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Original Article

Epidemiological Studies on Echinococcosis and Characterization of Human and Livestock Hydatid Cysts in Mauritania

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ABSTRACT

Background: Echinococcosis/hydatidosis is considered endemic in Mauritania. The aim of this study is to present an epidemiological study on the echinococcosis in man and animals in the Nouakchott region.
Methods: The internal organs from livestock carcasses were inspected for research of hydatid cysts. The hydatid fluid was examined for research of the protoscoleces. Dogs were necropsied for the collect of *Echinococcus granulosus.*
Results: In the Nouakchott Hospital, 24 surgical operation of human hydatid cysts have been performed, out of which 50% were localised in the lung, 33% in the liver and 17% elsewhere. Then, the incidence rate would be of 1.2% per 100 000 inhabitants in Mauritania. In the dog, the prevalence rate is 14%. The average number of *E. granulosus* on the whole dogs is 172 and 1227 on the positive dogs. Concerning the livestock, hydatid cysts found in 30.1% of the dromedary, 5.5% of the cattle and 6.5 of the sheep. The fertility rate of hydatid cysts in humans (75%) and camels (76%) was significantly higher than that of sheep (24%) and cattle (23%) (P<0.0001). Hydatid infestation is characterized globally by the dominance of pulmonary localizations in humans (50%) and camels (72.7%) and in the liver in sheep (76.1%) and cattle (82.3%).
Conclusion: The differences between prevalence rates, the fertility of hydatid cysts and diversity sites localization observed in humans and camels of one hand and the sheep and cattle on the other hand, depends possibly the strain(s) diversity of *E. granulosus.*

Keywords: Prevalence, Hydatidosis, Echinococcosis, Mauritania

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Introduction

Echinococcus granulosus is a helminth parasite, which causes a zoonotic disease known as echinococcosis or hydatid disease. "The larval stage (hydatid cyst) infects both livestock herbivores and humans whereas the adult lives in the small intestine of carnivores (mainly canines)" (1, 2). Within the fertile cysts are the protoscoleces derived from the germinal layer, which if ingested by a dog evaginate and develop into worms in the small intestine (3, 4). Adults produce egg, which is passed out with the dog's faeces (5, 6). If eaten by herbivores or humans, the eggs hatch releasing larvae (oncosphère) that invade through the intestinal wall and evolve to hydatid cysts (7, 8).

Human hydatidosis was considered as scarce in Mauritania, the report of 24 cases operated in one year led to consider this disease as a new problem in this country, the surgical incidence rate being of around 1.6 per 100.000 inhabitants. However, two studies conducted years ago in Mauritania had shown that stray dogs of Nouakchott harbour *E. granulosus* with a low prevalence rate, and that all domestic ruminant species can develop hydatid cysts: such cysts were evidenced in 54% to 64% of the inspected dromedary carcasses, and in much lower percentages of sheep, goats, and cattle's carcasses (9). There is no figure available about wild carnivores, in particular jackals. Those data lead to consider that many protagonists can act as host of the zoonotic parasite strains.

Therefore, epidemiological investigation are needed, firstly: to get more precise data on the human prevalence rate, so as to evaluate the importance of this disease in term of public health problem, secondly: to identify the intermediate and definitive hosts of the zoonotic strains of the parasite in Mauritania, in order to focus the prophylactic actions on the important species. The molecular biology characterisation of human hydatid cysts, and the comparison of their patterns with those of cysts collected from different ruminant species and with those of dogs' echinococcosis, is considered as the first step of the epidemiological study to carry out. Then, the questions are, does this emergence of human cases correspond to a formerly under-evaluated problem? Is it a public health problem? In addition, what animal species are involved in the human infection?

To answer these questions, we decided to carry out epidemiological surveys on both humans and target animal species. We considered that the veterinary studies were the first to undergo, since they can provide quickly valuable information about the epidemiological situation. Molecular biology characterisation of the Mauritania strains could not be carried out until now, and we present here mainly descriptive epidemiology data.

Material and Methods

The medical part of our work is up to now limited to the registration of the human cases and the collection of cyst samples for biological investigations. The logistic, technical and management problems raised by medical studies led us to wait for epidemiological and biological results that could be used to validate a serological test.

Dogs

Veterinary investigations were first conducted on stray dogs, which were killed by poisoning during an eradication (limitation) campaign designed to prevent rabies in Nouakchott.

Necropsy

One hundred twenty one dogs killed in various parts of the city were necropsied. Once their age, origin and sex were recorded, the complete small intestine of each dog was removed, ligatures tied on its extremities, and were stored, if needed, at minus - 20°C until examination. At the time of examination, each gut was thawed, cut, washed and rubbed with a microscope slide under tap water. The whole content, washings and rubbing products were examined with a dark background (10, 11). Counts of *E. granulosus* were made either on the entire population when they were less than around 1000 or on a 10% aliquot when they were more numerous (12). *E. granulosus* samples of every positive dog were stored for further morphological and molecular biology studies.

Hydatid cysts

Several visits were paid to the chirurgical service of the Nouakchott hospital after every chirurgical operation and the Nouakchott slaughter. A total of 54 hydatid cysts human, 6229 of camel, 1657 of sheep and 632 of cattle were examined. The internal organs, lungs and livers were inspected for the presence of hydatid cysts. Cysts were counted and their sizes measured. They were also aspirated and the fluid was examined for research of the protoscoleces.

Fertility of hydatid cysts and viability of protoscoleces

Every hydatid cyst was removed and brought to the laboratory, where the following observations were made: measurement and characterisation of the volume, structure, number and viability of the protoscoleces. This viability was estimated by direct microscopic examination and by gentian violet staining with a 1°/oo solution (13, 14).

Statistical analysis

All results were statistically analysed by Chi 2 test.

Results

The prevalence rate of the dog *Echinococcosis* was 14%. The number of parasite*s* per positive animal is highly variable, and varies from 5 to 5360. The average number of *E. granulosus* overall dog sample was 172, and 1227 on the positive dogs. When looking at the influence of the age, origin (place of killing) and sex, we see that the variables related to the age only, demonstrate significant differences between classes Fig. 1. In fact, *E. granulosus* were evidenced more often and in larger numbers in old dogs. Concerning the intermediate host species, we found hydatid cysts in 30.1% of the dromedaries, 5.5% of the cattle and 6.5% of the sheep carcasses. Those cysts were dispatched unequally in the liver and lungs, with marked differences between dromedaries on one hand, and cattle and sheep on the other hand: 72.7% of the infected dromedaries harboured cysts in their lungs only, when 19.4% exhibited cysts in the liver only. (Both organs showed hydatid cysts in 7.9% of the infected camels).

The situation is the opposite in cattle and sheep: the greatest proportion of infection was seen in the liver, which is the only one organ infected in respectively 82.3% of the infected cattle and 76.1% of the sheep. (In those species, lungs are exclusively infected in 12% of the cattle and 17.3% of the sheep, whereas both organs are infected respectively in 5.7% and 6.5% of the infected animals Fig. 2. The fertility rate of hydatid cysts in humans (75%) and camels (76%) was significantly higher than that of sheep (24%) and cattle (23%) (P<0.0001).

The difference between the three species taken together for the cyst distribution was highly significant. However, the difference between cattle and sheep was not. For camels, we found significant differences for the prevalence rate only between ages classes, the medium-aged one being the most frequently infected. There were also striking differences between species when we looked at the structure, number and fertility of their cysts. For both hepatic and pulmonary cysts, we saw that in spite of similarities regarding the number of cysts, the % of fertile ones was greater in dromedaries; accordingly, the numbers of protoscoleces and viable protoscoleces were also much greater in this species than in the others (Table 1 and 2).

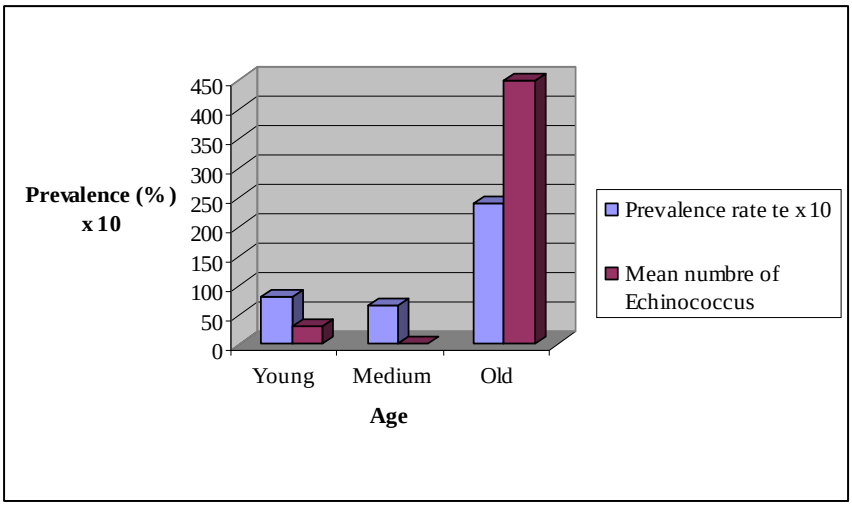

Fig. 1: Dogs echinococcosis status of three age classes

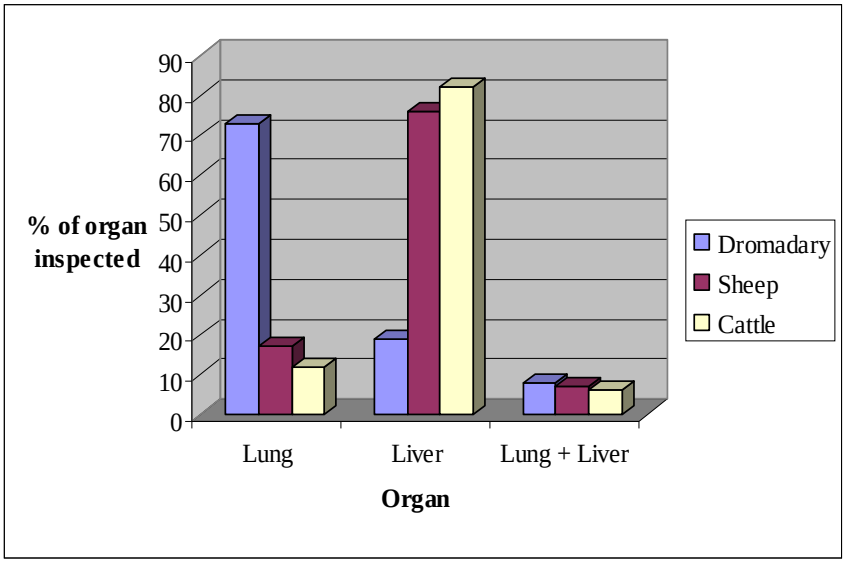

Fig. 2: Frequency of the localisations of hydatid cyst in the different organs from domestic animals

Table 1: Characteristic of human and livestock hydatid cysts

Intermediate Host species	Organ involved	Total number of cyst delaminated	Average of cyst / organ	Total number of fertile cysts (%)	Total number of sterile cysts (%)	Total number of calcified cysts (%)
Human	liver	21	1	14 (66. 60)	5 (23.80)	2 (9.20)
	lung	33	1	25 (75.75)	8 (24.24)	0 (0.00)
Camel	liver	1700	4	1006 (59.70)	229 (13.40)	465 (27.50)
	lung	4529	4	3443 (76)	527 (11.63)	559 (12.40)
Sheep	Liver	1313	3	321 (24.40)	191 (14.54)	801 (61.00)
	lung	344	3	78 (22.67)	95 (27.61)	171 (49.70)
Cattle	Liver	534	3	68 (12.73)	183 (34.26)	283 (53.00)
	lung	98	2	23 (23.46)	26 (26.53)	49 (50.00)

Table 2: Viability of protoscoleces from human and livestock hydatid cysts

Intermediate Host species	Organs involved	Average volume of cysts / ml	Average number of protoscoleces / ml	Average number of live protoscoleces / ml (%)
Human	liver	11	134	83 (61.94)
	lung	13.02	164	117 (70.05)
Camel	liver	14.5	274	206 (75.18)
	lung	18.5	350	267 (76.28)
Sheep	liver	5.72	80	35 (43.75)
	lung	6.85	62	29 46.77)
Cattle	liver	7.17	23	9 (39.11)
	lung	4.38	19	7 (36.80)

Discussion

Regarding the emergence of human cases in Mauritania, there is no doubt that the recent improvement of the diagnostic and surgical possibilities in Nouakchott, contributed to shed light of this disease. (Ultrasonographies for examples, which are now of common use at the National Hospital Centre of Nouakchott, allowed many diagnostics). In addition, hydatid cysts are now operated in this hospital, when this was not the case formerly, patients being addressed to other hospitals in Senegal or Europe when possible). It must be emphasised that the pulmonary localisation seems to be the most frequent in Mauritania. (Also, we spoke of the disease, and since then, we assumed that there would be less hydatid cysts misidentified).

The 14% prevalence rate of the dog echinococcosis in Nouakchott is quite elevated, and suggests that stray dogs represent a major threatening for people. (Unfortunately, our dog sampling did not include animals of the abattoir surroundings: it would have been interesting to verify that dogs are more infected in this area, this hypothesis being in accordance with an infection of dogs caused by camel and sheep cysts). This percentage is much more important than the figure reported by El Mogdad (8), who reported only 2.4% positive dogs in Nouakchott, but this researcher did not explain his method of examination. In contrast, our 14% is low when compared to prevalence rates of high endemicity areas of Maghreb: 50.8% infected dogs in Morocco, around 33% in Tunisia, and 31.5% in Libya (15, 16).

An interesting feature of the dog infection in Nouakchott is that old animals are significantly more infected than young and medium-aged ones. Then, we can expect that in the absence of etiological factors, eradication campaigns directed towards stray dogs would be even more effective as they would be repeated every year.

About intermediate hosts, our results are roughly in accordance with those reported previously (9, 17): the prevalence rates of hydatidosis given by the first author are 54% for camels, 0.85 % for cattle, 2.1% for sheep and 2.04% for goats. Pangui and O/Ahmedou (17) worked only on dromedaries and found 53.7% infected animals. Therefore, it is clear that the dromedary is by far the most frequently infected intermediate host species in Mauritania. However, our percentage of camel's hydatidosis is rather low when compared to those reported by El Mogdad and Pangui (9, 17) for Mauritania, and to those of countries like Morocco (80%), Algeria (56.5%) and Sudan (45.4%), but it is close to those of Libya (31.9%) and Tunisia (34.5%) (18, 19).

The preferential localisation of hydatid cysts in the lungs of dromedaries are in accordance with observations made by most authors, but not with those of El Mogdad in Mauritania, who reported similar infection rates in dromedaries for lungs and liver. We must recognise also that Pangui and O/Ahmedou found a significantly greater proportion of infected livers in dromedaries (20.3%) (12). Given that our technique allowed us to find many small cysts of around 10 millilitres, we assume that our findings are not far from the reality, especially for lung cysts. This might not be definitely true with hepatic cysts, which are less easy to find by palpation when they are small. Even then, we must notice that our technique enabled us to detect a greater proportion of cattle and sheep infected livers than in the work of El Mogdad (9).

The fertility rate of hydatid cysts in humans (75%) and camels (76%) was significantly

higher than that of sheep (24%) and cattle (23%) (P<0.0001).

Now, what about the strains circulating in Mauritania? Our results show clearly that we face a predominant dromedary strain, but the question is whether it is alone or not. The fact that cattle are infrequently affected and that a great proportion of their cysts are sterile is typical of a bad adaptation of the parasite to its host, which would be abnormal and play no significant role in the epidemiology of *E. granulosus* in this country. Sheep exhibited a slightly greater proportion of fertile cysts. However, their fertility is much lower than this of dromedarys, and there are numerous calcified cysts. Furthermore, we did not find any hyperactive fertile cyst in sheep, when they are frequently seen in this species with the sheep strain of Maghreb (20). Finally, according to El Mogdad, goats and sheep would be affected in a similar manner in Mauritania, which is also not the case in Maghreb with the sheep strain. We assume consequently that sheep in this country, at least in its southern part, are not infected with the same sheep strain of northern Africa. In contrast, our results would be in accordance with the hypothesis of a unique dromedary strain, which would be less infective to cattle and sheep.

Then, we would have to admit that the Mauritanian dromedary strain is likely to be responsible for the human infections in Mauritania. This hypothesis is also corroborated by the frequent pulmonary localisation seen in our cases, which is unusual with the well-known sheep strain. This feature has to be compared to similar but isolated human cases reported in Mali and Niger. If we are right to incriminate camels, it is important to notice that its human cysts exhibits features of good adaptation to humans since our human cysts looked well-developed and demonstrated high fertilities when checked.

In conclusion, the recent cases of human hydatidosis in Mauritania shows that this problem was probably under-estimated, which rises the question of whether it is a public health concern or not; then, serious epidemiological investigations are needed. Our results about dogs confirm and strengthen previous findings in showing that it is infected by *E. granulosus* in Nouakchott at a quite high prevalence rate. Dog is likely to be the most important definitive host of the parasite in this country. However, wild canids should be included in further prospects, particularly jackals, considering that they often live close to humans, and share areas with stray dogs.

Regarding the intermediate host species, we showed that the dromedary strain is predominant and might be even unique, at least in the southern half of Mauritania. Given that the human cases must have been contaminated in this region and that some of their cysts demonstrated good adaptation features to their host, this dromedary strain would have a good infection potential to humans.

This hypothesis has to be tested through molecular biology investigations: the human cysts must be characterised by DNA and/or isoenzyme analyses, and their patterns compared to those of referenced zoonotic strains and to the Mauritanian dromedary strain. For now, we would recommend to focus the control measures at the abattoir towards pulmonary cysts of the dromedaries first, and second, towards hepatic cysts of dromedaries and sheep. Control measures against stray dogs should be reinforced.

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