

Original Article

Ultrasonic scalpel combined with internal oxygen assisted sodium nitroprusside in laparoscopic cholecystectomy for elderly patients with acute cholecystitis

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Abstract: To analyze the application value of an ultrasonic scalpel combined with internal oxygen assisted intravenous drip of sodium nitroprusside in laparoscopic cholecystectomy for elderly patients with acute cholecystitis. **Methods:** A total of 76 patients with acute cholecystitis who were admitted to our hospital from January 2017 to December 2018 were included and equally divided into two groups. The control group was treated with ultrasonic scalpel alone, while the study group was treated with ultrasonic scalpel combined with internal oxygen and intravenous drip of sodium nitroprusside. The incidence of postoperative adverse reactions, the recovery of surgical indicators, the quality of life score before and after treatment, and the changes of serum sICAM-1 and IL-6 expression were observed. **Results:** The incidence of postoperative adverse reactions in the study group was significantly higher than that in the control group ($P < 0.05$); and the recovery of surgical indicators in the study group was better than that in the control group ($P < 0.05$). After treatment, the levels of serum sICAM-1 and IL-6 in the two groups showed a certain degree of decline, and the levels of serum sICAM-1 and IL-6 inflammatory factors in the study group were significantly lower than those in the control group ($P < 0.05$). After treatment, the scores of psychological state, physical health, independent ability, social relationship, surrounding environment and personal belief of the two groups were significantly higher than those before treatment ($P < 0.05$). After treatment, the scores of each field in the treatment group were significantly higher than that in the control group ($P < 0.05$). **Conclusion:** It is safe and feasible to use an ultrasonic scalpel combined with internal oxygen to assist intravenous drip of sodium nitroprusside in the treatment of elderly patients with acute cholecystitis, but proper operation time and skilled operation are necessary.

Keywords: Ultrasonic scalpel, internal oxygen, intravenous nitroprusside, acute cholecystitis in the elderly, laparoscopic cholecystectomy, clinical application

Introduction

Laparoscopic cholecystectomy (LC) has the advantages of mild trauma, light pain, fast recovery and short hospital stay [1]. However, acute cholecystitis (AC) was considered as a relative contraindication of LC because of inflammatory edema, tissue adhesion and unclear structure of the gallbladder triangle. Many doctors have used either LC as a bridge to surgery or as definitive management of AC. These studies however are entirely retrospective with limited case numbers [2, 3]. Few studies have reported on the use of ultrasonic scalpel combined with internal oxygen assisted intravenous drip of sodium nitroprusside in LC for elderly patients with acute cholecystitis.

Therefore, no solid evidence regarding its benefit has been established in the medical literature so far. In recent years, we have used ultrasonic scalpel to treat AC, and initially realized that it has many advantages over a high-frequency electric scalpel [2, 3]. We selected 76 patients with AC in our hospital to explore the effect of ultrasonic scalpel combined with internal oxygen assisted intravenous drip of sodium nitroprusside in LC for elderly patients with AC. The report is as follows.

Materials and methods

Research subjects

A total of 76 patients with acute cholecystitis who were admitted to our hospital from January

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Table 1. General information of the two groups of patients

group	Gender (male/female)	Age (years)	BMI (Kg/ m ²)	NYHA heart function grading [n (%)]		Combined diseases [n (%)]	
				Grade II	Class III	diabetes	hypertension
Research Group (38)	18/20	65.5±8.4	26.24±2.01	12 (31.57)	26 (68.42)	23 (60.52)	15 (55.26)
control group (38)	20/18	69.4±7.5	26.10±1.05	16 (42.11)	22 (57.89)	17 (44.73)	21 (55.26)
t/χ ²	0.216	1.099	0.756	0.013		0.072	
P	0.642	0.273	0.450	0.908		0.788	



Figure 1. Ultrasonic scissors usage in transoral endoscopic thyroidectomy: clear the lymph nodes.

2017 to December 2018 were equally randomized into groups. There were 18 males and 20 females in the study group, with an average age of (68.5±8.4) years. In the control group, there were 20 males and 18 females, with an average age of (69.4±7.5) years. This study was approved by the Ethics Committee of Shanghai Tenth People's Hospital and all patients signed the informed consent. The basic data and condition of the two groups were generally comparable ($P > 0.05$). See **Table 1**.

Inclusion criteria

① All patients met the diagnostic criteria of AC by imaging examination; ② All patients were in accordance with the indications of laparoscopic surgery for AC.

Exclusion criteria

① Acute cholecystitis (empyema, gangrene, perforation, etc.) with serious complications; ② With acute cholangitis; ③ Primary choledocholithiasis and hepatolithiasis; ④ Choledochectasis with obstructive jaundice; ⑤ Abdominal infection with peritonitis; ⑥ Patients with poor general condition, incomplete function of important organs, and not tolerant to surgery; ⑦

Patients with cardiopulmonary insufficiency, malignant tumors, cardiovascular and cerebrovascular diseases and other medical diseases.

Main instruments and methods

① The control group was only treated with an ultrasonic knife. The ultrasonic knife: Houkai ultrasonic knife [Houkai (Tianjin) Medical Technology Co., Ltd., main machine model: usg10, open multi-purpose shear: use23, vibrating at 55.5 khz (stretching

movement), according to the selected gear, the amplitude of the knife head is between 40-100 μM] (as shown in **Figure 1**). ① Before anesthesia implementation and maintenance, patients were given intramuscular injection of phenobarbital 2 mg/kg and atropine 0.006-0.010 mg/kg 30 minutes before entering the operating room. Patients in the control group were given epidural injection of tg-g, injected with 0.75% ropivacaine 4-8 ml, and the block range was measured 5-10 minutes later. Local anesthetics were added according to the block plane to control the block plane below ts. General anesthesia was induced with propofol 1.0-1.5 mg/kg, fentanyl 2-5 μg/kg, and icoson 0.5-0.8 mg/kg. General anesthesia was maintained with propofol 2-5 mg/(kg. H); blea se-6500 anesthesia machine controlled breathing, tidal volume (VT) 7 ml/kg, respiratory frequency (RF) 14 times/min, inhaled isoflurane, combined with intravenous fentanyl and vecuronium. The dosage was adjusted according to the vital signs of patients, operation conditions and time. ② Operation for those with adhesion around the gallbladder, we used a gallbladder grasping forceps to gently lift the adhesion, and used the ultrasonic knife to quickly close the gallbladder to coagulate and

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Figure 2. Equipment and instruments for the harmonic scalpel usage in the endoscopic surgery: A. Generator (USG10); B. Connecting cable with generator connector and transducer–hand-piece for the instruments connection (HP25); C. Instrument (scissors) for the harmonic scalpel endoscopic usage (USE14).

break the adhesion. In case of stone incarceration in the neck of the gallbladder, which often leads to cholecystitis edema, high tension and even gangrene. It is difficult to grasp the wall of the gallbladder with the forceps, so we first puncture and decompress the gallbladder to pull it. We follow the “exploration, positioning, window opening, and confirmation”. The method of “resection” was used for cholecystectomy. The cystic duct was cut after being clamped with absorbable clamp or titanium clamp. If the stone was still embedded in Hartmann bag after decompression, it was squeezed gently to the gallbladder along the lower edge of the stone to make it loose and move to the gallbladder. If the stone was tightly embedded and could not be loosened by extrusion, the neck of the gallbladder was cut to remove the stone, or the gallbladder was peeled retrogradely to the neck and then the stone was cut to retain part of the neck tissue of the gallbladder in the gallbladder burn and damage the remnant gallbladder mucosa, and suture the remnant with absorbable suture. If there was a stone embedded in the cystic duct, after dissecting the cystic duct, the ante-

rior wall of the cystic duct where the stone was cut to be of proper size, and the stone was carefully squeezed out from the common bile duct to the cystic duct. If the proximal part of the cystic duct was not cut and there was enough of a stump, it was clamped and closed, otherwise it was closed with an absorbable suture. In the process of dissecting the anterior and posterior trigonometry of gallbladder, the gallbladder artery can be coagulated and cut off at the right time with ultrasonic knife or the cystic duct can be cut off, then the gallbladder artery can be exposed and then coagulated and cut off with ultrasonic knife in a step like slow speed, generally without the treatment of hemostasis clamp; if the anatomy of the gallbladder artery is unclear, it is not necessary to dissect it deliberately, and it can be cut off close to the gallbladder wall in the trigonometry area. The gallbladder mesangium can be directly clipped by an ultrasound knife and then coagulated. After the cholecystectomy, the gallbladder bed is mostly dry. The blade can be used as a point-shaped supplement to stop bleeding without intensive burning to avoid side injury. When stripping the gallbladder, antegrade, retrograde or antegrade and retrograde method can be used flexibly, and the blunt head end push, stripping, scraping and suction separation of endoscopic aspirator can be used to assist in anatomy. If the gallbladder wall is obviously thickened, it is difficult to remove the gallstones, or the gallstones are broken when the gallbladder wall is free and fall off, we put them into the specimen bag, enlarged the xiphoid process and took them out, disinfected them with Iodophor after operation, washed the abdominal cavity with normal saline, placed the abdominal drainage tube for 1-2 days, and applied antibiotics for 3-5 days (as shown in **Figures 2** and **3**).

② The patients in the study group were treated by ultrasonic scalpel combined with internal oxygen and intravenous drip of sodium nitroprusside. ① The operation of the ultrasonic scalpel was the same as that of the control group. ② Internal oxygen supply for injection: i.e. carboxamide peroxide for injection (Hebei Tiancheng Pharmaceutical Co., Ltd.), characterized by a white crystal or crystalline powder, soluble in water, mainly composed of carboxamide hydrogen peroxide, which can be decomposed in the case of a strong oxidizing or reduc-



Figure 3. Ultrasonic scissors usage in transoral endoscopic thyroidectomy: dismember the isthmus of thyroid.

ing substance. Specification: 1 g/piece. ③ Anesthesia implementation and maintenance of general anesthesia in the study group was similar to that in the control group. Map, HR, spo₂ and ECG were monitored by the multi-function monitor during the perianesthesia period, and 0.5-6 μg of sodium nitroprusside was injected intravenously during the operation in patients with hypertension/(kg.min). ④ Treatment A, B, C, D, 4 holes were located in the umbilicus, xiphoid process, right costal margin of the middle clavicle, right axillary front. The pneumoperitoneum pressure is 7-10 mmhg (0.9-1.3 kpa). Point B was close to the right side of xiphoid process in three holes A, B and D operation. The liver was turned to the head side with the long pole of the instrument, and the triangle area of gallbladder was separated from the top left to the bottom right. With curved forceps, the serous membrane of the cystic duct and the ventral and dorsal sides of the triangle area were torn open. The metal suction head is usually used for blunt cold pushing and stripping, and it is washed at any time to absorb blood stains. The obliquity of laparoscope was turned to the right side, the visual field of triangle area was enlarged, and the space of triangle area was enlarged with curved separating forceps or ultrasonic knife to expose the cystic duct and blood vessels. The cystic duct and blood vessel with diameter less than 3 mm can be coagulated in steps with the ultrasonic scalpel plane first, then cut off with sharp surface in between; the traditional titanium clamp or absorbable clamp can still be used to close the cystic duct and blood vessel with diameter more than 3 mm. Most of the gallbladder can be successfully completed with 10 mm ultrasound knife. ③ When the gallbladder bed space is small, 5 mm ultrasonic scalpel can be used to grasp the cutting depth more accurately. After cholecystectomy, the

gallbladder fossa should be flushed and sucked clean. A little bleeding can be stopped by compression such as gelatin sponge or hemostatic gauze. When bleeding is obvious, titanium clip or ultrasonic knife plane can be used to stop bleeding directly. In order to detect bile leakage in time, small gauze strips can be placed on the wound to observe whether there is yellow staining.

When the residual end of the cystic duct leaks, if the extrahepatic bile duct is clear and the cystic duct remains longer, it can be clamped or ligated again. When the triangle area is not anatomically clear or the cystic duct is short, the common bile duct leakage is suspected, suture is often needed. The right hepatic duct and extrahepatic bile duct injury should not be excluded. After the operation, the abdominal drainage was placed routinely.

④ Postoperative gyrus.

Short-term efficacy evaluation

① Incidence of postoperative adverse reactions in patients was assessed. Adverse reactions included postoperative bile leakage, death, gangrenous cholecystitis etc.

② The recovery of surgical indexes were observed. The surgical indexes include time of emergencies, operation time, intraoperative blood loss, number of open laparotomy, CRP value after 48 hours, postoperative abdominal drainage and postoperative hospital stay.

③ GQOLI-74 scale was selected to evaluate the quality of life of the patients before and after treatment, with a full score of 100 points. The higher the score, the higher the quality of life; quality of life includes: environmental, social, physical, psychological scores and total scores.

④ Before and after treatment, enzyme-linked immunoassay method was used to detect the inflammation indicators (sICAM-1 and interleukin-6 inflammatory factors) in both groups.

Statistical method

SPSS 23.0 statistical software was used for data processing. Quantitative data were expressed as ($\bar{x} \pm s$), comparison between groups was tested by t test, qualitative data were expressed by (n, %), and comparison

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Table 2. Comparison of incidence of postoperative adverse events between the two groups (n/%)

Group	Number of cases	Postoperative bile leakage	death	Gangrenous cholecystitis	Incidence
Control group	38	4 (10.52)	1 (2.63)	3 (7.89)	21.04%
research group	38	2 (5.26)	0 (0.00)	1 (2.63)	7.89%
χ^2	/	5.836	0.997	0.820	11.653
P	/	0.039	1.101	0.963	0.000

Table 3. Comparison of various surgical treatment indexes between two groups of patients ($\bar{x} \pm S$)/(n, %)

Index	Control group (n=38)	research group (n=38)	t/ χ^2	P
Time of onset (h)	52.05±0.03	52.06±0.05	13.994	0.323
operation duration (min)	44.54±1.43	54.53±2.32	12.546	0.642
Intraoperative blood loss (ml)	95.32±1.23	65.43±2.54	26.899	0.004
Laparotomy (n)	25 (65.79)	12 (31.58)	12.545	0.674
CRP value at 48 hours after operation	43.33±1.32	18.45±1.32	11.324	0.043
Postoperative abdominal drainage (ml)	97.43±1.42	42.42±1.34	12.432	0.054
Days after hospitalization (d)	8.37±1.31	4.73±1.15	8.706	0.003

between groups was performed using χ^2 test. P-values of < 0.05 were considered to be statistically significant.

Results

Comparison of incidence of postoperative adverse events between the two groups

The incidence of postoperative adverse reactions in the study group was significantly better than that in the control group (P < 0.05). See **Table 2**.

Comparison of various surgical treatment indexes between the two groups of patients

The recovery of surgical indexes in the study group was better than that in the control group (P < 0.05). See **Table 3**.

Comparison of expression levels of sICAM-1 and IL-6 inflammatory factors between the two groups

Before treatment, there was no significant difference in serum sICAM-1 and IL-6 expression levels between the two groups (P > 0.05). After treatment, the expression levels of serum sICAM-1 and IL-6 in the two groups showed a certain downward trend, and the expression levels of serum sICAM-1 and IL-6 inflammatory factors in the study group were significantly lower than those in the control group (P < 0.05). See **Table 4**.

Comparison of scores of quality of life between two groups of patients before and after treatment

Before treatment, there was no statistically significant difference between the scores of the two groups of patients in terms of mental state, physical health, independence, social relations, surrounding environment, and personal beliefs (P > 0.05). After treatment, the scores of the two groups of patients in the psychological state, physical health, independence, social relations, surrounding environment and personal belief scores were significantly higher than before treatment, and the difference was statistically significant (P < 0.05). After treatment, the scores of the treatment group were significantly higher than those of the control group, the difference was statistically significant (P < 0.05). See **Table 5**.

Discussion

AC is a disease with sudden, persistent and paroxysmal exacerbations. It is usually caused by the irregular diet of the patient, eating a lot of greasy food, etc., which is related to the modernization of people's living standards [4]. The disease is more common in middle-aged people, and it often occurs at night, which seriously affects the quality of life of patients [5, 6].

Driven by the concept of minimally invasive surgery, clinics generally adopt minimally invasive

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Table 4. Comparison of expression levels of sICAM-1 and IL-6 inflammatory factors between the two groups ($\bar{x}\pm S$)

Index	time	Group		t	P
		research group (n=38)	Control group (n=38)		
sICAM-1 ($\mu\text{g/L}$)	Before treatment	354.28 \pm 59.38	356.35 \pm 59.36	0.140	0.889
	After treatment	257.59 \pm 19.24	219.15 \pm 19.39	4.036	0.000
	t	6.735	2.357	-	-
	P	0.000	0.021	-	-
IL-6 (ng/L)	Before treatment	153.49 \pm 14.45	149.08 \pm 15.28	0.458	0.648
	After treatment	33.35 \pm 8.42	54.25 \pm 11.35	2.144	0.035
	t	5.359	2.288	-	-
	P	0.000	0.025	-	-

laparoscopic surgery to treat various general surgical diseases, which is helpful for patients to recover as soon as possible and have an early discharge; this improves the limitations of previous laparotomy which had a large amount of trauma and bleeding [7]. Studies have shown that the use of laparoscopic surgery can reduce the stress response and reduce the negative impact of surgery on the body's physiology. At the same time, the use of laparoscopic surgery can reduce interference with organ function and promote postoperative exhaust [2].

An ultrasonic knife has little damage to the tissue, high cutting accuracy, and little smoke and eschar. It can directly coagulate the blood vessels with a diameter of 3 mm, and the damage to the surrounding tissue is only within 1 mm. When the gallbladder adheres to the surrounding tissues such as the omentum, the ultrasonic knife's flat, blunt, and sharp sides can be flexibly used to free the adhesion around the gallbladder, reduce intraoperative bleeding, and shorten the operation time [8]. There are dense adhesions around the gallbladder, especially when it is attached to the gastric antrum and duodenum. You can use an ultrasonic knife to close the gallbladder for sharp and careful separation, with less blunt and electrothermal separation, to avoid damage to the stomach or intestinal wall. When dealing with the cystic duct and the cystic artery, we used "breakwater" coagulation technology, that is, we use the ultrasonic knife to repeatedly coagulate and cut the cystic duct and the cystic artery, repeatedly at 5 to 10 mm in length, making the tissue white, and confirming that it has coagulated. Then we made the cut in the middle of the coagulation site, which can effectively treat the cystic duct and cystic artery to avoid arterial bleeding. When the cystic duct is shorter, a tita-

nium clip can be placed on the gallbladder side after 5 mm coagulation, and the cystic duct can be cut close to the gallbladder. When the gap of the gallbladder bed is large or there is a mesentery, it is very convenient to use an ultrasonic knife to separate and remove the gallbladder with little bleeding. When using a high-frequency electrocautery in the operation of a patient with a pacemaker, high-frequency current and electromagnetic waves of a certain intensity will be generated, which will have a certain impact on the function and perception of the pacemaker. At present, the use of ultrasonic knives can solve this problem, because no current passes through the body, so it does not interfere with the pacemaker function.

Sodium nitroprusside is a nitrohydrocyanate, a strong dilator that directly acts on arteriovenous vascular beds. The drug has a direct expansion effect on resistance and volume vessels, and has a greater effect on afterload than nitroglycerin, so it can reduce the patient's left ventricular filling pressure and increase cardiac output. For acute decompensation in patients with chronic left ventricular failure, sodium nitroprusside has a faster and stronger effect than furosemide. Because sodium nitroprusside mainly acts on resistance vessels in the coronary circulation, it can cause issues. Sodium nitroprusside can increase the arterial and venous shunts of the myocardium and lungs, so the increase in total blood flow may not necessarily show an increase in the part of the blood flow that has improved perfusion. The increase of stroke volume can counteract the decrease of peripheral vascular resistance, so the arterial blood pressure will not be greatly reduced. Heart rate generally does not increase, and may even decrease due to improved hemodynamics. Its mechanism of action is the same

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Table 5. Comparison of scores of quality of life between two groups of patients before and after treatment ($\bar{x} \pm S$)

Group	time	Mental state	Physical health	independence ability	social relationship	surroundings	Personal belief
Control group (n=38)	Before treatment	7.63±1.25	7.15±1.17	7.02±0.98	8.53±1.33	9.02±0.99	8.14±1.32
	After treatment	11.12±1.07 ^a	10.98±1.25 ^a	11.34±2.34 ^a	11.59±0.99 ^a	11.63±0.87 ^a	12.28±1.04 ^a
research group (n=38)	Before treatment	7.69±1.31	7.12±1.09	7.13±1.02	8.61±1.38	8.95±0.94	8.26±1.37
	After treatment	12.95±0.98 ^a	13.12±1.37 ^a	13.18±2.03 ^a	14.25±1.03 ^a	13.37±0.82 ^a	14.19±0.95 ^a
Comparison between groups before treatment	t	0.204	0.116	0.479	0.257	0.316	0.389
	P	0.985	0.650	0.887	0.624	0.568	0.601
Comparison between groups after treatment	t	7.775	7.113	3.662	11.478	8.972	8.359
	P	0.002	0.005	0.036	0.000	0.000	0.000

Note: Compared with the same group before treatment, ^aP < 0.05.

as nitrates, which can cause vascular endothelial cells to release NO and activate guanylate cyclase, increase intracellular cGMP levels, and dilate blood vessels. The specific types of clinical hemodynamic changes and the underlying pathological changes may contribute to the choice of drugs [9]. If the pump function is obviously abnormal, the left ventricular filling pressure is increased and the peripheral vascular resistance is significantly increased. For patients with reduced cardiac output and normal or increased arterial pressure, short-term intravenous infusion of sodium nitroprusside is appropriate.

CO₂ pneumoperitoneum has a greater impact on human physiological functions, especially cardiopulmonary function and hemorheology. A large amount of CO₂ absorbs human blood through the peritoneum, which will increase the partial pressure of carbon dioxide and cause hypercapnia. Zhang Yumei believes that intermittent hyperventilation by adjusting the respiratory rate during laparoscopic surgery is conducive to the discharge of excessive CO₂ and improves the safety of surgery. However, elderly people with low heart and lung function are usually unable to tolerate a pneumoperitoneum of 1.6 to 2.0 kPa (12 to 15 mmHg), and excessive airway pressure may increase the risk of complications. The author once encountered a 56-year-old patient with interstitial lung disease. Closed drainage was required for LC complication with pulmonary rupture [10-14]. Elderly people are more prone to decline in arterial blood oxygen saturation during LC. The use of low-pressure pneumoperitoneum of 0.9 to 1.3 kPa under skilled conditions is beneficial to reduce LC complications and improve safety. At the same time, due to the poor lung function of the elderly, in order to prevent and correct hypercapnia, maintain normal blood oxygen saturation, and ensure full oxygenation of the tissues [15-17], intravenous oxygenation is used to replace the traditional oxygen infusion after injection. After decomposing hydrogen peroxide in the body, and then catalyzing by catalase to release oxygen, oxygen is directly combined with hemoglobin in the blood, and the oxygen partial pressure is significantly increased. For the prevention and correction of hypercapnia, maintaining normal blood oxygen saturation to a degree, to ensure that the tissue is fully oxygenated, has an important role [18, 19].

The results of this study showed that ultrasonic knife combined with internal oxygen-assisted intravenous drip of sodium nitroprusside in laparoscopic cholecystectomy in elderly patients with acute cholecystitis can improve the patient's body inflammation indicators and perioperative indicators, including sICAM-1 (ICAM-1 hydrolysate), it has the effect of promoting the migration of leukocytes, and it plays an important role in inflammatory activity with interleukin-6. In addition, the hydrolysate of ICAM-1 plays an important role in regulating the adhesion of leukocytes. Improvement indicates that laparoscopic surgery combined with anti-inflammatory and gallbladder tablets can improve postoperative inflammatory response, which is of great significance for improving the prognosis of patients. The improvement of perioperative indicators suggests that the combined treatment can shorten the recovery time of patients and accelerate the speed of postoperative recovery. Ultrasonic knife therapy alone is more conducive to improving the rehabilitation effect.

There were some limitations to the current study. For instance the sample size can be increased for better inclusion, and the samples were from a single hospital center. Therefore, in order to overcome these limitations, further research is needed.

Conclusion

It is safe and feasible to use an ultrasonic knife combined with internal oxygen to assist intravenous infusion of sodium nitroprusside for the treatment of elderly patients with AC. The right timing of surgery, and skilled surgical techniques are needed for best patient outcome.

Disclosure of conflict of interest

None.

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