

Percutaneous Needle Aspiration Versus Catheter Drainage in Treating Hepatic Abscess

Jawad Abdullah Ali Aldhafeeri¹, Haya Hussam N Alkahtani², Ahmad Mohammed A Dakheel³, Abdulghani Mohammed M Lodhi³, Khaled Masoud Alghamdi⁴, Mohammed Abdullah M Asiri⁵, Mohammed Abdullah M Alzahrani⁵, Fatima Alawi S Alhebshi⁵, Abdulwahab Malawi S Alshahrani⁶, Ahmed Omer S Alamoudi³, Muatz Ahmed Khayat³, Sameer Ali Y Alaidarous³

1- Najran University Hospital 1, 2- Ibn Sina National College, 3- King Abdulaziz University, 4- Health Control Centers in King Abdulaziz International Airport, 5- Taif University, 6- King Khalid University

ABSTRACT

Aim of the study: was to investigate the effectiveness of Percutaneous Needle Aspiration in comparison to continuous catheter drainage in the treatment of hepatic abscesses.

Methods: A review of the scientific literature (From 1980 to October 2017)

MEDLINE, EMBASE, SCOPUS, Current Contents, Cochrane Library, and Clinicaltrials.gov were searched to identify randomized controlled trials that investigated thoroughly the Percutaneous Needle Aspiration Versus Catheter Drainage in the treating of hepatic abscess and clearly met the inclusion criteria and the study primary endpoints (success rate, total resolution and mortality). Identification of papers and data extraction were performed by independent researchers.

Results: the search yielded six eligible RCTs covering 348 patients. The meta-analysis showed that outcomes in patients treated with PCD were superior to those in patients treated with PNA in terms of success rate (RR: 0.79, 95% CI=0.64–0.97; P = 0.04), days to achieve a 50% reduction in abscess cavity size (SMD: -1.076, 95% CI 0.63–1.51; P < 0.00001) and overall clinical improvement (SMD: 0.71, 95% CI 0.35–1.09; P =0.0001). On the other hand, no significant difference was notable in the duration of hospitalization (SMD: -0.15, 95% CI -2.03 to 1.72, P = 0.84) or procedure-related complications (RR: 0.48, 95% CI 0.13–2.58; P = 0.39).

Conclusion: The results of the present meta-analysis and systematic review indicated that PCD and PNA can be less safe and less invasive methods for the treatment of hepatic abscesses yet PCD is suggested to be more advantageous and superior to PNA.

Keywords: Catheter Drainage, LIVER ABSCESS, Percutaneous Needle Aspiration, Pyogenic abscess of liver

INTRODUCTION

Liver is an important and vital organ of the body. This organ is subjected to numerous systemic infections viral, bacterial and parasitic and lies at the distal end of the portal circulation⁽¹⁾. Liver abscesses are infectious, space-occupying lesions in the liver; the two most common abscesses being pyogenic and amoebic. Pyogenic Liver Abscess (PLA) is a rare but potentially lethal condition; its severity depends on the source of the infection and the underlying condition of the patient. Amebic Liver Abscesses (ALA) are common in tropical regions mainly where 'Entamoeba histolytica' is endemic and is more prevalent in individuals (mostly young males) with suppressed cell mediated immunity⁽²⁾.

Liver abscesses, both amoebic and pyogenic, continue to be an important cause of morbidity and mortality in tropical countries. The primary mode of treatment of amoebic liver abscess is medical; however, as many as 15% of amoebic abscesses may be refractory to medical therapy⁽³⁾.

Also, secondary bacterial infection may complicate 20% of amoebic liver abscesses⁽⁴⁾.

In such patients and in patients with pyogenic liver abscesses, surgical drainage has been the traditional mode of treatment⁽⁵⁾. However, operative drainage is associated with significant (10-47%) morbidity and mortality⁽⁶⁾. In recent years, imaging guided percutaneous drainage has been increasingly used to treat liver abscesses with reported success rates ranging from 70% to 100%⁽⁷⁾. Although percutaneous placement of an indwelling catheter is the method most widely preferred to drain liver abscesses, recent studies have shown therapeutic needle aspiration to be a simpler, less costly, and equally effective mode⁽⁸⁾.

Although mortality is improved, it is still high, making early diagnosis of HA exceedingly important to the clinical outcome. HA can be difficult to diagnose, and the symptomatology is variable. Often, objective findings are nonspecific, and therefore, diagnosis relies largely on imaging⁽⁹⁾. Percutaneous drainage is now considered the treatment of choice for most intra-

abdominal abscesses and fluid collections ⁽¹⁰⁾. Pyogenic liver abscesses respond well to percutaneous drainage ⁽¹¹⁾, given that certain essential technical and clinical details are emphasized to ensure successful therapy. These include differential diagnosis with the aid of cross-sectional imaging and awareness of the clinical-radiologic manifestations of pyogenic liver abscess; and proper catheter positioning to avoid contamination of the subphrenic, perihepatic, and pleural spaces.

However, some studies favour intermittent needle aspiration as equally effective and safe, but at the same time an easier, simpler, less aggressive, and cost-effective method ⁽¹²⁾.

MATERIALS AND METHODS

Search Strategy

We carried out a systematic review and meta-analysis of study enrolling patients undertaking either Percutaneous Needle Aspiration or Catheter Drainage for the treatment of hepatic abscesses from January 1980 to October 2017.

Data Sources

Literature searches of MEDLINE, EMBASE, SCOPUS, Current Contents, Cochrane Library, and Clinical trials gov. were performed.

Search terms

Terms used in combinations and together with the Boolean operators OR and AND.

Terms used were liver abscess, hepatic abscess, needles OR catheterization OR drainage, Needles, catheterization, drainage, Needle aspiration OR catheter drain*, (randomized controlled trial [pt] OR controlled clinical trial [pt] OR randomized [tiab] OR placebo [tiab] OR drug therapy [sh] OR randomly [tiab] OR trial [tiab] OR groups [tiab]) NOT (animals [mh] NOT humans [mh])

98 articles matched the stipulated criteria and were included in the current review.

**Authors independently reviewed titles and abstracts and then downloaded relevant studies. References were reviewed for additional studies.

Study Selection and Criteria

Search results were screened by scanning abstracts for the following

Inclusion criteria

- 1- Types of abscess: amoebic, pyogenic, mixed and indeterminate abscesses were included.
- 2- Randomized controlled trials (RCTs)
- 3- Outcomes of PNA and PCD in the management of liver abscesses must be compared.

Exclusion criteria

- 1- Articles published in languages other than English and Arabic
- 2- Non-RCTs
- 3- Not meeting study outcomes.

Data extraction

Two reviewers independently reviewed studies, abstracted data, and resolved disagreements by consensus. Studies were evaluated for quality. A review protocol was followed throughout.

STUDY OUTCOMES

- Mortality
- Treatment/resolution success rate (adequate drainage of the abscess to achieve the resolution of infection without the need for surgical drainage and with the subsequent discharge of the patient from hospital).
- Procedure-related complications.
- Hospital stay duration.
- Days to achieve clinical improvement.
- Days to achieve a 50% reduction in the size of the abscess cavity.
- Days to achieve total or near total resolution of the abscess cavity.

Complications such as pleural effusion/empyema, persistent bile drainage, catheter displacement, and sepsis, were also reported.

The present study was done according to the ethical board of King Abdulaziz university.

Statistical analysis

We performed statistical analyses using RevMan 5 ⁽¹³⁾. We analyzed dichotomous data using risk ratio (RR) and mean difference (MD)

We reported 95% confidence intervals (CI) for all estimates.

No continuous outcomes were included in this review. If included, we planned to analyze continuous data using the mean difference (MD) or the standardized mean difference (SMD) to combine trials that measure the same outcome but use different methods.

Incomplete outcome data (validation of possible attrition bias through withdrawals, dropouts, protocol deviations)

For each included study and for each outcome, we described the completeness of data including attrition and exclusions from the analysis. We noted whether attrition and exclusions were reported, the numbers included in the analysis at

each stage (compared with the total randomized participants), reasons for attrition or exclusion where reported, and whether missing data were balanced across groups or were related to outcomes. Where sufficient information was reported, or supplied by the trial authors, we re-included missing data in the analyses. We classified ascendingly the methods as follows:

- unclear risk.
- low risk (< 20% missing data);
- high risk (\geq 20% missing data)

Selective reporting bias

For each included study, we described how we investigated the possibility of selective outcome reporting bias and what we found. We assessed the methods as:

- low risk (where all of the study's pre-specified outcomes and all expected outcomes of interest to the review have been reported);
- high risk (where not all the study's pre-specified outcomes have been reported; one or more reported primary outcomes were not pre-specified; outcomes of interest are reported incompletely and so cannot be used; study fails to include results of a key outcome that would have been expected to have been reported);
- unclear risk.

Data synthesis

Where we judged meta-analysis to be appropriate, we carried out the analysis using RevMan 5⁽¹³⁾, supplied by The Cochrane Collaboration. We used the Mantel-Haenszel method for estimates of typical risk ratio and risk difference. No continuous outcomes were included in this review. We planned to analyze

continuous measures using the inverse variance method, if included.

We used the fixed-effect model for all meta-analyses.

RESULTS

The initial search was broad, accepting any article related to treating liver Abscess via PCD or PNA to ensure a comprehensive view of available work, and generated 98 articles. Preliminary application of study criteria identified 249 potential studies for inclusion that met one or more criteria. Further review of these investigations by two independent reviewers yielded 50 RCTs that fully met all inclusion criteria. No individual authors were contacted for information. No further review of methodological quality of the studies was conducted beyond that it appeared in a peer review journal and comprised an RCT.

The 50 eligible articles were again closely examined and data extracted using a standard protocol regarding target population, sample size, program provider, program content, intervention components, processes, and outcomes. Comparison among provider type was computation of differences between percent of successful program to number attempted. No further statistical analyses were employed.

Finally 6 studies were included and detailed as the focus for the present study.

We used Prisma guidelines⁽¹⁴⁾ in reporting the results (**Figure 1**).

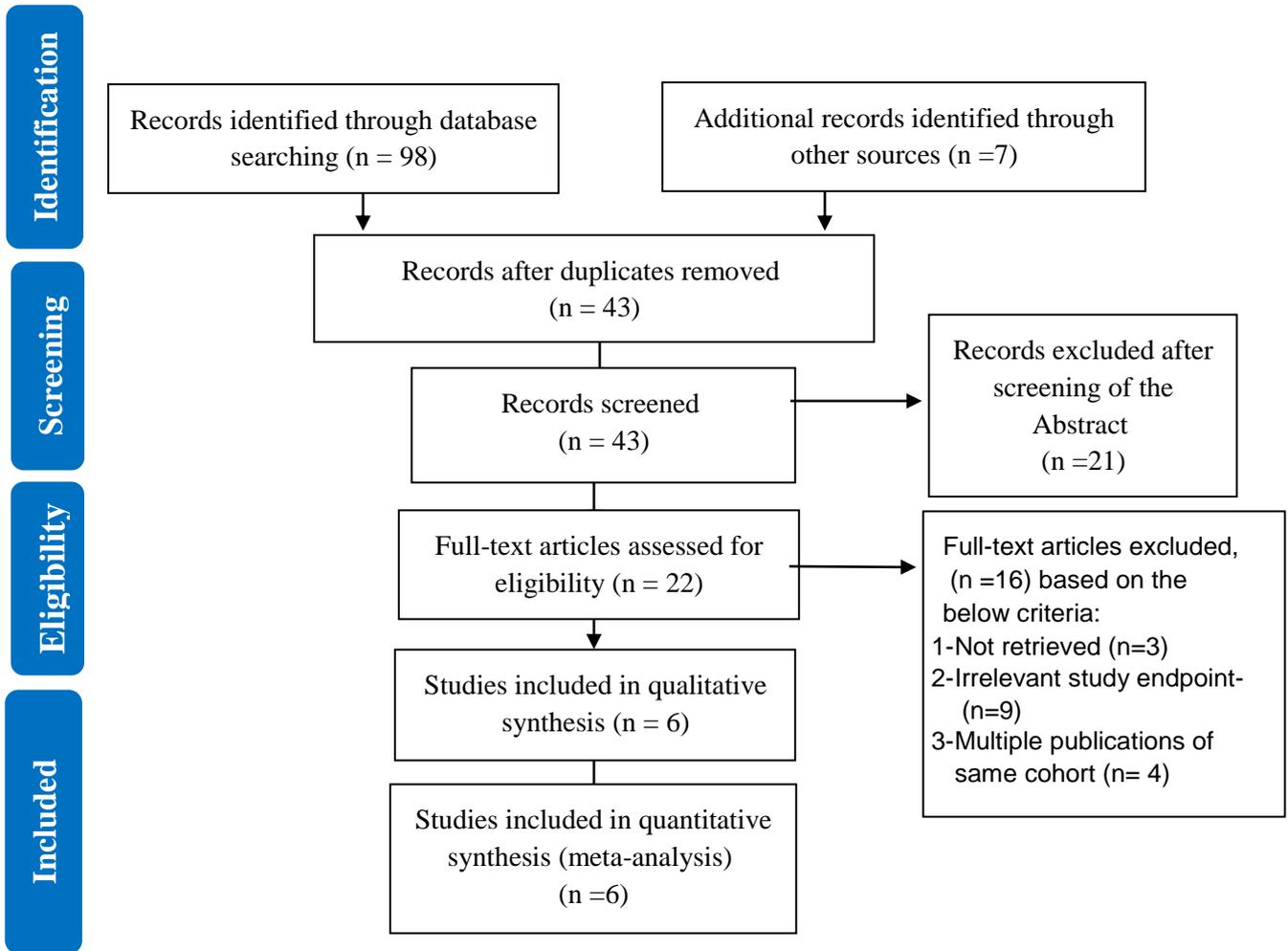


Figure 1: PRISMA flow diagram showing the selection criteria of assessed studies ⁽¹⁴⁾.

RESULTS

In the included six RCTs, the percutaneous treatment procedures were performed under continuous real-time sonographic guidance using freehand ultrasound. For PNA, a 16-G or 18-G trocar needle was advanced into the abscess cavity and the contents were aspirated in an attempt to completely evacuate the cavity. Aspiration was repeated if there was either no clinical improvement or no reduction in the size of the abscess cavity.

For PCD, an appropriately sized catheter (8-F to 14-F pigtail or drainage catheter) was introduced into the abscess cavity using the Seldinger technique or a single-step trocar technique.

Table 1: Baseline characteristics of the included studies

Publication (Authors, Year)	Total no of Participants	PNA Patients	PCD Patients	Abscess Type	Abscess Size	IV Antibiotic	Risk for bias
Dulku <i>et al.</i> 2015 ⁽¹⁵⁾	42	22	20	ALA and PLA	All sizes	Tazobactem +Pipercillin in combination with Metronidazole.	High
Singh <i>et al.</i> 2013 ⁽¹⁶⁾	60	30	30	ALA and PLA	All sizes	Cefazolin, gentamicin, metronidazole	High
Singh <i>et al.</i> 2009 ⁽¹⁷⁾	72	36	36	ALA and PLA	≥ 10 cm	Ceftriaxone, gentamicin, metronidazole	High
Zerem and Hadzic, 2007 ⁽¹⁸⁾	60	30	30	PLA only	All sizes	Cefazolin, gentamicin	High
Yu <i>et al.</i> 2004 ⁽¹⁹⁾	64	32	32	PLA only	All sizes	Ampicillin, cefuroxime, metronidazole	Low
Rajak <i>et al.</i> 1998 ⁽²⁰⁾	50	25	25	ALA and PLA	All sizes	Cloxacillin, gentamicin, metronidazole	High

OUTCOMES OF META-ANALYSIS

The meta-analysis showed that outcomes in patients treated with PCD were superior to those in patients treated with PNA in terms of success rate (RR: 0.79, 95% CI=0.64–0.97; P = 0.04), days to achieve a 50% reduction in abscess cavity size (SMD: -1.076, 95% CI 0.63–1.51; P < 0.00001) and overall clinical improvement (SMD: 0.71, 95% CI 0.35–1.09; P =0.0001). On the other hand, No significant difference was notable in the duration of hospitalization (SMD: -0.15, 95% CI -2.03 to 1.72, P = 0.84) or procedure-related complications (RR: 0.48, 95% CI 0.13–2.58; P = 0.39).

1. SUCCESS RATE

All of the six RCTs^(15,16,17,18,19,20) reported the success rate (Fig. 2a). Success rates were 77.8% (119 of 153 patients) and 96.1% (147 of 153 patients) in the PNA and PCD groups, respectively (P = 0.041). **Table 2**

Table 2: Meta-analysis outcome of the success rate results

Study (Authors, Year)	PNA		PCD		Weight	Risk ratio (RR)
	Events	Total	Events	Total		M-H, Random 95% CI
Dulku <i>et al.</i> 2015 ⁽¹⁵⁾	19	22	12	20	12%	0.58
Singh <i>et al.</i> 2013 ⁽¹⁶⁾	23	30	30	30	17%	0.76
Singh <i>et al.</i> 2009 ⁽¹⁷⁾	31	36	35	36	21%	0.87
Zerem and Hadzic, 2007 ⁽¹⁸⁾	20	30	30	30	17%	0.65
Yu <i>et al.</i> 2004 ⁽¹⁹⁾	30	32	27	32	18%	1.09
Rajak <i>et al.</i> 1998 ⁽²⁰⁾	15	25	25	25	14%	0.6

2. LENGTH OF HOSPITAL STAY

Five out of the six trials⁽¹⁵⁻¹⁹⁾ reported data on hospital stay, **Table 3**. The exception was Rajak *et al.*⁽²⁰⁾ who suggested no meaningful difference for the duration of hospitalization among patients successfully treated with either technique.

Table 3: Meta-analysis results of the hospital stay duration for the cases enrolled in the included studies

Publication (Authors, Year)	PNA			PCD			Weight	IV Random.95% CI clear
	Mean	SD	Total	Mean	SD	Total		
Dulku <i>et al.</i> 2015 ⁽¹⁵⁾	32.8	22.1	12	26.2	19.3	20	13%	2.74 (1.09, 3.45)
Singh <i>et al.</i> 2013 ⁽¹⁶⁾	10.5	5.2	30	11.3	3.7	30	23%	-0.80 (-3.1, 1.5)
Singh <i>et al.</i> 2009 ⁽¹⁷⁾	22.2	2	36	20.3	2.4	36	28%	1.90 (0.88, 2.92)
Zerem and Hadzic, 2007 ⁽¹⁸⁾	8,5	1.3	30	9	3.1	30	23%	-0.50 (-1.72, 0.78)
Yu <i>et al.</i> 2004 ⁽¹⁹⁾	10	10.2	32	15	9	32	25%	-4.00 (8.78, 0.78)

3. Analysis for Procedure-related complications, Clinical improvement and Days to achieve a 50% reduction in abscess cavity size were also analyzed as previously mentioned.

4. Days to achieve the total or near total resolution of the abscess cavity

Two of the included RCTs^(17,20) reported the time required to achieve the total or near total resolution of the abscess cavity. Singh S *et al.*⁽¹⁷⁾ found no significant difference between the two groups (PNA, 10.1 weeks; PCD, 10.9 weeks; $P = 0.454$). Similar observations were recorded by Rajak *et al.*⁽²⁰⁾ ($P > 0.05$), although the latter group did not give the specific data. Thus, only one study provided the mean \pm SD and thus these values were not calculated in this analysis.

5. Mortality

Yu *et al.*⁽¹⁹⁾ reported five deaths (four in the PCD group and one in the PNA group). All four of the patients who died in the PNA group had an underlying malignancy and the remaining patient in the PCD group had chronic obstructive pulmonary disease. While Singh O *et al.*⁽¹⁶⁾ reported one patient, in the PCD group, who suffered abscess rupture and died. No deaths were reported in the three remaining RCTs.

DISCUSSION

Hepatic abscess can be drained either with needle aspiration or by insertion of a pigtail catheter drain under US or CT guidance⁽²¹⁾. With percutaneous needle aspiration, a⁽²²⁾ Ga needle is inserted into the abscess cavity, and contents are aspirated until it is evacuated completely⁽²³⁾. Similarly, during percutaneous catheter drainage, 8-14 F pigtail catheter is inserted into the lesion and left in place. It is then drained by gravity until empty⁽²³⁾. Several studies have found percutaneous catheter drainage to be more effective than percutaneous needle aspiration, as it has higher success rates⁽²³⁾.

Generally, Percutaneous, either needle aspiration or catheter drainage has become more popular given the minimal invasiveness property of both procedures compared to surgical intervention in the management of liver abscess. Previous investigations have shown that the combination of parenteral antibiotics and image-guided percutaneous treatment is also successful⁽²⁴⁾.

The main objective of the present study was to determine which approach is superior concluded after the systematic review and meta-analysis for the carefully selected -six- studies included.

Here we discuss briefly the conclusion and recommendation of the included studies:

Yu *et al.*⁽¹⁹⁾ recommend PNA as a first-line approach because the procedure is simple, facilitates patient comfort, and is of low cost. Rajak *et al.*⁽²⁰⁾ conclude that PCD is more effective than PNA. Zerem and Hadzic⁽¹⁸⁾ recommend PNA only in patients with liver abscess cavities of < 5 cm in diameter. Singh S *et al.*⁽¹⁶⁾ and O *et al.*⁽¹⁷⁾ hold the view that PCD represents a better treatment option than PNA for large liver abscesses (≥ 10 cm in diameter). Therefore, in the setting of diametric conclusions meta-analytical techniques may provide evidence as to which treatment option is superior.

Regarding the effectiveness of treatment, the current meta-analysis showed a higher rate of success in the PCD group. This may be a convincing argument in support of the PCD method. Two reasons were identified to explain the lower rate of success in the PNA group. The first concerns the number of aspiration attempts. In the study by Rajak *et al.*⁽²⁰⁾, which reported the lowest success rate (PNA: 60%) of the five RCTs, aspiration attempts were restricted to two. However, Yu *et al.*⁽¹⁹⁾ did not limit the number of attempts made and achieved the highest rate of

success (PNA: 97%). The remaining four trials⁽¹⁵⁻¹⁸⁾ limited attempts to three and reported success rates of 67–86%. In addition, PCD was associated with the highest success rates (97.2–100%) except in the study by Yu *et al.*⁽¹⁹⁾ (84.7%), in which the deaths of four (12.5%) patients with underlying malignancies decreased the success rate.

Thus, even with repeat aspirations, the success rate of PNA remains inferior to that achieved with PCD. Furthermore, a recent retrospective study revealed that decrease in success rates are associated with subsequent aspiration attempts⁽²⁵⁾. This finding confirms the conclusions of four of the RCTs⁽¹⁵⁻¹⁸⁾.

Another reason for the low rate of success achieved by PNA relates to the size of the liver cavity or the volume of the abscess. In smaller abscesses, the amount of pus produced per day may be small and can be completely evacuated by PNA. However, a larger abscess cavity produces a larger quantity of pus, which needs to be drained continuously and is not suitable for PNA. In the study by Zerem and Hadzic⁽¹⁸⁾, the mean \pm SD of the longest diameter of the abscess cavity in the PNA group was significantly greater in patients in whom PNA was unsuccessful (97 ± 42 mm) than in patients in which it was successful (62 ± 35 mm). Rajak *et al.*⁽²⁰⁾ also reported a larger mean volume of abscesses (425 ml) in patients in whom PNA failed in comparison with that in patients in whom it was successful (178 ml) ($P < 0.05$). Baek *et al.*⁽²⁶⁾ and Giorgio *et al.*⁽²⁷⁾ initially reported a much lower incidence of complications with PNA than with PCD as one of the major advantages of PNA over PCD. These results are inconsistent with findings in the current analysis, which indicated no significant difference between PNA and PCD. Major procedure-related complications were rare in either group. Recent studies report a low incidence of minor complications⁽²⁵⁾.

Furthermore, advantages of PCD overweighs PNA since it requires less time to achieve clinical improvement and a 50% reduction in the cavity size, as the current meta-analysis shows. Percutaneous catheter drainage has the obvious advantage of providing continuous catheterization by the placement of an indwelling drainage catheter. Because of this, pus can be evacuated more frequently and the abscess cavity shows a faster rate of collapse during the initial period in patients treated with PCD. However, the extent of this evidence is

insufficient because only two RCTs report these data. Moreover, IV antibiotics may play an important role in these outcomes. Unfortunately, the antibiotics used differed among all six RCTs⁽¹⁵⁻²⁰⁾.

CONCLUSION

Our results showed that despite the fact that PNA and PCD can both be a safe option for draining liver abscesses, nevertheless, PCD has higher success rates as well as 50% faster in reduction in abscess cavity size. Moreover, PCD is a better modality as compared to percutaneous needle aspiration particularly in larger thick abscesses.

REFERENCES

1. **Branum G, Tyson GS, Branum MA and Meyers WC (1992):** Hepatic abscess: changes in etiology, diagnosis and management. *Ann Surg.*, 212:655-62.
2. **Sharma MP, Ahuja V(2001):** Management of amoebic and pyogenic liver abscess. *Indian J Gastroenterol.*,20(1):C33-6.
3. **Thompson JE, Jr, Forlenza S and Verma R(1985):** Amebic liver abscess: a therapeutic approach. *Rev Infect Dis.*,7:171–179.
4. **Sherlock S, Dooley J(1993):** Diseases of the liver and biliary system; pp. 471–502.
5. **Theron P(1947):** Surgical aspects of amoebiasis. *Br Med J.*, 2:123–126.
6. **Satiani B, Davidson ED(1978):** Hepatic abscesses: improvement in mortality with early diagnosis and treatment. *Am J Surg.*, 135:647–650.
7. **Seeto RK, Rockey DC(1996):** Pyogenic liver abscess. Changes in etiology, management, and outcome. *Medicine (Baltimore)*, 75:99–113.
8. **Giorgio A, Tarantino L, Mariniello N et al.(1995):** Pyogenic liver abscesses: 13 years of experience in percutaneous needle aspiration with US guidance. *Radiology*,195:122–124.
9. **Pang TC, Fung T, Samra J, Hugh TJ, Smith RC(2011):** Pyogenic liver abscess: An audit of 10 years' experience. *World J Gastroenterol.*,17:1622–1630. doi: 10.3748/wjg.v17.i12.1622
10. **Mueller PR, vanSonnenberg E, Ferrucci JT (1984):** Percutaneous drainage of abdominal abscesses and fluid collections in 250 cases. Part II: Current procedural concepts. *Radiology* .,151 :343-347
11. **Martin EC, Karison KB, Fankuchen E, Cooperman AA, Casarella WJ(1981):** Percutaneous drainage in the management of hepatic abscesses. *Surg Clin North Am.*, 61 :157-167
12. **Thomas J, Turner SR, Nelson RC, Paulson EK(2006):** Postprocedure sepsis in imaging-guided percutaneous hepatic abscess drainage: how often does it occur? *A J R Am J Roentgenol.*,186(5): 1419-22.

13. community.cochrane.org/tools/review-production-tools/revman-5/about-revman-5.
14. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009): Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 6(7): e1000097. doi:10.1371/journal.pmed1000097.
15. Dulku G, Mohan G, Samuelson S, Ferguson J, Tibballs J(2015): Percutaneous aspiration versus catheter drainage of liver abscess: A retrospective review. *The Australasian medical journal*,8(1):7.
16. Singh S, Chaudhary P, Saxena N, Khandelwal S, Poddar DD, Biswal UC(2013): Treatment of liver abscess: prospective randomized comparison of catheter drainage and needle aspiration. *Ann Gastroenterol.* ,26:332–339.
17. Singh O, Gupta S, Moses S, Jain DK(2009): Comparative study of catheter drainage and needle aspiration in management of large liver abscesses. *Indian J Gastroenterol.*, 28:88–92.
18. Zerem E, Hadzic A(2007): Sonographically guided percutaneous catheter drainage versus needle aspiration in the management of pyogenic liver abscess. *AJR Am J Roentgenol.*, 189:W138–W142.
19. Yu SC, Ho SS, Lau WY, Yeung DT, Yuen EH, Lee PS *et al.*(2004): Treatment of pyogenic liver abscess: prospective randomized comparison of catheter drainage and needle aspiration. *Hepatology*,39:932–938.
20. Rajak CL, Gupta S, Jain S, Chawla Y, Gulati M, Suri S(1998): Percutaneous treatment of liver abscesses: needle aspiration versus catheter drainage. *AJR Am J Roentgenol.*, 170:1035–1039.
21. Lardiè-re-Deguelte S, Ragot E, Armoun K, Piardi T, Dokmak S, Bruno O *et al.*(2015): Hepatic abscess: diagnosis and management. *J Visc Surg.*, 152:231–243.
22. Jeong SW, Jang JY, Lee TH, Kim HG, Hong SW, Park SH *et al.*(2012): Cryptogenic pyogenic liver abscess as the herald of colon cancer. *J Gastroenterol Hepatol.*, 27:248–255.
23. Cai YL, Xiong XZ, Lu J, Cheng Y, Yang C, Lin YX *et al.*(2015): Percutaneous needle aspiration versus catheter drainage in the management of liver abscess: a systematic review. *HPB (Oxford)* ,17:195–201.
24. Mohan S, Talwar N, Chaudhary A, Andley M, Ravi B, Kumar A(2006): Liver abscess: a clinicopathological analysis of 82 cases. *Int Surg.*, 91:228–233.
25. Abusedera MA, Ashraf ME(2014): Percutaneous treatment of large pyogenic liver abscess. *Egypt J Radiol Nucl Med.*, 45:109–115.
26. Baek SY, Lee MG, Cho KS, Lee SC, Sung KB, Auh YH(1993): Therapeutic percutaneous aspiration of hepatic abscesses: effectiveness in 25 patients. *AJR Am J Roentgenol.*, 160:799–802.
27. Giorgio A, Tarantino L, Mariniello N, Francica G, Scala E, Amoroso P *et al.*(1995): Pyogenic liver abscesses: 13 years of experience in percutaneous needle aspiration with US guidance. *Radiology*,195:122–124.