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COMPARATIVE EVALUATION OF SURGICAL METHODS FOR LIVER ECHINOCOCCOSIS FROM A CLINICAL AND ECONOMIC PERSPECTIVE

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Abstract. We analyzed a 15-year experience of surgical treatment for hepatic echinococcosis in 96 patients to determine an optimized approach and its cost-effectiveness. Patients ranged from 13 to 55 years old; 62.5% were female and 37.5% male. Rural residents with livestock contact comprised 44.8%, and urban residents 55.2%. All patients underwent ultrasound for diagnosis. Cysts were categorized by size, location, and number. Surgical approaches included midline laparotomy, right subcostal laparotomy, or thoraco-phreno-laparotomy. Residual cavities after cyst removal were managed by either capitonnage, omentoplasty, or active vacuum drainage. A total of 136 hydatid cysts were identified in 96 patients (83.3% had a single cyst, 16.7% had multiple). Cyst diameters ranged from 45 to 170 mm (volumes 135–510 cm^3). Midline laparotomy was performed in 36.4% of patients, subcostal in 40.7%, and thoracoabdominal in 22.9%. Residual cavities were closed by capitonnage in 49.0% of cases, by omentoplasty in 8.3%, and drained with an active vacuum system in 37.6%. Comparative analysis of outcomes showed that active vacuum drainage of the residual cavity significantly improved results: it shortened hospital stay and reduced postoperative complications, indicating superior cost-effectiveness.

Keywords. Hepatic echinococcosis; hydatid cyst; surgical treatment; capitonnage; omentoplasty; vacuum drainage; residual cavity obliteration; cost-effectiveness.

СРАВНИТЕЛЬНАЯ ОЦЕНКА ХИРУРГИЧЕСКИХ МЕТОДОВ ЛЕЧЕНИЯ ЭХИНОКОККОЗА ПЕЧЕНИ С КЛИНИЧЕСКИХ И ЭКОНОМИЧЕСКИХ ПОЗИЦИЙ

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Аннотация. Проанализирован 15-летний опыт хирургического лечения эхинококкоза печени у 96 пациентов с целью выявления оптимальной тактики и её экономической эффективности. Возраст пациентов варьировал от 13 до 55 лет; 62,5% составляли женщины, 37,5% — мужчины. Сельские жители с контактами с животными составили 44,8%, городские — 55,2%. Всем

пациентам выполнялось ультразвуковое исследование для диагностики. Кисты классифицировались по размеру, локализации и количеству. В качестве хирургических доступов применялись: срединная лапаротомия, правосторонняя подреберная лапаротомия и торакофренолапаротомия. Остаточные полости после удаления кист обрабатывались методом капитонажа, сальникопластики или активного вакуумного дренирования. Всего у 96 пациентов было выявлено 136 гидатидных кист (у 83,3% — одиночные, у 16,7% — множественные). Диаметр кист варьировал от 45 до 170 мм (объём 135–510 см³). Срединная лапаротомия применялась у 36,4% больных, подреберная — у 40,7%, торакоабдоминальная — у 22,9%. Закрытие остаточной полости выполнялось методом капитонажа в 49,0% случаев, сальникопластики — в 8,3%, активного вакуумного дренирования — в 37,6%. Сравнительный анализ показал, что активное вакуумное дренирование остаточной полости достоверно улучшает исходы лечения: сокращает сроки госпитализации и снижает частоту послеоперационных осложнений, демонстрируя более высокую экономическую эффективность.

Ключевые слова: эхинококкоз печени; гидатидная киста; хирургическое лечение; капитонаж; сальникопластика; вакуумное дренирование; облитерация остаточной полости; экономическая эффективность.

Relevance. Echinococcosis remains a pressing medical and socioeconomic problem in endemic areas. Despite advances in diagnosis and ongoing efforts in prevention, the incidence of echinococcosis continues to rise, particularly among individuals of working age, leading to significant economic losses for public health systems. The liver is the most commonly affected organ in 54–85% of cases of echinococcosis. Often, hepatic echinococcal cysts grow silently and only manifest when complications develop, which complicates treatment and rehabilitation and can be life-threatening. Such complications occur frequently (reported in 15–52% of cases). Nevertheless, surgery remains the mainstay and only radical treatment for cystic echinococcosis of the liver. In this context, optimizing surgical techniques for hepatic echinococcosis is highly relevant, with the goal of improving patient outcomes and reducing treatment costs.

The objective of this study was to summarize the clinical experience in surgical treatment of patients with liver echinococcosis and to evaluate the economic efficiency of an optimized method for managing the residual cavity after echinococcectomy.

Materials and Methods. Over the past 15 years, 96 patients with liver echinococcosis were treated at the Department of Surgical Diseases No.2 of Avicenna Tajik State Medical University and the affiliated reconstructive microsurgery unit. All patients were of young working age (range 13–55 years). Women predominated (n = 60, 62.5%) over men (n = 36, 37.5%). Forty-three patients (44.8%) were rural inhabitants with a history of contact with domestic

animals (a risk factor for Echinococcus infection), while 53 (55.2%) were urban residents likely infected via food or water (alimentary route).

The diagnosis in all cases was established based on clinical presentation, history, physical examination, and imaging. Ultrasonography (US) was the primary diagnostic modality, used to assess cyst location, size, and internal structure (presence of daughter cysts). In every case, ultrasound revealed a spherical cystic lesion in the liver with well-defined contours. In the majority of patients (≈54%, over half), the cyst contained daughter cysts within the mother cyst. No alternative diagnoses were evident on imaging. Each patient's cysts were counted and measured; where multiple cysts were present, all were evaluated.

In total, 136 cystic lesions were identified in 96 patients. Most patients (80 cases, 83.3%) harbored a single hepatic hydatid cyst, whereas 16 patients (16.7%) had multiple cysts (ranging from 2 up to 7 cysts in one patient). The diameters of the cysts ranged from 45 mm to 170 mm, with volumes from approximately 135 cm^3 up to 510 cm^3. For analysis, cysts were categorized by size as small (<5 cm), medium (6–10 cm), large (11–15 cm), or giant (>15 cm). Table 1 summarizes the distribution of cyst sizes and their locations in the liver. Notably, the vast majority of cysts (83.1%) were located in the right lobe of the liver, while only 14% were in the left lobe. One patient presented with an exceptionally high cyst burden (7 cysts in total: 3 in the right lobe of the liver, and 4 additional cysts in the peritoneal cavity of the right flank and pelvis, outside the liver parenchyma). Giant cysts (>15 cm) often spanned multiple hepatic segments.

Table 1

Distribution of echinococcal liver cysts by size and location

Cyst size category	Total number of cysts	Percentage of total (%)	Located in right lobe	Located in left lobe
Small (≤ 5 cm)	28	20.6%	21	5
Medium (6–10 cm)	55	40.4%	42	11
Large (11–15 cm)	41	30.2%	38	3
Giant (> 15 cm)	12	8.8%	12	0
Total	136	100%	113*	19

The anatomical segmental distribution of the liver cysts is detailed in **Table 2**. Overall, 97.1% of cysts were located within the defined liver segments. Segments VII and VIII (right lobe) were the most frequently involved areas, together accounting for over a quarter of all cysts. A small number of cysts (<3%) were found in segments I, II, or III (left lobe segments). No cysts were recorded in segment IX (caudate lobe) in this series.

Table 2

Localization of hepatic echinococcal cysts by liver segments

Liver segment(s)	Number of cysts	Percentage (%)
I	4	2.9%
II	1	0.7%
II–III (combined)	3	2.2%
III	3	2.2%
IV	8	5.9%
III–IV (combined)	5	3.7%
V	8	5.9%
IV–V (combined)	17	12.5%
VI	12	8.8%
VI–VII (combined)	18	13.2%
VII	17	12.5%
VIII	15	11.1%
VII–VIII (combined)	21	15.5%
Total (in segments)	132*	97.1%

All patients underwent surgical removal of cysts (echinococcectomy). The choice of surgical approach (incision) was tailored to cyst location within the liver. A midline laparotomy was used in 35 patients (36.4%), a subcostal (right subcostal) laparotomy in 39 patients (40.7%), and a thoraco-phrenico-laparotomy (combined chest and abdominal incision) in 22 patients (22.9%). In two cases, where the cyst was located at the extreme inferior edge of the liver, a closed or so-called “ideal” echinococcectomy was performed – meaning the cyst was removed without spillage and the residual cavity was managed without wide opening of the cyst (this approach is rarely feasible and was only possible in 2.1% of cases). In all other cases (97.9%), an open echinococcectomy technique was employed.

During surgery, after gaining abdominal access and isolating the liver area, we followed standard precautions to prevent spillage of cyst contents. Pads and gauze sponges soaked in hypertonic saline or povidone-iodine were placed around the cyst to protect the operative field from contamination. The cyst was then punctured with a wide-bore needle attached to suction, aspirating as much cyst fluid as possible. This decompressed the cyst, reducing internal pressure. Next, the cyst’s fibrous capsule was incised (about 3–5 cm) carefully using electrocautery or a scalpel, and the opening was enlarged. The endocyst (inner germinal membrane) and any daughter cysts were meticulously removed using oval fenestrated forceps or a long spoon/curette. Instruments that came into contact with cyst contents were immediately immersed in 2% formalin solution to kill echinococcal scoleces and prevent implantation. The residual cavity was thoroughly irrigated with a scolicidal solution – we used 3% Lugol’s iodine (an iodine-based scolicidal agent) and

additionally rinsed with 96% ethanol – to eliminate any remaining parasitic elements.

After evacuation of the cyst contents and sterilization of the cavity, attention was turned to managing the residual cavity in the liver. We employed three different techniques for residual cavity obliteration, selected according to intraoperative circumstances (such as cavity size, location, and surgeon preference):

Capitonnage (Closure by Sutures): In 47 cases (49%), the walls of the empty residual cavity were collapsed by suturing. We placed a series of purse-string and additional absorbable sutures from inside the cavity, imbricating the fibrous cavity walls. This effectively closed off the space. An atraumatic needle with monofilament absorbable sutures (e.g., Maxon, Monocryl, PDS, or Monosin, size 0 or 2/0) was used for stitching the cavity walls in layers. Capitonnage is a traditional method to obliterate the cavity.

Omentoplasty: In 8 cases (8.3%), primarily those where the cavity was deep in the parenchyma or difficult to collapse by sutures, we opted for omentoplasty. A pedicled flap of the greater omentum was harvested and gently placed into the residual cavity, filling the space. The omental flap (attached to its blood supply) was sutured to the cavity edges, effectively obliterating the space and promoting healing. In 5 additional cases (5.2%), we combined capitonnage and omentoplasty (suturing the cavity partially, then filling with omentum) for extra security.

Active Vacuum Drainage: In 36 cases (37.6%), we employed an active drainage technique with negative pressure. Whenever feasible, portions of the fibrous cyst wall that were not adjacent to vital structures were excised to open up the cavity. A large-bore silicone drain (≥10 mm diameter) was placed into the cavity through a separate small incision, and the drain was secured to the edge of the cavity with a few catgut sutures. This drain was connected to a vacuum reservoir, creating continuous negative pressure within the residual cavity. The suction helped to appose the cavity walls from inside, thereby eliminating dead space and promoting adhesion of walls. One or two additional silicone drains were placed prophylactically in the subhepatic space (below the liver) or subphrenic space (beneath the diaphragm) to drain any serous fluid or blood and to monitor for bleeding. These ancillary drains were not connected to suction and were usually removed after 3–4 days postoperatively, once ultrasound confirmed no fluid collections. The main large-bore vacuum drain inside the residual cavity was left in place for 4–6 weeks, with the vacuum reservoir periodically checked and maintained. After 4–6 weeks, the drain was removed percutaneously during an outpatient visit, following a confirming ultrasound that the cavity had obliterated or significantly decreased in size.

Two patients in the series required special consideration due to advanced disease complications. In those cases, a hepatic cyst had ruptured into the biliary tract, causing acute obstructive jaundice (echoing the serious complication of cystobiliary fistula). For these patients, in addition to the echinococcectomy, a biliary drainage procedure was performed: the common bile duct was drained

externally using a tube (Vishnevsky's method of T-tube choledochal drainage) for 2–3 weeks to relieve biliary hypertension and allow the bile ducts to heal. Only after bile flow was normalized were these patients taken for definitive surgery to address the cyst cavities.

Finally, in cases of multiple echinococcal cysts, a staged surgical approach was sometimes necessary. For example, two patients with numerous cysts (5–6 cysts) underwent two separate operations, a few months apart, to clear all cysts in a safer manner rather than performing overly prolonged single-stage surgeries.

Postoperatively, all patients received standard care. Notably, only 9 patients (9.4%) received adjuvant albendazole antiparasitic therapy after surgery as a preventive measure against recurrence (dosage ~10 mg/kg per day for 4–6 weeks) – this was decided based on individual case considerations. Adjuvant albendazole was underutilized in this cohort due to concerns about drug toxicity and varied accessibility.

Each patient's postoperative course was monitored with weekly check-ups (clinical and ultrasound) during the first month, then monthly for the next two months, and quarterly thereafter for at least one year. Ultrasound imaging and plain chest X-ray were the primary follow-up imaging modalities, as recommended in literature for hydatid disease [5–7]. Liver function tests were also monitored in those on albendazole therapy, given the drug's hepatotoxicity profile.

Results and Discussion. The demographic and clinical characteristics highlight the significant burden of echinococcosis in young, working-age adults. The high proportion of rural patients underscores the epidemiological link between livestock husbandry and infection risk. The distribution of cysts predominantly in the right hepatic lobe (over 80%) is consistent with known patterns of blood flow distribution in the portal circulation (the right lobe receives the bulk of portal blood). The incidence of multiple cysts (~17% of patients) aligns with other reports that a minority of patients develop secondary daughter cysts or multiple primary cysts seeded simultaneously. The large range of cyst sizes (from 45 mm up to 170 mm) indicates that many patients harbored cysts for extended periods (echinococcal cysts can grow several millimeters per year). The presence of giant cysts (>15 cm in 12 patients) is particularly concerning, as these often involve multiple hepatic segments and pose surgical challenges.

All 96 patients underwent successful cyst removal surgeries. There were no intraoperative deaths. The choice of surgical approach was individualized, demonstrating the need for flexible tactics in echinococcosis surgery. Standard midline or subcostal laparotomies sufficed in most cases; however, a significant subset (22.9%) required a thoracoabdominal incision, reflecting large upper liver cysts or those adhering to the diaphragm and requiring superior exposure.

No severe intraoperative anaphylactic reactions were encountered in this series, despite the inherent risk of spillage of antigenic hydatid fluid. The precautionary measures (aspiration of fluid and use of scolicidal agents) likely contributed to this

outcome. Instruments and field contamination were managed with formalin and iodine, as described, which is a standard effective practice.

All patients were followed for at least 6 months, and 87 patients (90.6%) had long-term follow-up data up to 10 years post-surgery. The recurrence rate of echinococcosis in our series was extremely low. We observed no true recurrences of the treated cysts in any patient. Only one patient (1.1%) developed a new echinococcal cyst 5 years later, but this was considered a re-infection (new infestation) rather than a relapse of the original cyst, as it occurred in a different liver segment (right lobe) after a long interval. That patient was successfully re-operated with no further issues. This recurrence rate is notably lower than the up to 25% recurrence reported in some studies where patients did not receive optimal surgical or medical management. Our rigorous surgical technique and careful removal of cyst contents likely contributed to the low recurrence. Additionally, while only 9 patients received albendazole, it is possible that even limited use of anti-parasitic medication postoperatively helped in some high-risk cases. However, one must consider that literature reports albendazole therapy has an efficacy of 41–72% in preventing recurrence, but it carries hepatotoxic risks in about 15% of patients. In our practice, we reserved albendazole for cases with spillage or multiple cysts to balance benefits and risks.

The follow-up strategy utilizing regular ultrasound proved effective in early detection of any potential problems (such as fluid collections or new cysts). It is a cost-effective and non-invasive surveillance tool, aligning with recommendations [5–7]. None of our patients developed late postoperative complications such as incisional hernia or chronic pain, which speaks to the quality of surgical wound closure and perhaps the less invasive nature of some techniques (mini-laparotomy in vacuum drainage cases vs extensive suturing in capitonnage).

From a health economics perspective, the optimized approach – specifically the use of active vacuum drainage – demonstrated clear benefits. By reducing the average hospital stay and minimizing complications, this method lowers treatment costs per patient. Shorter hospitalization directly translates to reduced expenditure on bed-days, nursing care, and hospital resources. Fewer complications mean less need for interventions like endoscopic bile duct procedures (in the case of biliary fistulas) or secondary surgeries for abscess drainage, which are costly. Although the vacuum drainage system has a material cost (the drainage kit and portable suction device), this cost is marginal compared to the savings gained by avoiding prolonged hospital stays and complications. Therefore, we can assert that active vacuum drainage is not only clinically effective but also cost-effective for managing residual cavities in hepatic echinococcosis. By contrast, complications from capitonnage or omentoplasty can incur significant additional costs (management of bile leaks, longer ICU stays, etc.). Our findings strongly support a shift in surgical practice toward routine use of vacuum-assisted closure of residual cavities, especially for large or deep cysts where the risk of space issues is high.

In summary, our results indicate that careful surgical technique combined with modern cavity management can virtually eliminate recurrence and significantly improve recovery in hepatic echinococcosis. We have achieved excellent long-term outcomes with an approach that emphasizes complete cyst content removal, prudent use of scolicidal agents, and effective obliteration of the residual space. Among the methods evaluated, active vacuum drainage stands out as the superior technique, offering both medical and economic advantages. These findings are in line with an emerging consensus favoring minimally invasive and active approaches to echinococcal cyst management, as reported by other authors who note the advantages of laparoscopic and mini-incisional surgeries with active drainage [8, 9, 10]. However, we also acknowledge that not every case is amenable to minimally invasive techniques – large, complex cysts with multiple daughter cysts or those in challenging locations may still require open surgical approaches. The key is to apply the principles of optimized management (avoid leaving a large dead space, ensure adequate drainage) regardless of the incision used.

Conclusions

1. The study demonstrates that an optimized approach to surgical treatment of liver echinococcosis – particularly the use of active vacuum drainage for residual cavities – significantly improves patient outcomes. This approach led to shorter hospital stays and a reduction in postoperative complications compared to traditional methods of residual cavity management (such as capitonnage).
2. By reducing the length of hospitalization and minimizing the rate of complications, the optimized surgical strategy is more cost-effective. Fewer complications mean lower additional treatment costs, and shorter inpatient stays reduce overall healthcare expenditures for each patient. Thus, the optimized approach offers substantial economic benefits alongside clinical advantages.
3. Active vacuum drainage of the residual cavity is a safe, effective, and economically efficient technique for managing the post-resection cavity in hepatic echinococcosis. Based on our 15-year experience, we recommend implementing this technique widely in surgical practice for hydatid liver disease. Routine use of vacuum drainage can improve recovery and should become a standard component of echinococcosis surgery, except in cases where contraindicated.
4. Complete removal of cyst contents combined with appropriate use of antiparasitic measures (scolicidal agents intraoperatively and selective albendazole postoperatively) results in a very low recurrence rate of hepatic echinococcosis. Thorough elimination of the parasite during the initial surgery is crucial for long-term success.

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