method for the diagnosis of schistosomiasis is the detection of eggs in stool for all species except *S. haematobium*, for which eggs are shed in urine [1,6]. Whilst microscopic approaches provide tolerable sensitivity in areas of high endemicity [7], sensitivity is poor in regions with low prevalence and in persons with acute or low level infection [1,8], such as in tourists returning from endemic areas [9,10]. Infection occurs in freshwater through skin penetrating cercariae. Eggs can first be detected after a prepatent period of 6–8 weeks. The quantity of shed eggs depends on the parasite burden and number and intensity of freshwater contacts. Furthermore, egg-shedding varies from day to day [9,11–14]. This explains the low sensitivity of microscopy, leading to a permanent under-evaluation of active infections and prevalence [1,15–17].

Compared with direct proof of the presence of the pathogen, referred to as “parasitological diagnosis”, serology provides a sensitive tool for the diagnosis of schistosomiasis, especially for infections with low intensity [12,18–20]. In the human host, antibodies against the four life-cycle stages of *Schistosoma* spp., represented by i) penetrating cercariae, ii) migrating juvenile worms (schistosomula), iii) adult worms, iv) eggs produced by worm pairs, and against v) proteins associated with these stages, e.g., circulating proteins regurgitated by adult worms, can be detected [6,12,13].

Some serological assays have been widely evaluated in endemic