Optimum criterion to be dependable in early cholecystectomy in acute calculous cholecystitis

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ABSTRACT

Early cholecystectomy in acute cholecystitis is still avoided by many surgeons due to discrepancy in knowledge available about the management options when dealing with acute cholecystitis and the lack of suitable and considrable criterion to be depend on when choosing early cholecystectomy as an preferred option. So, in this study , the analytic hierarchy process is used to investigate the most optimum criterion that can be depended when choosing early appraoch in cholecstectomy cases. The study data had been supplied by a four expert consultant surgeons working at baqubah teaching hospital with excelent expereince about cholecystectomy cases. The investigated criteria involve intraopertive complications (bleeding,common bile duct injury, visceral injury), operative time, postoperative compilcations(wound infection, intraabdominal infection,bile leak,deep venous thrombosis) and length of Stay in the Hospital. The experts give an optimum weight for each criterion on a multiple comaparison scales. The intraopertive complications have the highest mean value recorded and is equal to 0.353 for cholecystectomies done within 3 days of onset of acute cholecystitis and is equal to 0.471 for cholecystectomies done within 7 days of onset of acute cholecystitis and so the intraopertive complications represent the optimum and the most dependable criterion when choosing early cholecystectomy as an approach of choice to treat acute cholecystitis.

1.Introduction

Gallbladder is a pear shape organ ,it's location is on the inferior surface of the liver and is consists of four parts (fundus, body, infundibulum and neck). The fundus contains smooth muscle fibers while the body contains elastic fibers which permit it's maximum distention when any obstructrion of cystic outlet occurs. The infundibulum is an outpouching near the junction of gallbladder neck and cystic duct while the neck repressnts the narrowest point where the cystic duct communicates[1].

The arterial supply of the gallbladder is by the cystic artery, a branch of the right hepatic artery while the venous drainage is via cystic vein which is drained into the portal vein with a number of small veins crossing from upper surface of the gallbladder to the liver and drained into the hepatic veins[2].

The lymphatic drainage is to the cystic lymph nodes and the nerve supply is via a sympathatic and parasympathatic vagal nerve fibers from the ciliac plexus and here, it should remember that the contraction of the gallbladder is under the effect of cholecystokinin hormone[3].

Calot's triangle is the area bounded by the common hepatic duct, the cytstic duct and inferior border or surface of the liver [1].

Right and left hepatic duct exit from the porta hepatis of the liver and unite together forming the common hepatic duct which runs downwards and joined by the cystic duct to form the common bile duct which will also run downwards posterior to the duodenum to be accompanied by the pancreatic duct and the both are joined together to form the ampula of vater which is opend into the duodenum and both ends of the common bile duct and pancreatic duct with the ampula of vater are surrounded by circular muscle fibers(the sphenictor of oddi)[4].

The biliary system with the relating vessels Characterized by a bounding of variations which necessate carefullness during biliary surgery including cholecystitis[5].

Bile is a solution produced and secreted by the liver cells (the hepatocytes) and it's major or key compenents are:bile salts (which play rule in fat digesion), bile pigment, cholesterol.this bile stored in the gallbladder and the later pushs the bile into the common bile duct and so into the duodenum in responce to eating meals with fat content[6].

By impaction of the gallstone into the orifice of the cystic duct or on neck of the gallbladder, there will be initiation of an inflammatory response [4]. This iflammatory responce will results in destruction of the normal protective mucous layer inside the gallbladder with exposure of the mucosal epithelium to the effect of bile together with increasing intramural pressure and gallbladder distension with finally compromising the blood flow and later on the bacterial contamination may develops, so acute calculous cholecystitis is defined as an acute inflammation of the gallbladder which is triggered by obstruction of cystic duct or gallbladder neck by a gallstone[7].

In 90-95% of acute cholecystitis there is an association with the presence of gallstones[1].

The prevelance of gallstones in western countries is 10-15% and the prevelance in the united kingdom is 17% at death time[8].

Acute cholecystitis incidence is increasing throughout the world from day to day [9]. It is a serious complication of gallstones with mortality about 3% which is inceasing with age and comorbidity[10]

The diagnosis and management of acute cholecystitis is in continuos development and require a good clinical assessement and operative skill and this is facilitated by the development in the diagnosis and grading systems such as Tokyo guidlines[11].

In these guidlines ,there should be a fulifulment of clinial, labaratory and imaging criteria for accurate diagnosis and so clinically the patient with acute cholecystitis will develop right upper quadrent abdominal pain (usually not remitting), tenderness, gaurding with positive murphy's sign and fever together with labaratory findings of leukocytosis with or without (CRP more than or equal to 3 mg/dl)and may be mild jaundice and the severity can be classified into:Grade1=mild(mild local inflammation,no organ dysfunction),Grade2 =moderate(symptoms lasting more 72 hours, significant leukocytosis, features of local complications such as peritonitis or abscess), Grade3=severe(at least one organ dysfunction)[12].

Regarding imaging tests for the diagnosis of acute cholecystitis, ultrasonography (U/S) is regarded as the most helpful one as it is effective in showing gallbladder wall thickness, pericholecystic fluid, gallstones, sonographic murphy's sign, while CT scan can demonstrates the same findings of U/S in acute cholecystitis but with less sensitivity while biliary scintigraphy (HIDA scan) may be used for diagnosis of acute cholecystitis in some cases with doubt diagnosis[1].

Complications of acute cholecystitis include empyema ,mucocele, gangrene of gallbladder, perforation of gallbladder, fistula formation, gallstone ilius, limey(milk of calcium)bile and porcelain gallbladder[13].

In a case of acute cholecystitis, the initial management should invovles antibiotics, intravenous fluids and may be electrolytes as the first step prior to definitive surgical intervention[14].

Cholecystectomy is the current standard of the treatment of acute cholecystitis[15].

Cholecystectomy is defined as the removal of gallbladder surgically[16,17].

Langenbuch was the first who performed cholecystectomy in 1882.The surgery was done in berlin and his patient was discharged from the hospital after 7 days of the operation. Before that, in 1867, John Stough Bobbs performed the first cholecystestomy and removed gallstones[18].

Cholecystectomy can be done either via open or laparascopic approach[12].

Laparascopic cholecystectomy is regarded as the gold standard in acute calculous cholecystitis treatment[19].

The timing of operative intervention in acute cholecystitis is considered as a point that needs further search and investigation[11].

This timing inludes two approaches:early cholecystectomy and delayed cholecystectomy[20].

Early approach is cholecystectomy within admission to hospital[21].

Delayed approach is cholecystectomy after a gap of 6-8 weeks of the acute attack[20].

Recent studies showed suggestion of preference of urgent early cholecystectomy in the management of acute cholecystitis but the delayed approach after a period of conservative treatment is still common practice in many centers[22].

The usual management of acute cholecystitis includes initial treatment and control of inflammation of the gallbladder followed by cholecystectomy after 6-8 weeks but this approach is associated with increased risk of morbidity during waiting period with chances of acute attacks and gallstones related complications together with the fact that after 72 hours there is development of adhesions, hypervascularity, fibrosis and necrosis.[23].

The international guidlines mention that early approach cholecystectomy is appropriate for acute cholecystitis and is associated with reduced stay in the hospital and decreased costs[21].

The analytic heirarachy process (AHP) is regarded as an inclusive system which is used to make decisions with multiple criteria[24]

The analytic heirarachy process (AHP) is used to give a priority to the challenges or criteria based on their importance[25]

The purpose of this study is to select the best and optimum critrion that should be dependable in the correct decision in early cholecystectomy in acute cholecystitis through the use of analytic hierarchy process depending on experience of a group of surgeons.

2.Litrature review

Arasi et al (2018) mention that early approach is better due to overall better life quility with less morbidity and less cost of hospital stay[15].

Litratures such as Gursimranjit et al (2020) mention that early appraoch is characterized by less hospital stay and is more economical[9].

Ankit et al (2018) conclude that early cholecystectomy within 72 hours is a safe procedure[26].

Maria et al (2020) deduced that early cholecystectomy within 72 hours is preferred as it is characterized by less complications, shorter length of hospital stay, less readmission and emergency department visits[27].

Tom et al (2019) mention that early cholecystectomy within 72 hours characterized by the advantages of decreased intraoperative conversion, less postoperative biliary related complications and less hospital stay[28].

Rajneesh et al (2019) conclude that early cholecystectomy within 72 hours has the advantage of less morbidity with shorter mean duration of surgery and less length of hospital stay[23].

Jamal et al (2020) study outcome go with the fact that early cholecystectomy within 7 days is safe and feasible in acute cholecystitis and is better approach as it is associated with less hospital stay with major economic benefit for patient and health system[20].

Yunxiao et al (2018) conclude that early laparascopic cholecystectomy is effective and also safe for acute cholecystitis within 7 days of presentation and may be associated with shorter hospital stay[29].

Yuksekdag et al (2021) deduce that early cholecystectomy is safe within 7 days of onset of symptoms of acute cholecystitis[30].

3.Methadology:

The main objective of this study is to find the best and optimum criterion that can be dependable in our decision of early cholecystectomy wheather in the first 3 days or in the first 7 days through the assessment of the weights of all criteria listed below by using the analytic hierarchy process(AHP).

3.1. Selection of the criteria:

The criteria used in this study are listed below and are the most mentioned in litratures:

1. Intaopertive complications(IOC):(bleeding,common bile duct injury, visceral injury).
2. Operative time(OT): is the time between the first incision and final closure.
3. Postoperative compilcations(POC): (wound infection, intraabdominal infection,bile leak,deep venous thrombosis)
4. Length of Stay in the Hospital (LOS).

3.2. Calculation of the pairwise comparison:

AHP is depended on a pairwise comparison to derive priority scales[31]

In this study , surgeons were the cornerstones as experts and concentrate their knowledge to weigh the above criteria through the pairwise comparison between each two given criteria.

Those four surgeons are general surgery consultants at baqubah teaching hospital in diyalah governarate.

### 3.3. consistency ratio configration:

This step is important. After collection of the data as numerical values in the scales of the study. These numbers represent the opnions of doctors then we insert these numerical values in the study matrix and throughly calculate the consistency ratio(CR) which is important in the assessment of the consistency of the study and it should be equal or less than 1 and if the result is more than 1 this indicate an inconsistency.

So the consistency ratio is significant as indicator of the accuracy of the results as many researchers face inconsistency in the answers collected through the quisionaire.

3.4.Estimation of the weights of criteria from experts choices.

This section involves explanation about the way that was used to assess experts choices. The data of choices of the criteria were collected through asking the consultant surgeons and their answers were fixed by them on the comparison scale as numerical values in the quesionaire according to their preference and their experience as shown in the following structure and from these numerical values we will gain weights of the criteria are represented and arranged in the study matrix.

Srtructure below showing the scale of pairwise comparison between criteria (C represnt a criterion)
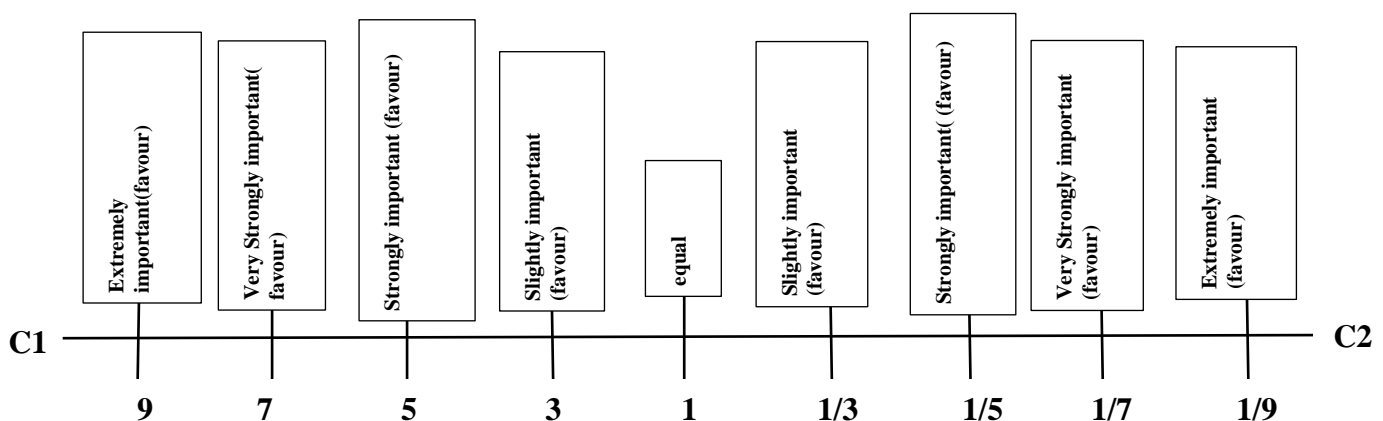
The numerical values mentioned above on the comparison scale have a corresponding fundamental measures and these measures are simply shown in the table (1) below:

Table (1) showing fundamental measures and their descriptions:

Priority of measure	Description of measure
1	Equal favour
2	Slight favour
3	Strong favour
4	Very srtong favour
5	Extreme favour

3.5. Comparison matrix

All weights of all criteria are inserted in the compaiirison matrix and these values are represented in the table(2) and table(3) which are stand for 3 days cholecystectomy and 7 days cholecystectomy.

Table (2) showing weights of creteria in case of cholecystectomies that are done within 3 days

Criteria weights in the 3 days cholecystectomy			
Criteria	**IOC**	**OT**	**POC**	**LOS**
Ex.1	0.130	0.046	0.249	0.575
Ex.2	0.524	0.109	0.136	0.231
Ex.3	0.581	0.104	0.279	0.035
Ex.4	0.179	0.191	0.217	0.413

Table (3) showing weights of creteria in case of cholecystectomies that are done within 7 days:

Criteria weights in 7 days			
Criteria	**IOC**	**OT**	**POC**	**LOS**
Ex.1	0.217	0.101	0.195	0.487
Ex.2	0.631	0.112	0.220	0.037
Ex.3	0.584	0.077	0.159	0.179
Ex.4	0.450	0.235	0.050	0.265

3.6 statistical values:

In this section we do assessement of important statistical values(mean and standard deviation) for all criterion weights given by the experts . so, each criterion has a mean and a standard deviation as shown below in tables (4) and (5)

Tables (4) showing mean and a standard deviation values in 3 days cases:

criteria	IOC	OT	POC	LOS
mean	0.353	0.113	0.220	0.314
stadev	0.231615	0.059707	0.061928	0.232686

Tables (5) showing mean and a standard deviation values in 7 days cases:

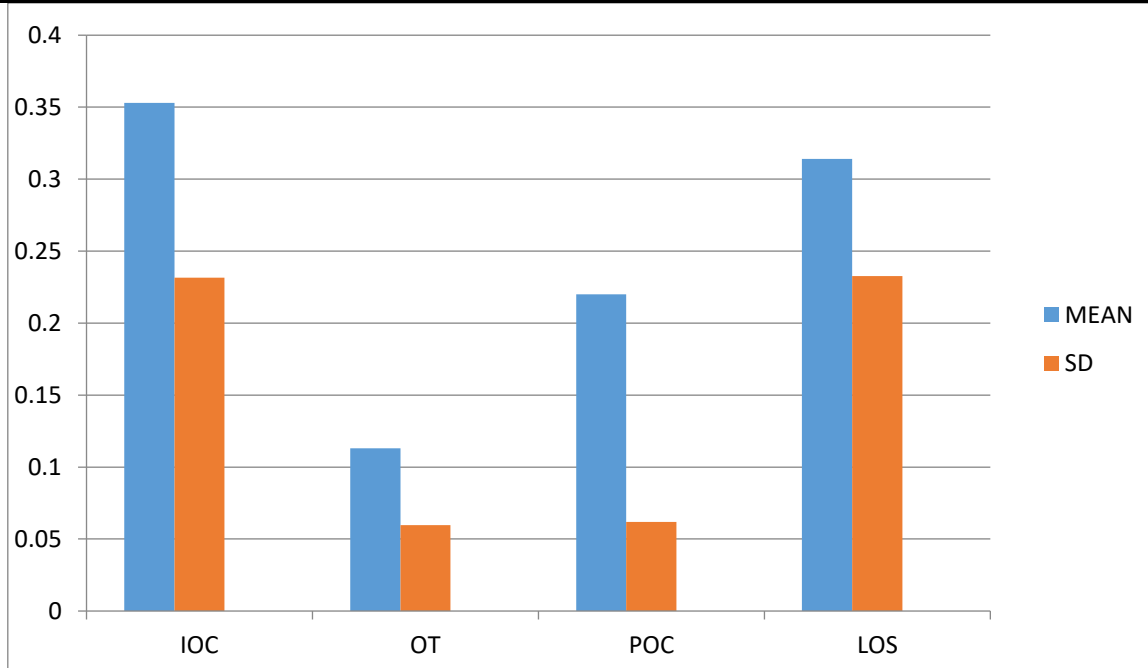| Criteria	IOC	OT	POC	LOS
mean	0.471	0.131	0.156	0.242
standev	0.18577	0.070446	0.075077	0.188568

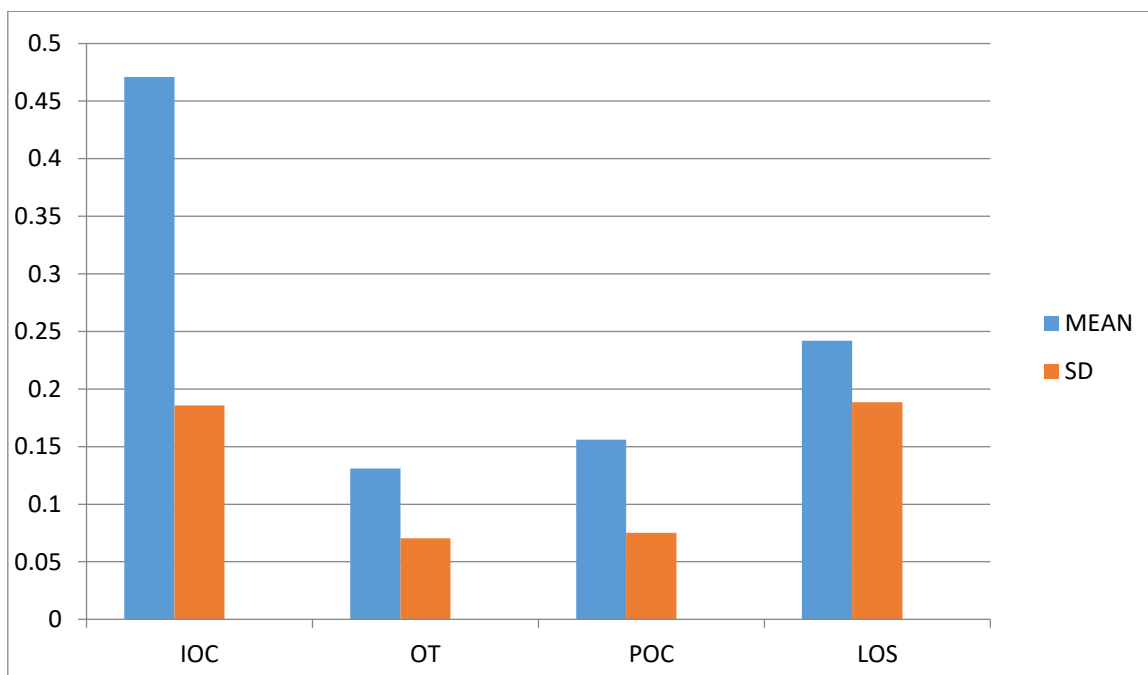**Diagram showing statistical values in 3 days cholecystectomy**

Diagram showing statistical values in 7 days cholecystectomy

4.Results and Discussion

In this section the results are discussed according to the analytic hierarchy process method. The weight of each criterion in early cholecystectomy were estimated based on surgeon choice and prference. The highest weight criterion has the most priority and is the most optimum to be dependable. Each surgeon give weights to four criteria. For the cholecystectomies done within 3 days of onset of acute cholecystitis, the highest weights in the study matrix were recorded as following(LOS=0.575 recorded by expert 1)(IOC = 0.524 recorded by expert 2)(IOC = 0.581 recorded by expert 3)(LOS=0.413 rdecord by expert 4) and the highest value mean was recorded for IOC with value equal to 0.353 with standard deviation equal to 0.231615.

While for the cholecystectomies done within 7 days of onset of acute cholecystitis, the highest weights in the study matrix were(LOS =0.487 recorded by expert 1)(IOC =0.631 recorded by expert 2)(IOC = 0.584 recorded by expert 3)(IOC =450 recorded by expert 4) while the highest value mean was recorded for IOC with value equal to 0.471 with standard deviation equal to 0.18577.

5.Conclusion

The final conclusion of this study is that intraoperative complications (IOC) represnt the most important criterion to be dependable when surgeons choose early cholecystectomy as an approach of choice to treat acute cholecystitis within the first 3 days and 7 days of onset of symptoms.

References

1. Haisley KR, Hunter JG. Gallbladder and the Extrahepatic Biliary System. In: brunicardi FC, Andersen DK, Billiar TR, Hunter JG, kao LS, Matthews JB et al (eds). Schwartz's principles of suergery.11thed. NewYork:McGraw-Hill; 2019:p1393-1427.
2. Singh V. Textbook of Anatomy abdomen and lower limb. 2nd ed. volume 2. India:Reed Elsevier India Private Limited; 2014. Chapter 8, Liver and Extrahepatic Biliary Apparatus; p. 109-25
3. Snell RS. Clinical Anatomy by Regions. 9TH ed. China:Wolters Kluwer Health/Lippincott Wiliams and Wilkins; 2012.
4. Farquharson M, Hollingshead J, Moran B. Farquharson's Textbook of Operative General Surgery. 10th ed. Boca Raton:CRC Press Taylor and Francis Group; 2015. Chapter 19, gallbladder and Biliary Surgery; p 321-38
5. Hansen JT, Netter FH. Netter's Clinical Anatomy. 4th ed. Philadelphia: Elsevier; 2019.
6. Silverthorn DU. Human Physiology an Integrated Approach. 7th ed. Italy: Pearson; 2016. Chapter 21, The Digestive System; p 678-716
7. Kumar V, Abass AK, Aster JC. Robin and Cortan Pathologic Basis of Disease.9TH Ed. Canada: Elsevier Saunders; 2015.18:877
8. Williams NS, Bulstrode CJK, O'connell PR. Bailey and loves.26th ed.Boca Raton: Taylor and Francis Group; 2013.
9. Singh G, Singh RR, Bansal D. A comparative study of interval cholecystectomy and early cholecystectomy in acute cholecystitis. International Surgery Journal. 2020; 7(5), 1419-1423.
10. Lee SO, Yim SK. Management of Acute Cholecystitis. Korean J Gastroenterol. 2018 May 25;71(5):264-268. Korean. doi: 10.4166/kjg.2018;71.5.264. PMID: 29791985.
11. Mou D, Tesfasilassie T, Hirji S, Ashley SW. Advances in the management of acute cholecystitis. Annals of gastroenterological surgery. 2019; 3(3), 247-253.
12. Bang JY, Sherman S. Cholelithiasis and Cholecystitis. In: Friedman LS, Martin P (eds). Handbook of Liver Disease. 4TH ed. China: Elsevier;2018:p270-78
13. Greenberger NJ, Paumgartner G. Diseases of the Gallbladder and Bile Ducts. In: Longo DL, Fauci AS,Langford CA (eds). Harrison's Gstroenterology and Hepatology. 1st ed. USA:McGraw-Hill Education; 2013:p439-55
14. Cruz WWB, Han HS. Preoperative Evaluation and Management of Acute Cholecystitis: Optimal Timing and Surgical Approach. In Difficult Acute Cholecystitis. switzerland: Springer, Cham;2021:p53-63
15. Thangavelu A, Rosenbaum S, Thangavelu D. Timing of Cholecystectomy in Acute Cholecystitis. The Journal of Emergency Medicine.2018;54(6):892-97, ISSN07364679,https://doi.org/10.1016/j.jemermed.2018.02.045.
16. Mosby's Dictionary of Nedicine, Nursing and Health Professions.3rded. australia: Elsevier; 2019.cholecystectomy;350

17. Dictionary of Anatomy and Physiology. New Delhi(India):Sarup and Sons; 2000. Cholecystectomy;35

18. Watters C.R. Basic Techniques of Laparoscopic Cholecystectomy. In: Pappas TN, Schwartz LB, Eubanks S ,(eds). Atlas of Laparoscopic Surgery. London. Current Medicine Group; 1996. https://doi.org/10.1007/978-1-4757-9316-1_6

19. Kuhlenschmidt KM, Taveras LR, Cripps MW. Current Management of Acute Calculous Cholecystitis. Curr Surg Rep **9.** 2021(4). https://doi.org/10.1007/s40137-020-00282-2

20. Ahmed JU, Rajbongshi S, Hiquemat N. Early versus delayed cholecystectomy in acute cholecystitis: a comparative study in a tertiary care hospital. International Surgery Journal. 2020; 7(8), 2656-2661.

21. Cockcroft A, Verrico E, Xing S, Westerman S, Jung M, Sullivan R,et al . Hospital Enforcement of Early Cholecystectomy for Acute Cholecystitis. The American Surgeon. 2019. 85(8), 858-860.

22. Sakran N, Kopelman D, Dar R, Abaya N, Mokary SE, Handler C, Hershko DD. Outcome of Delayed Cholecystectomy after Percutaneous Cholecystostomy for Acute Cholecystitis. Isr Med Assoc J. 2018;20(10):627-631. PMID: 30324780.

23. Kumar R, Mahi SS, Walia RPS, Goyal S. Comparison between early and delayed laparoscopic cholecystectomy in acute cholecystitis: a prospective study. Age (years).2019;18(58):35-0.

24. Taherdoost, Hamed, Decision Making Using the Analytic Hierarchy Process (AHP); A Step by Step Approach (2017). International Journal of Economics and Management Systems, Vol. 2, 2017, Available at

25. Shameem M, Kumar RR, Kumar C, Chandra B, Chan AA. Prioritizing challenges of agile process in distributed software development environment using analytic hierarchy process. Journal of software:Evolution and Process. 2018.

26. Meena A, Chaudhari A, Akhtar M A. Laparoscopic cholecystectomy in acute calculus cholecystitis. International Surgery Journal. 2018; 5(5):1843-46.

27. Altieri MS, Brunt LM, Yang J, Zhu C, Talamini MA, Pryor AD. Early cholecystectomy (< 72 h) is associated with lower rate of complications and bile duct injury: a study of 109,862 cholecystectomies in the state of New York. Surgical endoscopy. 2020;34(7): 3051-56.

28. Wiggins T, Markar SR, MacKenzie H, Faiz O, Mukherjee D, Khoo DE., et al. Optimum timing of emergency cholecystectomy for acute cholecystitis in England: population-based cohort study. Surgical endoscopy. 2019;33(8):2495-2502.

29. Lyu Y, Cheng Y, Wang B, Zhao S, Chen L. Early versus delayed laparoscopic cholecystectomy for acute cholecystitis: an up-to-date meta-analysis of randomized controlled trials. Surgical endoscopy. 2018;32(12):4728-41.

30. Yuksekdag S, Bas G, Okan I, Karakelleoglu A, Alimoglu O, Akcakaya A, et al. Timing of laparoscopic cholecystectomy in acute cholecystitis. Nigerian Journal of Clinical Practice. 2021; 24(2):156.

31. Shapiro AF, Koissi MC. Fuzzy logic modifications of the analytic hierarchy process. Insurance: Mathematics and Economics, 2017;75: 189-202.

Questionnaire for the assessment of the optimum timing of cholecystectomy in acute cholecystitis

- Name :
- Speciality :
- Experience duration(since the first surgery residency):
- This quesionaire involving a pair wise comparison between the criteria that are involved in this study to assess the optimum timing of cholecystectomy in acute cholecystitis.
- The criteria are:
5. Intaopertive complications(IOC):(bleeding,common bile duct injury, visceral injury).
6. Operaative time(OT): is the time between the first incision and final closure.
7. Postoperative compilcations(POC): (wound infection,intraabdominal infection,bile leak,deep venous thrombosis)
8. Length of Stay in the Hospital (LOS).

Less IOC ———————————————————— Shorter LOS
9   7   5   3   1   1/3   1/5   1/7   1/9

Shorter OT ———————————————————— Less POC
9   7   5   3   1   1/3   1/5   1/7   1/9

Shorter OT ———————————————————— Shorter LOS
9   7   5   3   1   1/3   1/5   1/7   1/9

Less POC ———————————————————— Shorter LOS
9   7   5   3   1   1/3   1/5   1/7   1/9