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Mini Review

Tungiasis: Neglected Diseases of Resource-Poor Community

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Summary
Tunga penetrans (Siphonaptera: Tungidae) is an ectoparasite, which causes Tungiasis in humans and animals. Tungiasis is peculiar to America, Caribbean islands, and sub–Saharan Africa. Residents in poor dwells are at a higher risk of getting Tungiasis. Social behaviors, economic status, and environmental factors are the major determinants for tungiasis. Companion animals, such as pigs, dogs, and cats are reservoirs for *T.penetrans*. The complete life cycle of Tunga flea takes one month to a year. Tunga flea has restricted jumping capacity and infestation is possible mostly at the lower extremities. Inflammation, self-amputation of digits, distortion and loss of nails, fissures, ulcers, gangrene and abnormal gait are some of clinical symptoms. Secondary infection also poses possible risks. Presumptive diagnosis is done by identifying lodged fleas or infected body parts and known travel history. Dermoscopy is a confirmatory method. Histological finding of the skin examination infected by Tungiasis is also possible. In sterile setup, the best treatment is surgical removal. Topical ointments like Dimethicone, Zanzarin, Ivermectin, Metrifonate, and Thiabendazole are also effective and safe. Infestations are often prevented by wearing protective clothing, spraying insecticides, sweeping floors, and personal hygiene. There is a little number of studies and the status of Tungiasis is not well known in Ethiopia, therefore further studies should be initiated and funded.
Keywords: Tungiasis, Tunga peneterans, Reservoirs, Epidemiology.

Introduction

Tunga penetrans (Siphonaptera: Tungidae) is an ectoparasite, which causes tungiasis both in human and animals. Initially, this disease was discovered in America and now found in almost all continents (Heukelbach et al., 2001). In Africa it is found in all sub-Saharan countries (Douglas-Jones and Mills, 1995; Heukelbach et al., 2001). Morphologic flea identification requires vigorous knowledge and skills (Whiting, 2008). *Tunga penetrans* uses multivariate reservoir hosts to complete life cycle (Ibáñez-Bernal and Velasco-Castrejón, 1996; Ugbomoiko et al., 2007)). It resides on habitats such as sandy soil and irregularly nourish warm-blooded host (Pilger et al., 2008). The two main predilection sites infested by this parasite are toe folds and interdigits (Feldmeier et al., 2004; Thong and Jee, 2011). In developing countries, millions of people are at risk of infection. It is an impairing disease in resource-

poor populations (Feldmeier et al., 2004). It elicit serious incidence and debilitating conditions (Heukelbach et al., 2001; Ugbomoiko et al., 2007). A brownish-red spot nearly with diameter 1-3 mm and protruding visible posterior segment of the flea are early symptoms for Tungiasis (Heukelbach, et al., 2004). Any physician can tentatively diagnose the disease by using area of infection and typical history of the disease, even though dermoscopy is the confirmatory method (Heukelbach et al., 2001). Surgical removal is the gold standard treatment under sterile conditions (Heukelbach et al., 2001; Feldmeier et al., 2003). Behavioral, social and environmental changes play significant role for tungiasis prevention and control (Muehlen et al., 2006; Ugbomoiko et al., 2007).

Epidemiological distribution

Tunga penetrans is one of the few parasites, which has early spread from the Occidental to the Oriental Hemisphere. In the 17th century, it was first discovered and only found in the American continent (Heukelbach et al., 2001). The incipient clinical case of Tungiasis was investigated by Gonzalo Fernande (Feldmeier et al., 2003). In 1872, this flea entered the first African country, Angola, and then observed in Senegal along with human transportation across the water body. In 1899, it reached Madagascar with Senegalese troops of the French army and later spread to several parts of Africa, and in the same century entered the Indian Subcontinent by returnees of British troops (Eisele et al., 2003; Durden and Hinkle, 2018). Within few years it spread from Angola to whole sub-Saharan Africa along with trading routes and advancing troops (Heukelbach et al., 2001; Feldmeier et al., 2003). Currently, Tungiasis is a peculiar disease in Latin America, sub-Saharan Africa, and the Caribbean regions. Scattered circumstance has been reported from the corridor of Asia and Oceania (Ibáñez-Bernal and Velasco-Castrejón, 1996). Tungiasis has a sporadic spread, and occurs in underdeveloped society in rural Hicksville, in secluded fishing hamlets along water shores, and in the dump of urban centers (Cestari and Silva, 2007).

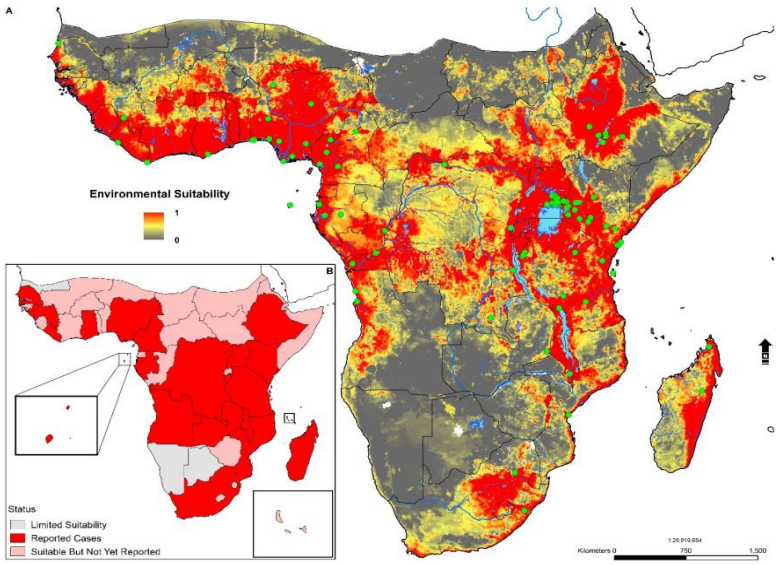

Fig. 1. Map showing predicted distribution of Tungiasis across sub-Saharan Africa. The green dots correspond to occurrence locations (Deka 2020).

Biology and Identification

The length of an adult flea is only 1 mm, although the pregnant female flea becomes a globular white mass reaching up to a diameter of 12 mm and having a black dot at the center. The abdominal cone together with the black dot at the center of the niosome is used for respiration, new eggs outlet, and excretion pathway. The fecal waste material

expelled by the female flea has a pheromonal activity and attracts other fleas toward the embedded one (Gordon, 1941; Eisele et al., 2003; Pilger et al., 2008; Durden and Hinkle, 2018). The male flea has protruded, whereas the female has a groove-like copulatory organ at the abdominal end (Heukelbach et al., 2004; Pampiglione et al., 2009). The identification of flea morphology requires vigorous knowledge and skills. Fleas have a phylogenic relationship at the level of family, genus, and order (Whiting et al., 2008). Cephalic capsule, maxillary palps of the head, pronotum and mesonotum fusion of the thorax and the size of the spiracles are the major morphological features to distinguish *T.penetrans* from other species of fleas (Winter et al., 2009).

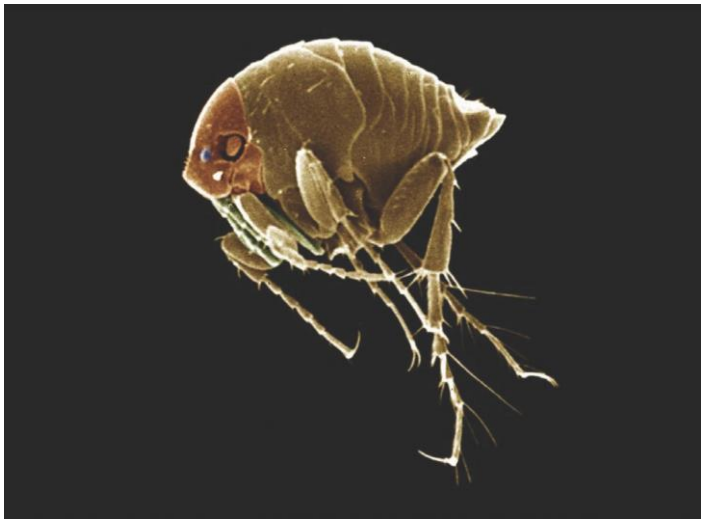

Fig. 2. Female *Tunga Penetrans* (Heukelbach, 2005)

Life cycle

Copulation takes few to two seconds after getting the female flea inside the skin and does not occur at external environment. In a single reproductive cycle, a female flea lies up to 100-200 hatchable eggs (Heukelbach et al., 2004; Pampiglione et al., 2009). The hatched eggs grow into the larval stages within three to four days (Nagy et al., 2007). Larvae then hatch into pupae that are in cocoons. Finally, under favorable condition pupae emerges as adult flea during few weeks, but under adverse conditions, it can be as long as a year. The adult flea then emerges and hunts for an appropriate host to get its meal and completes its life cycle (Heukelbach et al., 2001; Feldmeier and Krantz, 2013).

Reservoirs

Tunga penetrans affect ranges of mammalian orders including Cingulata, Pilosa, Artiodactyla, Perissodactyla, Carnivora, Rodentia, Primates and Proboscidea, and 27 genera of animals (Avelar, 2010). Both domestic and wild animals are the predominant source of Tungiasis. Animals like monkey, cattle, elephant, sheep, goat, dog, cat, and pig are important animal reservoirs (Wilcke et al., 2002; Heukelbach et al., 2004).

Health Importance

Bulging of Tunga flea inside the epidermis cause annoyance in human and animals (Durden and Hinkle, 2018). It elicits debilitating conditions like inflammation, malformation, chasmic-ulcers, Onycholysis, gangrene, gait abnormalities and toe cleavage (Ugbomoiko et al., 2007; Feldmeier et al., 2014). A subordinate complication also raise decent risks like insomnia, tetanus, Hepatitis and HIV if a common non-sterile flea removal tool is employed and shared among household members

(Muehlen et al., 2006; Feldmeier and Krantz, 2013).

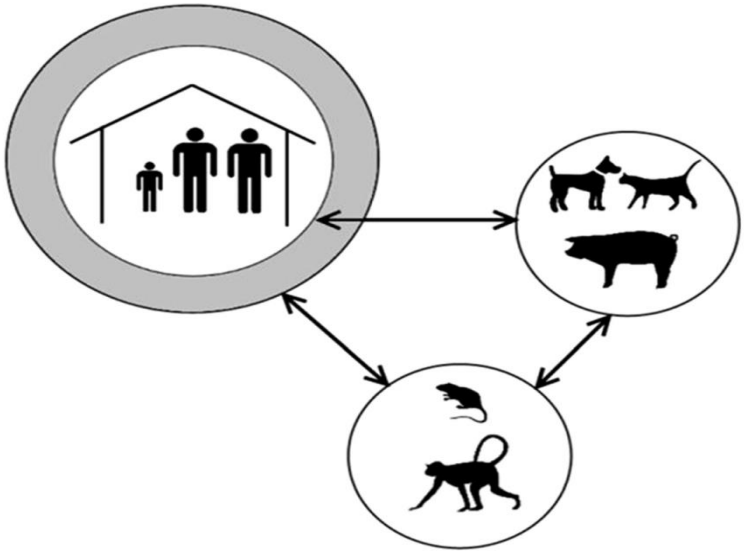

Fig. 3. Human, animal, and sylvatic transmission cycle of *T. penetrans* in tropical environment (Feldmeier et al., 2014).

Transmission factors

Temperature is a driving factor for Tungiasis and flea growth optimum temperature is 22-31 °C (Heukelbach et al., 2004). The disease is highly aggravated with the presence of sandy soils and agricultural practice (Muehlen et al., 2006; Wilcke et al., 2002). People residing with animals, poverty, and limited resource risk groups to Tungiasis. Behavioral attributes associated with age and gender are also risk factors (Heukelbach et al., 2004; Heukelbach et al., 2005; Hotez et al., 2008; Mazigo et al., 2010). Social attitudes, health infrastructures, and treatment modalities are also factors (Winter et al., 2009). Tunga parasite mounts unprotected part of the human skin and has restricted capacity of jumping. Penetration mostly occurs around the periungual region (area under the nail) but can also occur on legs, groin, hands, genitals, face, elbows, wrists, breasts, back, thighs (Bezerra, 1994; Fein et al., 2001; Feldmeier et al., 2004; Escamilla-Martinez et al., 2008; Thong and Jee, 2011).

Clinical presentation

Clinical features and premature symptoms are not obvious and indistinguishable. As the female flea increase in its size, irritation or itching intensifies and proceeded by swelling, soreness, and pain (Feldmeier et al., 2004). Brownish-red spot nearly with a diameter of 1-3 mm and the presence of protruding posterior segment of the flea is an early clinical symptom. At the later stage, the protruding segment of the flea increases forming a black dot surrounded by a white patch and the diameter of the lesion get to 1-4 mm (Heukelbach et al., 2004).

Fig. 4. Typical Tungiasis lesion on the fingertip (Heukelbach, 2005).

Diagnosis

Primarily tungiasis is diagnosed by identifying lodged fleas under the skin, usually as a black annoyance dot followed by pain. Diagnosis also possible by using flea morphology, travel history, and area of affected body part. In tungiasis prevalent area, diagnosis is performed using a microscope (Eisele et al., 2003; Feldmeier et al., 2004). In most cases, the patients grumble with itch and pain at the lower extremity of the body. The presence of expelled eggs anchoring to the skin, and liberating threads of brown feces is pathognomonic for the presence Tunga fleas (Heukelbach et al., 2001). Cases like; Mycosis, wart, bacterial infection, granulomas, exostosis, myiasis, tick bite, and melanoma are differential diagnosis for Tungiasis (Veraldi and Valsecchi, 2007; Pampiglione et al., 2009).

Treatment

Under sterile conditions, flea surgical removal is a first-line treatment option. Surgical removal is not a simple task; it requires experience and good look of eye. After the removal of the flea, the sore area should be applied with topical antibiotics (Heukelbach et al., 2001; Feldmeier et al., 2003). Additionally, Dimethicone, Zanzarin, Ivermectin, Metrifonate, and Thiabendazole are also effective and safe. These drug work by reducing viability of the parasite and facilitating manual removal (Heukelbach, 2006; Feldmeier and Heukelbach, 2006; Thielecke et al., 2014). The surgical and topical options may not remove parasite completely; additional treatments such as cryptotherapy and electrodesiccation should also be initiated (Heukelbach et al., 2003).

Control and prevention

Control and prevention of Tungiasis is possible by using evidence-based multi-sectorial approaches (Heukelbach et al., 2021). Plant-based repellents prevent tungiasis occurrence and reduce morbidity to insignificant levels. The regular application of coconut oil reduces the attack rate by 92% to almost 100% and prevents the development of morbidity (Feldmeier and Heukelbach, 2006; Feldmeier et al., 2013; Thielecke et al., 2013). Tungiasis is prevented by using protective shoes, boots, socks, sweeping of the floor and spraying insecticides (Pampiglione et al., 2009). Daily and frequent observation of feet and digits for the presence of the flea, timely removal, and personal hygiene can also prevent Tungiasis (Olomolehin and Adewunmi, 1982). Health, behavioral, social and environmental promotion can play role for Tungiasis control and prevention (Muehlen et al., 2006; Ugbomoiko et al., 2007).

Conclusion

Tungiasis is peculiar to the American, Caribbean islands, and sub–Saharan Africa. Tungiasis incidence increases to higher rate where animals and humans are living together. Tungiasis is zoonotic infection. Animals like pigs, dogs, and cats are reservoirs for *Tunga penetrans*. People living in poor dwelling are risk groups of getting

Tungiasis. Social behaviors, economic status, and environmental factors are the major determinants. Inflammation, self-amputation of digits, distortion and loss of nails, fissures, ulcers, gangrene and abnormal gaits are clinical features. Secondary infection poses considerable risks. It is detectable both in presumptive and confirmatory ways. It is a preventable and treatable disease. There is a little number of studies and the status of Tungiasis is unknown in Ethiopia, therefore further studies should be initiated and funded.

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Conflict of interests

No conflict of interests.

Ethical approval

Not applicable.

References

Ade-Serrano A., Olomolehin G. & Adewunmi A. Treatment of Human Tungiasis with Niridazole (Ambilhar) a Double-Blind Placebo-Controlled Trial. *Annals of Tropical Medicine and Parasitology,*1982, 76(1), 89-92.

Avelar M. Sistemática e Análise Cladística Das Espécies Neotropicais Do Gênero Tunga Jarocki (Siphonaptera: Tungidae), 2010, 18(38), 215.

Cestari F., Simone P. & Marcia R. Tungiasis and Myiasis. *Clinics in Dermatology*, 2007, 25(2), 158–64.

Chen T. & Shiou J. Tungiasis: A Case Report and Review of the Literature. *Dermatologica Sinica* , 2011, 29(1), 29–31.

Deka A. Mapping the Geographic Distribution of Tungiasis in Sub-Saharan Africa. *Tropical Medicine and Infectious Disease*, 2020, 5(3), 1–20.

Durden A. & Nancy H. 2018, *Fleas (Siphonaptera)*. Elsevier Inc. 145-169.

Eisele M., Heukelbach J., Eric Van M., Heinz M., Oliver M., Sabine F. & Hermann F. Investigations on Biology, Epidemiology, Pathology and Control of Tunga Penetrans in Brazil: I. Natural History of Tungiasis in Man. *Journal of Parasitology Research*, 2003, 90(2), 87–99.

Feldmeier H., Sentongo E. & Krantz I. Tungiasis (Sand Flea Disease): A Parasitic Disease with Particular Challenges for Public Health. *European Journal of Clinical Microbiology and Infectious Diseases*, 2013, 32(1), 19–26.

Feldmeier H., Margit E., Eric Van M., Heinz M., Ronaldo R. & Heukelbach J. Investigations on the Biology, Epidemiology, Pathology and Control of Tunga Penetrans in Brazil IV. Clinical and Histopathology. *Journal of Parasitology Research*, 2004, 94(4), 275–82.

Feldmeier H., Heukelbach J., Uade Samuel U., Elizabeth S., Pamela M., Georg von S-H. & Ingela K. Tungiasis-A Neglected Disease with Many Challenges for Global Public Health. *PLoS Neglected Tropical Diseases*, 2014, 8(10).

Heukelbach J., Costa A., Wilcke T., Mencke N. & Feldmeier H. Animal Reservoir of Tunga Penetrans in Severely Affected Communities , North-East Brazil. *Medical and Veterinary Entomology*, 2004, 18(4), 329–35.

Heukelbach J., Eisele M., Jackson A. & Feldmeier H. Topical Treatment of Tungiasis: A Randomized, Controlled Trial. *Journal of Tropical Medicine and Parasitology*, 2003, 97(7), 743–49.

Heukelbach J., Sahebali S., Van Marck E., Sabóia Moura R.C. & Feldmeier H. An Unusual Case of Ectopic Tungiasis with Pseudoepitheliomatous Hyperplasia. *The Brazilian Journal of Infectious Diseases*, 2004, 8(6), 465–68.

Heukelbach J., Sales De Oliveira F., Hesse G. & Feldmeier H. Tungiasis: A Neglected Health Problem of Poor Communities. *Tropical Medicine and International Health*, 2001, 6(4), 267–72.

Heukelbach J. Invited Review-Tungiasis. *Revista Do Instituto de Medicina Tropical de Sao Paulo*, 2005, 47(6), 307–13.

Heukelbach J. Revision on Tungiasis: Treatment Options and Prevention. *Expert Review of Anti-Infective Therapy*, 2006, 4(1), 151–57.

Heukelbach J., Liana A., Rukayat Queen A. & Uade Samuel U. Sustainable Control of Tungiasis in Rural Nigeria: A Case for One Health." *One Health & Implementation Research*, 2021, (1), 4–13.

Ibáñez-Bernal S. & Velasco-Castrejón O. New Records of Human Tungiasis in Mexico

(Siphonaptera:Tungidae). *Journal of Medical Entomology*, 1996, 33(6), 988–89.

Michael F.W., Alison S.W., Michael W.H. & Katharina D.A Molecular Phylogeny of FLeas. *The Willi Hennig Society*, 2008, 24, 677–707.

Muehlen M., Feldmeier H., Wilcke T., Winter B. & Heukelbach J. 2006. Identifying Risk Factors for Tungiasis and Heavy Infestation in a Resource-Poor Community in Northeast Brazil. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 2006, 100(4), 371–80.

Nagy N., Abari E., D'Haese J., Calheiros C., Heukelbach J., Mencke N., Feldmeier H. & Mehlhorn H. Investigations on the Life Cycle and Morphology of Tunga Penetrans in Brazil. *Journal of Parasitology Research*, 2007, 101(2), 233–42.

Pampiglione S., Fioravanti M. L., Gustinelli A., Onore G., Mantovani B., Luchetti A. & Trentini M. Sand Flea Infections in Humans and Domestic Animals: State of the Art. *Medical and Veterinary Entomology*, 2009, 23(3), 172–86.

Pilger D., Stefan S., Heukelbach J., Lars W., Heinz M., Norbert M., Adak K. & Feldmeier H. Investigations on the Biology, Epidemiology, Pathology, and Control of Tunga Penetrans in Brazil: VII. The Importance of Animal Reservoirs for Human Infestation. *Parasitology Research*, 2008, 102(5), 875–80.

Thielecke M., Per N., Nicholas N. & Feldmeier H. Treatment of Tungiasis with Dimeticone: A Proof-of-Principle Study in Rural Kenya. *PLoS Neglected Tropical Diseases*, 2014, 8(7), 30-58.

Ugbomoiko U., Ariza L., Ofoezie I. & J. Heukelbach. Risk Factors for Tungiasis in Nigeria: Identification Targets for Effective Intervention. *PLoS Neglected Tropical Diseases*, 2007, 1(3), 1–7.

Wilcke T., Heukelbach J., César Sabóia Moura T., Regina Sansigolo Kerr-Pontes L. & Feldmeier H. High Prevalence of Tungiasis in a Poor Neighbourhood in Fortaleza, Northeast Brazil. *Acta Tropica*, 2002, 83(3), 255–58.

Winter B., Fabíola A., Oliveira T. W., Heukelbach J. & Feldmeier H. Tungiasis-Related Knowledge and Treatment Practices in Two Endemic Communities in Northeast Brazil. *Journal of Infection in Developing Countries*, 2009, 3(6):458–66.