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ORIGINAL ARTICLE

LeGoo polymer injection into hydatid cyst would eliminate intraoperative spillage of scolices

Fadhil Al-Amran · Hayder M. Abdulnabi

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Abstract
Background Hydatid disease is caused by the tapeworm *Echinococcus granulosus* or *Echinococcus multilocularis* or *Echinococcus Vogeli*. It is the most severe helminthic zoonosis, with a major medical, social, and economic burden in endemic areas such as the Mediterranean region, South America, Australia, Turkey, New Zealand, Alaska, Canada, and the Middle East. The cornerstone in the management of hydatid cysts is surgery, and its recurrence is due mainly to the spillage of hydatid scolices rich fluid into the surrounding tissues.
Aim In this study, we test a polymer benefit in intraoperative scolices spillage prevention, this polymer is called LeGoo.
Methods The LeGoo polymer was used here in vivo animal's hydatid cysts and in vitro hydatid cysts excised from human beings.
Result Microscopic examination of the aspirated fluid from human being and sheep hydatid cysts before LeGoo injection showed numerous alive scolices. All sheep lung hydatid cysts with LeGoo injection transformed into a solid gelatinous mass, microscopic examination of the content swabs showed no scolices. LeGoo polymer injection into human hydatid cysts in vitro changed them into a solid gelatinous mass that can be mobilized easily with negative swabs for scolices.

F. Al-Amran (✉) · H. M. Abdulnabi
Surgical Department, Medical College,
Kufa University, Najaf, Iraq
e-mail: fadhil.al-amran@ucdenver.edu
URL: www.ctsnajaf.com; http://med.kufauniv.com/dr/fghaly/

Keywords Hydatid cyst disease · LeGoo polymer · Intraoperative scolices spillage

Introduction

Hydatid disease is caused by the tapeworm *Echinococcus granulosus* or *Echinococcus multilocularis* or *Echinococcus Vogeli*. It is the most severe helminthic zoonosis, with a major medical, social, and economic burden in endemic area. Echinococcosis is endemic in the Mediterranean region, South America, Australia, Turkey, New Zealand, Alaska and Canada, and the Middle East. In Iraq, the middle Euphrates governorates are considered to be endemic areas [1, 2].

Hydatid disease had been known since the time of Galen and Hippocrates, and was described by Thebesius in the 17th century [1, 2]. Rudolphi (1808) first used the term hydatid cyst to describe echinococcosis in humans. Infestation is confined to geographic areas in which there is continuous contact between humans and certain domestic carnivores such as dogs and some ungulates including cats. IT can affect any organ and the lung is the second most commonly affected organ (10–40 %) after the liver [2] (Fig. 1). Postoperative hydatid cyst recurrence is mainly due to intraoperative spillage of scolices which are the head-like segment of the tape worm that grow into hydatid cyst [3]. Till now there is no specific technique or agent that can perfectly prevent intraoperative spillage of scolices. In this study, we used a polymer to test its advantage in preventing intraoperative spillage of scolices during surgery, this polymer is called LeGoo.

LeGoo (Pluromed, Woburn, MA, USA) is a novel reverse thermosensitive gel. Animal studies demonstrated that it is safe, easy to apply, and an effective alternative

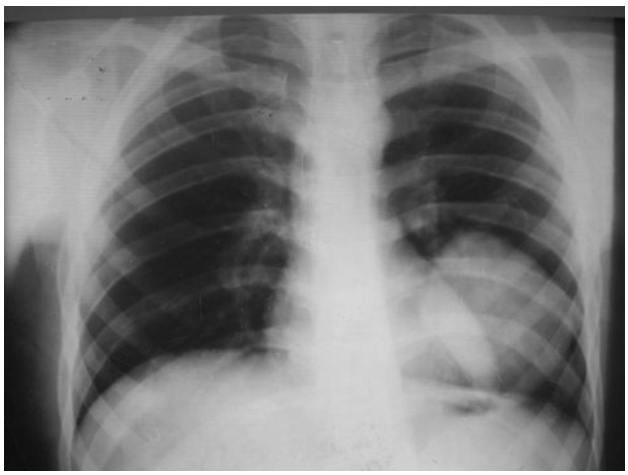


Fig. 1 Chest X-ray, hydatid cyst seen in *left lower* lung zone

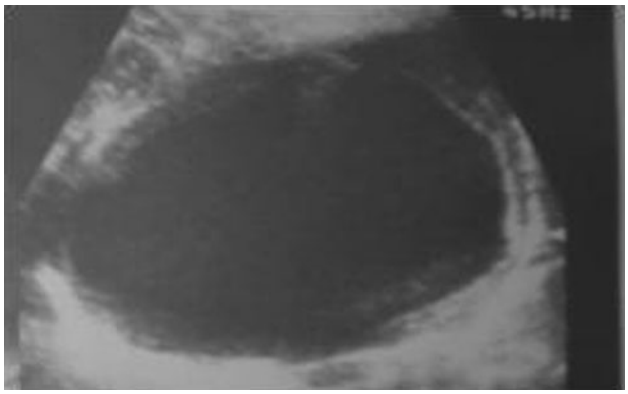


Fig. 2 Pulmonary (sheep) hydatid cyst seen through chest ultrasound

to traditional methods of temporary coronary artery occlusion during off pump coronary artery bypass graft. [4–8]. Recent clinical experience in humans also indicates that LeGoo is safe and highly effective for temporary flow interruption during off pump coronary artery bypass graft and minimally invasive direct coronary artery by pass graft surgery [9–11]. LeGoo is a non-toxic, non-absorbed, and non-metabolized polymer that is a viscous liquid at room temperature and transits to a solid gel instantaneously when exposed to body temperatures [12]. Intravascular administration of LeGoo produces a firm gel plug that lasts a number of minutes, allowing work in a bloodless field [11]. The gel dissolves spontaneously after minutes or, when desired, instantaneously by topical application of crushed ice or iced saline. Once dissolved below a minimum concentration, the polymer will not solidify again and is excreted unmetabolized from the body [12].

In this study, we hypothesize that LeGoo polymer injection into hydatid cyst would transform hydatid cyst scolices contained fluid into a solid mass graving the scolices into its new gelatin texture that prevent any intraoperative dissemination.

Objective

To test the role of LeGoo injection into hydatid cysts in the prevention of scolices dissemination.

Methods

In this study, four sheep were diagnosed to have lung hydatid cyst by chest ultrasound (Fig. 2), using GE portable ultrasound machine voluson, and 4 intact human hydatid cysts were carefully excised surgically and the hydatid fluid was aspirated from all the cysts for microscopic examination.

LeGoo polymer was then injected into in vivo sheep cysts and in vitro human cysts after aspiration of 50 % of their fluid content in an amount equal to the aspirates. All the four sheep hydatid cysts were excised surgically and microscopic examination of the content of all the eight LeGoo injected cysts was accomplished.

Results

1. Microscopical examination (10X) of the aspirated fluid from the four human being hydatid cysts and the four sheep cysts shows numerous alive scolices before the injection of LeGoo polymer (Fig. 3a, b, c.)
2. All the eight cysts that had LeGoo injection transformed into solid gelatinous mass, and microscopical examination of the content swabs showed no scolices (Fig. 4a, b, c).
3. LeGoo polymer injection into the hydatid cysts has transformed them into a solid gelatinous and easily handled masses, and on opening them, there was no spillage of the contents (Figs. 5 and 6).

Discussion

Hydatid disease is considered a big economic and health burden in endemic areas. Medical treatment till now is not considered an effective treatment to cure patients as drug penetration is barely possible through the avascular membrane of the cyst and surgery is the only effective treatment to cure the disease, yet recurrence after the surgical treatment is a possible complication.

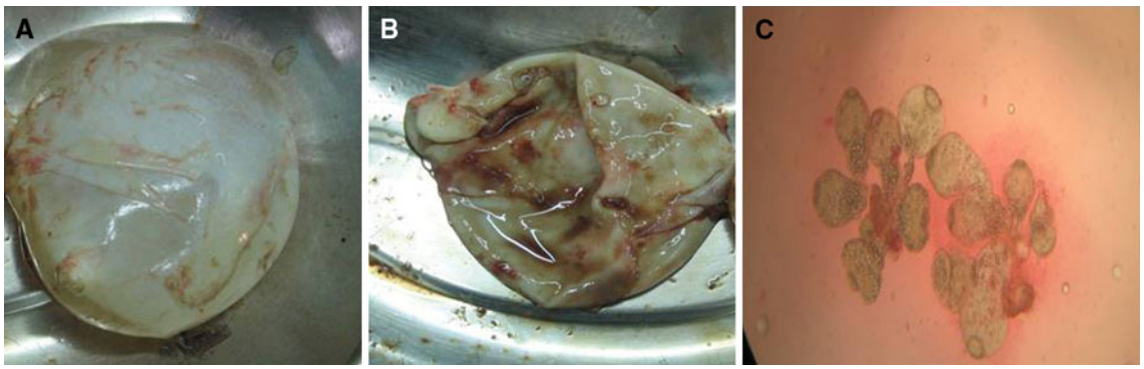


Fig. 3 **a**, **b**, **c** Microscopical examination (10X) of spilled fluid from in vitro human being hydatid cyst, shows numerous alive scolices

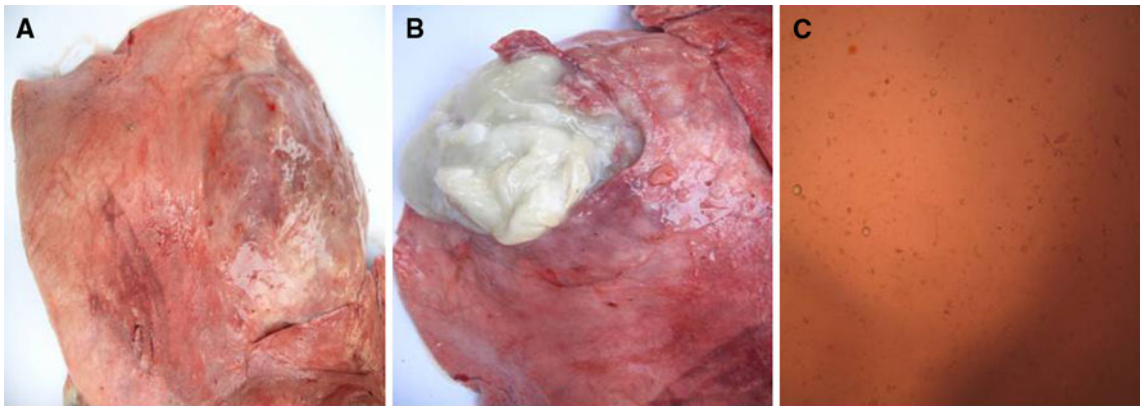


Fig. 4 LeeGo injected human in vitro cyst with negative scolices swab

Recurrence of hydatid cyst after surgery is hazardous psychological problem for the patient; additionally, redo surgery is technically more demanding than the first one because of tissue adhesions from the first operation.

The common cause of hydatid disease recurrence is the spillage of hydatid fluid during surgery into the surrounding tissues. As proved in this study and from previous studies, this spilled scolices contained fluid which has the ability to germinate into new hydatid cysts in the adjacent tissues [13]. Different scolicidal agents have been used to kill the spilled scolices either through injection of chemicals directly into the cyst or surrounding the site of the cyst with gauze soaked with scolicidal agent; either or both ways could not prevent recurrence all the time, as with all these precautions, spilled scolices might germinate.

1. In this study, we addressed that LeGoo injection into the hydatid cysts is consistently associated with the absence of scolices spillage. But since only half of the hydatid fluid is replaced by LeGoo, this might give a chance that the remaining hydatid fluid might spill and cause recurrence, yet this was not true in this study as swabs from spilled fluid consistently revealed no scolices by microscopic examination. This may be explained by the sedimentation of scolices under the effect of gravity into the most dependant part of the cyst, and this is the same for LeGoo. Both the polymer and the scolices would accumulate in the same dependent area, and so the scolices particles will be engraved and become part of the solid LeGoo gelatin inside the cyst and these particles would not spill into the surrounding tissue any more as proved by the negative smears. LeGoo polymer will be solidified once it is in contact with the remaining hydatid fluid, as the warm body temperature be the trigger to transform the LeGoo from its liquid form into solid gelatinous material that filled all the cyst, and the scolices will be trapped inside like stones in the cement and will not spilled in the nearby tissue. The action of LeGoo is achieved here by mechanical entrapment of scolices which is an important step in the prevention of spilling. This way, the scolices will be removed as one piece together with LeGoo without spillage.

Conclusion

Hydatid disease is a big health and economic burden in endemic area, scoliosis spillage is an important operative

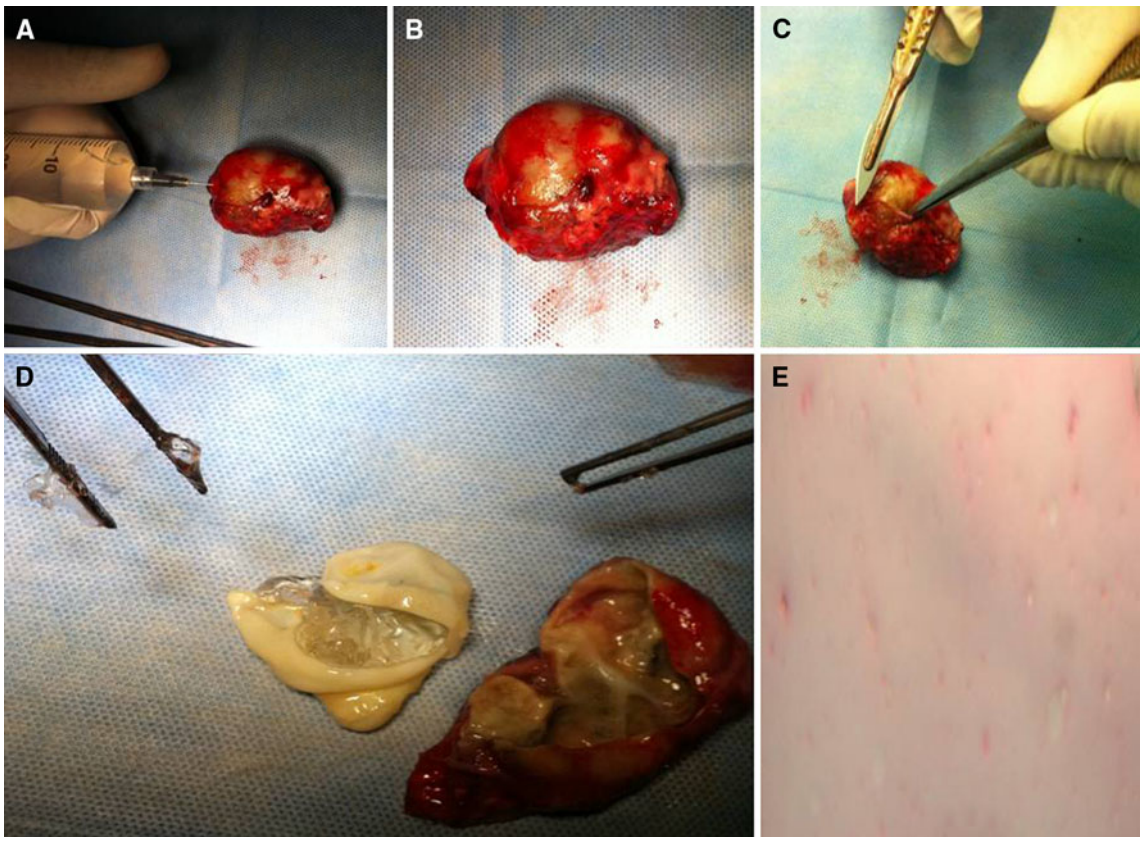
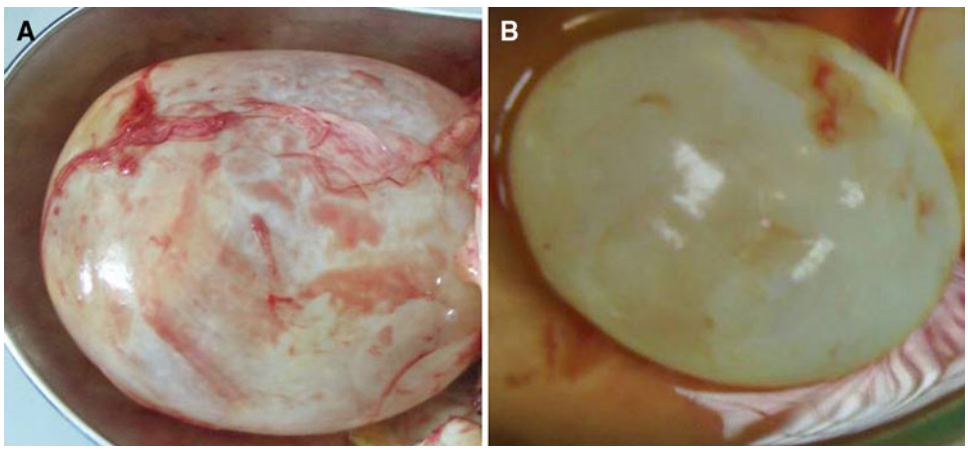


Fig. 5 Easy handling of LeeGo injected cyst

Fig. 6 A cyst before and after LeeGo injection



complication that is related to the recurrence of the disease. LeGoo injection into the cyst would facilitate its removal with less risk of rupture, and without likelihood of scolices spillage both in vivo animal hydatid cysts and in vitro human being cysts.

Recommendations

1. Introducing the LeGoo in vivo for human being hydatid cysts as a trial of further studies.
2. The implication of LeGoo in thoracoscopic hydatid cyst removal, the new approach for hydatid cyst surgery
3. Ultrasound guided percutaneous injection of LeGoo, especially for inoperable cases of hydatid cysts, is an important future proposed plan that needs to prove the efficacy of LeGoo in the regression of the cysts, prevention of spontaneous rupture, and stop further cyst growing.

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