

TISSUE SPARING TECHNIQUE IN LIVER HYDATID DISEASES: THREE-WAY TECHNIQUE VERSUS HYDATID CONE TECHNIQUE

By

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Abstract

Echinococcosis (known as hydatid disease or hydatidosis) is a serious, sometimes fatal, zoonotic disease caused by *Echinococcus* two species. *E. granulosus*, causes worldwide cystic echinococcosis (hydatidosis) maintained in domestic transmission cycle involving dogs and livestock mainly sheep, and *E. multilocularis*, causes alveolar echinococcosis endemic in the northern hemisphere in wild transmission cycle involving dogs and wild carnivores and rodents. Intermediate hosts including man are infected by ingestion of eggs dropped from dog with food, fluid or fingers, or by crawling insects from site of fecal deposition. Eggs hatch in gut into invasive oncospheres, which penetrate intestinal mucosa, enter venous and lymphatic pathways. These oncospheres according to species developed into unilocular or classical hydatid disease or cystic echinococcosis, with few years' incubation period or infiltration into alveolar or multilocular echinococcosis with 10-30 years incubation period. The clinical pictures of *E. granulosus* were usually from asymptomatic to fatal. But, alveolar echinococcosis particularly in the liver becomes metastatic and is frequently fatal. Chemotherapies (albendazole, mebendazole or praziquantel) may be of value prior to surgery or in inoperable cases, but alveolar cysts may require both surgery and prolonged chemotherapeutic treatment.

Liver surgery has gone through the phases of wedge liver resection, regular resection of hepatic lobes, irregular and local resection, extracorporeal hepatectomy, hemi-extracorporeal hepatectomy and others. Taking the modern technologies advantage, the liver surgery is stepping into an age of precise liver resection.

Key words: Patients, Hydatidosis, Scolicidal agent, Three-way technique

Introduction

Echinococcosis is an ancient disease known to Hippocrates who speaks "liver full of water" (Adams, 1939). Hydatidosis has a worldwide distribution (Schwartz, 1994). It is endemic in the sheep raising countries in the Mediterranean Basin, Eastern Europe, Middle East, South America, Australia and South Africa (Barnes and Lillemoe, 1997; Bouree, 2001). Human hydatidosis is a zoonotic infection caused by the larva cyst of a tape-worm *E. granulosus*, which inhabits the ileum of (definitive host) dogs and other members of Family Canidae (Sarkari and Rezaei, 2015). Hydatidosis is well documented in many Egyptian Governorates among man (El Shazly *et al*, 2001; 2007), farm animals (Ahmed, 1991; Abdel Rahman *et al*, 1992; Haridy *et al*, 1998) street dogs (Haridy *et al*, 2000) and pet dogs (Sabry *et al*, 2012).

Apart from Egypt, human and animals hydatidosis was reported in Tunisia (Ben-Osmann, 1965), Saudi Arabia (El Marsfy and Morsy, 1975), Algeria (Larbaoui *et al*, 1980), Sudan (Saad *et al*, 1983), Jordan (Al-Yaman *et al*, 1985), Morocco (Pandey *et al*, 1986), Kuwait (Abdul Salam and Farah, 1988), Libya (Ibrahim and Craig, 1998) and Iraq (Saeed *et al*, 2000). The disease is acquired by ingesting echinococcosis eggs in food or water or by close contact with an infected dogs, foxes and wolves (Turkyilmaz *et al*, 2004). Cysts may be single or multiple (at least 25%) liver being the first filter in eggs' way as 50%-75% were found (Saidi, 1997), and 20%-30% in lung (Amerglio *et al*, 1987).

Other sites were the kidney, spleen, heart, bones, muscles, central nervous system (Wilson, 1991) and spinal cord (Mazyad *et al*, 1998). In endemic areas, liver infection was 70-75% and lung infection was 4-20%, with

total liver and lung infections about 90-95% and rest of body about 5-10%. In patients, cyst in the liver right lobe was 66.4% and in left lobe 17% and both lobe 16% (Umhang *et al*, 2013). The abdominal cyst may reach a large size before the development of symptoms. Clinical features may be asymptomatic to fatal depend on site, number, and size of lesion(s). Fever is usually absent unless cyst was secondarily infected, wheezing, urticaria, and even anaphylaxis usually accompanied cyst fluid leak (Amir-Jahed *et al*, 1975).

Human hydatidosis was always unsuccessfully treated with chemotherapy as albendazole, mebendazole or praziquantel (Cobo *et al*, 1998; Saimot, 2001) or by the ultrasound guided aspiration as the puncture/aspiration/injection/respiration/pair (Lewall and McCorkell, 1985; Khuroo *et al*, 1997). Mortality for symptomatic patients not surgically treated was as high as 70% in some cases (Craig *et al*, 1986). Surgery is still the treatment of choice for hydatidosis management (Safiolas *et al*, 1994; Hofstetter *et al*, 2004; Turkylmaz *et al*, 2004; Abbas *et al*, 2006).

However, there were controversies about application of surgical procedures. Some authors advocated radical approaches (Pissiotis *et al*, 1989; Cirenei and Bertoldi, 2001; Yagci *et al*, 2005), others preferred more conservative surgical procedures that caused scolices inactivation, removal of germinal membrane and dealt with the residual cavity (Dimirci *et al*, 1989; Sayek and Onat, 2001).

Pathogenic sequence: the hydatid cyst has an inner germinated layer of cells, laminated membrane, and variable granulomatous reaction by the intermediate host. The secondary cysts bud internally from the germinal layer producing multiple protoscolices that if released from the mother hydatid cyst by rupture cause new infection sites. Cysts may cause local pressure and mechanical problems due to large size that may reach several liters volume (Schantz, 1982).

This paper aimed to evaluate tissue sparing technique in liver hydatidosis versus hydatid cone technique in infected male patients.

Material and Methods

The study was carried out on 15 patients with hydatid liver disease "cystic echinococcosis caused by echinococcus granulosus". These patients presented in Kobry El-Kobba Military Medical Campus and the Egyptian Peace-Keeping Forces in Afghanistan. Nine patients surgically treated in Afghanistan, and six patients in Kobry El-Kobba, all with ages varied between 25 & 50 years.

All patients suffered from hydatid disease, eleven patients from single liver hydatid cyst, two with 2 liver cysts, one in segment 5 and second in segment 7 of liver and last two patients suffered from single liver cyst and lung cyst.

Diagnosis apart from parasitological diagnosis, hydatidosis was established by the clinical examination of right upper abdominal pain and palpable right upper abdominal mass and liver ultrasound (Fig. 1) and liver and chest CT (Fig. 2a & b).

All patients were subjected to lab. examinations including CBC, blood sugar, liver and renal functions, PPT (prothrombin time), INR (international normalization ratio), ECG and chest X-ray. The operation was done after having informed written consent from them.

Operative technique: Patients were general anesthetized and place in the spine position. Abdominal incision was the midline incision or extended right subcostal incision with or without midline extension (Mercedes Benz Incision), based up the hepatic cysts number and site (Fig. 3).

Identification the hydatid cyst site and isolation of liver from rest of abdominal cavity was by abdominal bag impregnated by hypertonic saline to prevent scoliosis dissemination to peritoneal cavity (Fig. 4).

Preparation of 3 way and hypertonic saline for aspiration-injection of hypertonic saline and re-aspiration and procedure was applied 3 times, each one about 10-15 minute before cyst opening by this procedure: 1- Aspiration of hydatid fluid to prevent anaphylactic shock. 2- Cyst was sterilized to kill scoliosis and germinal layer before opening by injecti-

on of hypertonic saline 23.5% (Figs. 5, 6 & 7).

Aspiration (=suction) irrigation technique was carried out by 3 ways system after insertion into cystic cavity interval between every one (aspiration-irrigation technique) 10 minutes and repeated 3 times (Figs. 8 & 9).

The hydatid cyst was sterilized by aspiration /irrigation technique and enucleation of cyst end was done by using suction after open the cyst using diathermy (Figs. 10, 11 & 12).

After enucleation of germinal layer it was examined and cystic cavity was partial closed by suturing the edge of the cyst to cystic wall i.e. cap tonnage (Figs. 13, 14 & 15).

Closure of wound in layer i.e. subcutaneous by simple interrupted vicryl suture and skin by simple interpreted pollen after insertion of tube drain i.e. closed system drained beneath cystic cavity.

Albendazole 10mg/kg/day was given preoperative for 2 days and postoperative for 5 days and 1gm cephalosporin in the preoperative night as well as 1gm at the time of anesthesia induction & 1gm every 12hr for 3 days and postoperative prophylactic anticoagulant. The drain was removed 5 days postoperative or until fluid coming from drain was less than 35ml/days and the skin suture 10 to 15 days postoperative in the outpatients' clinic.

Operative time, postoperative hospital stay and postoperative complication were followed up in the outpatients' clinic by physical examination and abdominal US up on cystic cavity two weeks postoperative up to three months, then every month up to one year and then every three months up to second year.

Results

1-Age of patients ranged from 25 years up to 50 years with main of 30 years. 2- Operative time ranged from 60 up to 90 minutes depended up on cyst site in liver, a main 70 minute with well surgery specialist. 3- Hospital stay ranged from 7 up to 15 days based on the site, size and postoperative complications was mainly 9 days. 4- Postoperative complications (wound infection, wound seroma, biliary leak, chest problems, sub-phrenic (sub-

hepatic collection or abscess), abscess in residual cavity, bleeding (intraoperative & postoperative and blood transfusion). 5- Postoperative wound infection (super-facial & deep) wound infection occurred in three patients & were managed by antibiotic and early removal of the 2-stitches. Besides, one patient suffered from wound seroma and was managed by aspiration.

Biliary leak was found in one patient due to insertion of malacotic catheter in cyst cavity hopping to collapse the cyst cavity around the catheter. But, persisted up to 8 days postoperative and was managed by catheter disimpaction from cystic cavity and left it beneath the cystic cavity. This was done under ultrasound and follow up the cystic cavity showed reduction in size and obliteration of cystic cavity after 3 weeks and removal of the Malecot catheter to prevent complications 5 days after disimpaction (Fig. 16).

Postoperative chest infection in two patients was treated by antibiotic, mucolytic agent and bronchodilator, no postoperative pulmonary embolization. Two patients with lung hydatid were treated by thoracotomy and managed by technique similar to that of liver i.e. tissue sparing technique six months after liver hydatid management. No sub-phrenic (sub-hepatic collection in patients). Neither collection nor abscess in residual cavity, especially after capitonage (introflection) or a surgical closure of a cyst cavity, but there was dimple at cyst's site.

The follow up of liver hydatid showed decrease in cyst size of after surgical treatment and absence of cystic cavity in all patients after 1 to 1.5 month. There was dimple at the cyst site after three months without any residual cavity all patients (Fig. 17A & B).

Increasing migration make hydatidosis a global problem and in endemic hydatidosis remained a major health and socioeconomic problem as recognized by general surgeons in its simple and/or complicated form. There are three forms of hyatidosis, one caused by *Echinococcus granulosus*, second alveolar hydatid caused by *E. multiocularis* found exten-

sively in the northern hemisphere, commonly maintained in a wildlife life cycle involving two mammalian hosts. Wild canids, dogs, and less commonly cats act as definitive hosts, harboring the adult stage of tape worm. Ingestion of a rodent containing alveolar hydatid cysts by a wild canid can cause a heavy infection of tapeworms. The third one *E. vogeli* is a small cyclophyllid tapeworm found in Central and South America. Ingestion of *E. vogeli* eggs and the cysts spreading via infected host caused polycystic echinococcosis (Tappe *et al*, 2008). Although *E. granulosis* and *E. multilocularis* occur simultaneously in large endemic areas mixed infections of cystic echinococcosis were extremely rare in man, but reported in dogs (Zhang *et al*, 2006)

The surgical treatment of hydatidosis was controversial (tissue-sparing, conservative or radical re-sectional surgery). Up to date, there is no effective treatment for hydatidosis, rather medical or surgical, but the best surgical technique is still not known.

The diagnosis of hydatid disease done by imaging and immunodiagnosis the US, CT, X-ray, MRI and ERCP are diagnostic tool used. X-ray was limited because the radiodensity of a non-calcified hydatid cyst is the same as that of surrounding liver parenchyma. Ultrasound imaging used in diagnosis and classification of liver hydatid cyst into five types by Gharbi *et al*. (1981) followed up, during operation i.e. intraoperative US, interventional procedures PAIR “percutaneous, aspiration, scolicalid agent injection and re-aspiration”. It was the most important single diagnostic tool in endemic area.

In the present study, complete exposure of cyst done (Fig. 3) and safe the peritoneal cavity (Fig. 4) from contamination (spillage of cyst content in peritoneal cavity) by abdominal bag impregnate by hypertonic saline. Safe de-compression of cyst was done by insertion of three way system into cystic cavity (Fig. 8). Evacuation and sterilization of cyst were by scolicalid agent; hypertonic saline (Fig. 9) using 3 ways system. Enucleation of germinal layer was done by open the cyst by using

diathermy (Fig. 10) and insertion of suction muzzle was inserted into cystic cavity, the suction stick to the germinal layer and took out from the cystic wall via an open in cystic wall (Figs. 11 & 12). After taking out the germinal layer, it was carefully examined (Fig. 13) for loss part of germinal layer and the cystic cavity managed by capitonnage or introflexion technique (Fig. 15). The Malecot catheter for management cystic cavity was withdrawn back, the cavity didn't collapse around the catheter, with persistent discharge from cystic cavity more than 2 weeks as bile and serum discharge, so the best cystic cavity management was introflexion or capitonnage.

Discussion

Open surgery is still gold standard in management of liver hydatid disease-radical re-sectional procedures that remove the entire cyst and pericyst (part from healthy tissue with entire cyst). This method will affect organ physiological reserve but tissue sparing procedures that are limited to removing the parasite will pericyst left in situ. This technique preserve physiological reserve of organ as match, tissue sparing procedures its good procedure especially in endemic area, as the used organ may be re-infected again with every attack. The physiological reserve of the organ would be affect.

The goal of surgical procedure was: a- Safe and complete cyst exposure, b- Safe cyst de-compression, c- Safe cyst content evacuation, d- Sterilization of cyst by Zhang agent and enucleation of germinal layer, and e- Capitonnage or introflexion of cyst wall

Minimally invasive techniques with including “PAIR and laparoscopic” P.A.I.R. percutaneous drainage of hydatid cyst 1980 which including the following steps, percutaneous puncture of cyst, aspiration of cyst fluid, injection of protoscolicalid agent and re-aspiration of the cyst content after 15 to 20 minutes. This minimally invasive procedure done under ultrasound or CT guided and not applied in the present studied patients.

Laparoscopic management, a major drawback in laparoscopic management of liver hy-

datidosis is the risk of spillage and the results contamination of the peritoneal cavity- there are no absolutely effective measures to prevent spillage (Jani, 2014). No randomized clinical trials comparing laparoscopic with conventional open surgical treatment of hydatid disease has been performed.

Effective measures to prevent spillage in open surgery: a-Aarons hydatid suction cone and b- Replacement of hydatid suction cone by three ways technique system was used to all patients. Drawback of hydatid suction cone difficult to applied to inaccessible site, easy detachment from fixed site but three way system easily applied and accessible to difficult site.

The present technique showed: 1- Neither increase hospital time nor operative time that decreased by experience. 2- No blood transfusion. 3- No postoperative or intraoperative mortality. 4- Neither postoperative sub-phrenic collection or intra-cystic nor major complications.

The scolicial, "hypertonic saline" used in this study proved to be safe and effective.

Many scolicial agents including some plant extracts, mannitol, ABZ, chlorhexidine gluconate (Chx-Glu), honey, hypertonic saline, silver nitrate, cetrimide, ethanol, H₂O₂, and povidone-iodine were used to inactivate hydatid cyst content (Colebrook *et al*, 2004; Moazeni and Larki, 2010; Gholami *et al*, 2013). However, the commonest scolicial agents may cause unacceptable side effects (Besim *et al*, 1998; Rajabi, 2009). Sharafi *et al*. (2017) suggested that agents that in minimum concentration and minimum time have 100% scolicial activity could be good candidates for further investigations. They added that *F. vulgare* after 5min, metalonic extracts of *A. sativum* after 10min, hypertonic saline after 10min. and warm water after 2 min. killed all living protoscolices, and proved to be good candidates to be used as protoscolicides agents.

Generally speaking, treatment of hydatid cysts was either medical or surgical treatment. As to medical treatment, chemotherapy

with benzimidazoles (albendazole or mebendazole) was indicated for patients with inoperable hydatidosis and for those with multiple cysts in two or more organs. Cysts sited in bones were less susceptible to chemotherapy and needed surgical treatment (Mazyad *et al*, 1999). According to WHO recommendations, albendazole was given in daily doses of 10 to 15mg/kg of body weight in two divided doses postprandial for 3 to 6 months. The usual dose of mebendazole was 40 to 50mg/kg of body weight per day for at least 3 to 6 months (Kern *et al*, 2001). Results for over 2,000 well-controlled cases treated with benzimidazoles and evaluated for up to 12 months showed that cysts disappeared in 10 to 30% of patients (cure), there was objective evidence of response in 50 to 70% (degeneration or size reduction of cysts), and 20 to 30% did not exhibit morphological changes of cysts (Horton, 2003). Relapses after chemotherapy have been observed in 14 to 25% of patients, but are usually sensitive to retreatment (Pawlowski *et al*, 2001). In a comparative study with 448 patients, Franchi *et al*. (1999) assessed the efficacy of mebendazole and albendazole treatment (3 to 6 months) and found degenerative changes in 82% of the cysts in the albendazole group and in 56% in the mebendazole group ($P < 0.001$). Relapses were observed in 25% of the cysts. Side effects of chemotherapy were generally mild and rarely treatment limiting (WHO, 1996; WHO/OIE, 2001). Although the chemotherapy efficacy was not satisfactory and costs were high, it was an option of treatment predominantly for inoperable cases (Eckert and Deplazes, 2004).

As to surgery, there was an academic debate over surgical treatments of liver hydatidosis (Ammann and Eckert, 1996). Surgery, using various technical approaches (Morris and Richards, 1992), has the potential to remove the cysts and lead to complete cure. It was successfully performed in a high proportion of patients with simple forms of hydatidosis (number without risky locations,

and not too far advanced). However, surgery may be impractical in other cases, predominantly in patients with multiple cysts in several organs, in patients with a high surgical risk, and if facilities for advanced surgery were inadequate. In such situations, PAIR or chemotherapy can be considered as alternative options of treatment (Craig *et al*, 2007).

Generally speaking, hydatid disease treatment consisted of either of surgery or percutaneous drainage. So many surgical methods were described (Zinne, 1997), but basically there were 2 surgical alternatives; resection or conservative procedures (Langer *et al*, 1984). Resection of small or pedunculated cysts was simple and safe, but in most cases cystectomy involved a major resection, with the attendant increase in operative risk. Conservative procedures were easier to perform, but the rate of postoperative complications and hospital stay duration were not always accepted (Eckert *et al*, 1984). Balik *et al*. (1999) reported that omentoplasty, cystectomy, capitonnage, lobectomy, and cystoenterostomy proved superior to external drainage. In uncomplicated cysts these procedures had a shorter duration of hospitalization compared with tube drainage. In such case, marsupialization or tube drainage must be avoided as much as possible. Liver hydatidosis complications were secondary infection; obstructive jaundice due to pressure or rupture into biliary tree, peritoneum, or an adjacent structure; and anaphylaxis (Sozuer *et al*, 2014).

Abdelraouf *et al*. (2016) in Egypt reported that many surgical options could be done to manage the cyst, ranging from un-roofing of cyst, pericystectomy, up to liver resection for the affected liver parenchyma site. The cyst cavity could be managed by different techniques, capitonnage, external drainage, introflection or omentoplasty. They concluded that filling of residual cavity with either a Pedicle or an isolated omental pack, decreased the morbidity rate, especially operative bed collection, and deep abdominal abscess after surgical treatment (unroofing or pericystectomy) for hydatid disease of the liver,

and there is no difference between the Pedicle type and isolated type of flaps in omentoplasty, and must be recommended in such case. El Nakeeb *et al*. (2017) in Egypt reported that the cystobiliary communication (CBF) with hepatic hydatidosis was responsible for postoperative bile leakage post-surgical treatment. They found that cyst size was the only independent predictor of CBF occurrence. Intraoperative suturing and the T tube led to complete healing, and postoperative endoscopic retrograde cholangiopancreatography (ERCP) and tubal drainage led to a rapid reduction in the bile output and the healing of the fistulas after 9 ± 2.6 days.

However, as to cysts in liver and/or lung, Aldahmashi *et al*. (2016) in Saudi Arabia reported that hydatid cyst disease is endemic in many developing countries, especially in the rural areas with variable clinical courses and might be asymptomatic for many years. They concluded that conservative surgical procedure achieved complete removal of the pulmonary hydatid cyst. Enucleation of the intact huge cysts was safe. Careful and secured closure of the bronchial communication must be done by purse string or sutures, with or without Teflon pledgets, which were safe, reliable, and successful.

Aji *et al*. (2018) in China reported that the radical resection proved to be the best treatment for patients with advanced hepatic alveolar echinococcosis, and that liver transplantation was considered for selected advanced cases; but, a shortage of organ donors and postoperative recurrence risk were the major challenges. They added that radical resection could be an effective alternative to liver transplantation in patients with end-stage hepatic AE, with the advantage that it neither required organ transplantation, nor immunosuppressive agents.

Chen *et al*. (2018) in China analyzed the clinical data of 115 surgical treatment patients. They suggested that all stages of hepatic alveolar echinococcosis should take active surgical interventions and radical hepatic resection must be considered as the first-choi-

ce treatment for early stage of alveolar echinococcosis, while palliative surgery was still helpful to relieve symptoms and improved the advanced patients' life quality and that liver transplantation might also be an alternative option for the late-stage hepatic alveolar hydatidosis. Qiu *et al.* (2019) in China reported that vascular infiltration-based classification improved the anatomic comprehension thus, facilitated surgical planning for ex-vivo liver resection combined with auto-transplantation. They added that by cautious evaluation of operability, liver function, and its residual volume, together with delicate operative methods and careful postoperative management, ex-vivo liver resection combined with auto-transplantation achieved good results in the treatment of end-stage hepatic alveolar echinococcosis.

Conclusion

Undoubtedly, human hydatidosis is a risky zoonotic parasitic disease worldwide, particularly in the Middle East Countries. Periodical examination and de-worming at least of domestic dogs must be in mind. The conservative surgical management of uncomplicated hepatic hydatid cysts with perioperative anthelmintic chemotherapy was supposed to be a simple, safe and effective approach, if cysts rupture or leak during surgery. Its efficacy is comparable to radical surgical procedures with much less morbidity. However, evaluation for silent lesions in other locations and follow-up for postoperative recurrence is a must. Liver hydatidosis is a common benign condition in many countries. The compared to open surgery, laparoscopic treatment can play an important role in improving the post-operative recovery, reducing the morbidity and recurrence rate of the patients.

Therefore, selection of the most appropriate treatment to reach the lowest morbidity, mortality, and recurrence rates is mandatory for hydatid disease of the liver

Recommendations

1- Tissue sparing technique proved to be the best surgical method for liver hydatid cyst

especially in endemic area to preserve physiological reserve of organ.

2- Using three ways technique was useful to control spillage, allergic reaction and injection of 15-20% saline as protoscolicidal agent and re-aspiration of cyst content, as well as being cheap and easily applied.

3- Albendazole (10mg/kg/days) was the drug choice for pre- and post-operative with surgical treatment to prevent disease recurrence.

4- Ultrasound "U.S" is a useful tool in hydatidosis diagnosis especially in endemic area.

5- Capitonage "introflexion" managed cyst after evacuation of cyst content and endocyst "germinal layer" in hydatid liver disease.

6- Control of stray dogs and periodical examination and treatment of pet ones is a must.

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Explanation of figures

- Fig. 1: Abdominal US showing left lob liver cystic lesion measuring 134 ml with tiny irregular areas seen.
 Fig. 2: a- Complementary CT upon abdominal and chest showing one cystic lesion in right lung, & b- one cystic lesion in left lobe of liver.
 Fig. 3: Midline incision showed hydatid cyst undersurface of left lob of liver
 Fig. 4: Localization of hydatid cyst in left lob of liver and cyst isolation by abdominal bag in pregnant by hypertonic saline.
 Fig. 5: Hypertonic saline used to irrigate cystic cavity of 23.4% concentration.
 Fig. 6: Three ways line, subclavian canula connected to 3 ways valve and connected to 20mL syringe.
 Fig. 7: Three ways system for puncture cystic wall, aspiration of cystic fluid by one syringe, injection of hypertonic saline by another syringe.
 Fig. 8: Insertion of 3 way system into cystic cavity.
 Fig. 9: a&b-Aspiration of hydatid cyst fluid first and replace aspirated volume by hypertonic saline i.e. same volume.
 Fig. 10: Open hydatid cyst by diathermy and site of 3 ways system used as guideline.
 Fig. 11: Enucleation of germinal layer using suction.
 Fig. 12: Gentle traction on germinal layer.
 Fig. 13: Examination of germinal layer after taking out from hydatid cyst.
 Fig. 14: Examination of cystic cavity after extraction of germinal layer for daughter cysts.
 Fig. 15: Suturing edge of cystic wall to cyst wall i.e. capitonnage "introflexion"
 Fig. 16: Malecot catheter for insertion into cystic cavity to drain cystic cavity and collapse of cyst around it.
 Fig. 17: a- Cystic cavity before operation by U.S. examination, and b- Reduction of cystic cavity 5 days post-operative



