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The Comparison of Colon Anastomosis Patency of Hand-Sewn Technique with Application of 2-Octyl-Cyanoacrylate Tissue Adhesive in Wistar Rats

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ABSTRACT

Background: Intestinal anastomosis is often performed, especially in cases of infection or trauma. Generally, intestinal anastomosis can be performed using the hand-sewn technique or primary suture using absorbable or non-absorbable sutures. However, there is also another technique that uses 2-octyl-cyanoacrylate tissue adhesive to bind the two edges of the wound together and allow normal healing to occur. Both techniques have their advantages and disadvantages. ***Objective:*** This study aims to analyze the effectiveness of hand-sewn suturing techniques and the application of 2-octyl-cyanoacrylate tissue adhesive in Wistar rats. ***Methods:*** This study is an experimental analytical study with a randomized post-test only group design. This study involved 20 samples, each divided into 2 groups of 10 samples (50%). On day 0, colon anastomosis in both groups will be assessed using a syringe test to determine anastomotic patency. Observations will be made from day 0 to day 5 after anastomosis. In experimental animals that died before day 5, re-laparotomy was performed and anastomosis patency was examined using the syringe test. If the experimental animals survived until day 5, re-laparotomy was performed and anastomosis patency was re-examined using the syringe test on day 5. ***Results:*** The RR analysis showed a figure of 0.643 with a 95% confidence interval from 0.101 to 4.097, and a p-value of 0.64, indicating no statistically significant difference between the two groups. ***Conclusion:*** There was no significant difference in anastomotic patency risk between the hand-sewn suture group and the group using 2-octyl cyanoacrylate tissue adhesive in Wistar rats.

Keywords: intestinal anastomosis; anastomosis patency; hand-sewn suturing; 2-octyl cyanoacrylate adhesive tissue

INTRODUCTION

Intestinal anastomosis is a common procedure in general surgery, both elective and emergency. The anastomosis technique chosen depends on the location of the anastomosis, the caliber of the intestine, and the quality and underlying disease process. However, one important factor in the decision to perform a particular anastomosis remains the individual surgeon's experience and personal preference (Chen et al, 2012).

Generally, intestinal anastomosis can be performed using the hand-sewn technique or primary suture using absorbable or non-absorbable suture thread. The suturing technique can use the simple interrupted suture or simple continuous suture method (Hébert et al, 2019). Dermabond®, a brand of tissue adhesive containing 2-octyl-cyanoacrylate tissue adhesive, is marketed as a substitute for 5-0 or smaller diameter sutures. The use of adhesives versus sutures depends on the physician's decision based on their skills and experience (Bhende et al, 2002). The use of 2-octyl-cyanoacrylate tissue adhesive is intended to bind the two edges of the wound together and allow normal healing to occur. 2-octyl-cyanoacrylate tissue adhesive is also believed to have antimicrobial properties (Miller & Swank, 2010).

The use of anastomosis with hand-sewn suturing techniques is known to cause microtrauma to the tissue and sometimes cause hematoma in the anastomosis area, which can also lead to bacterial contamination in that area. The speed and strength of anastomosis using hand-sewn suturing techniques also depend on the technique of each surgeon.

Tight and dense sutures can cause local ischemia, necrosis, and dehiscence. The advantages of using tissue adhesive over hand-sewn suturing techniques include reducing the risk of microtrauma and allowing for faster work, which can reduce the duration of surgery. This is influential in surgeries that require a fast work duration (Paral et al, 2011).

METHODS

This study is an experimental analytical study with a randomized post-test only group design. Wistar rats were used as test animals and underwent colon anastomosis laparotomy. The test animals were divided into two groups: one group underwent colon anastomosis using hand-sewn sutures, and the other group underwent colon anastomosis using 2-octyl-cyanoacrylate tissue adhesive. Observations will be made from day 0 to day 5 after anastomosis. In experimental animals that died before day 5, re-laparotomy was performed and anastomosis patency was examined using the syringe test. If the experimental animals survived until day 5, re-laparotomy was performed and anastomosis patency was re-examined using the syringe test on day 5. The research began in January 2024 and will continue until June 2024. It is being conducted at the Integrated Biomedical Laboratory of the Faculty of Medicine, Udayana University.

The inclusion criteria in this study are Adult male Wistar rats, aged 2-3 months with a body weight of 150-250 grams. The exclusion criteria in this study are Wistar rats that were sick or died before the intervention was performed. Data analysis was performed using SPSS for Windows version 26 software. The statistical analysis included univariate analysis, bivariate analysis

RESULTS

Demographic Characteristics

This study involved two types of colon anastomosis, using hand-sewn suturing and 2-octyl cyanoacrylate tissue adhesive, each used on 10 samples (50%). In terms of anastomosis patency, 12 cases (60%) showed good results, while 8 cases (40%) experienced leakage. The body weight of Wistar rats varied with an average of 191.5 grams (range 156 to 230 grams), while the average duration of surgery was 17.45 minutes (range 10 to 30 minutes). Of the entire sample, 4 rats (20%) survived until the fifth day, while the other 16 rats (80%) died before the fifth day.

TABLE 1: Demographic data of Wistar rats.

Variable Name	n	%	Mean	(minimum - maximum)
Type of colon anastomosis				
Hand-sewn	10	50		
2-octyl cyanoacrylate tissue adhesive	10	50		
Anastomosis patency				
Good	13	65		
Leak	7	35		
Body weight			191.5	(156 – 230)
Duration of surgery			17.45	(10 – 30)
Clinical				
Alive on the fifth day	4	20		
Dead before the fifth day	16	80		
Bleeding during surgery	1	5		

Comparison of Colon Anastomosis Patency

Based on statistical analysis, researchers found that there was no significant difference in anastomosis patency between the two groups. RR analysis showed a figure of 0.643 with a 95% confidence interval from 0.101 to 4.097, and a p-value of 0.64, indicating statistical insignificance between the two groups.

TABLE 2: Comparison of colonic anastomosis patency between hand-sewn suturing and 2-octyl-cyanoacrylate tissue adhesive application in Wistar rats.

Variable	Anastomotic Patency		RR	95% IK	P value
Group	**Paten**	**Leakage**			
Hand-sewn suturing	6	4	0.643	0.101 – 4.097	0.64
2-octyl cyanoacrylate tissue adhesive	6	4			

Of the total 10 Wistar rats that underwent anastomosis using 2-octyl cyanoacrylate tissue adhesive, two rats died on the first day, one rat died on the second day, four rats died on the third day, and three rats survived until the fifth day. Meanwhile, of the total 10 Wistar rats that underwent anastomosis using hand-sewn sutures, three rats died on the first day, three rats died on the second day, three rats died on the third day, and one rat survived until the fifth day. The RR for this outcome was 0.259, with a 95% confidence interval from 0.022 to 3.063, and a p-value of 0.284.

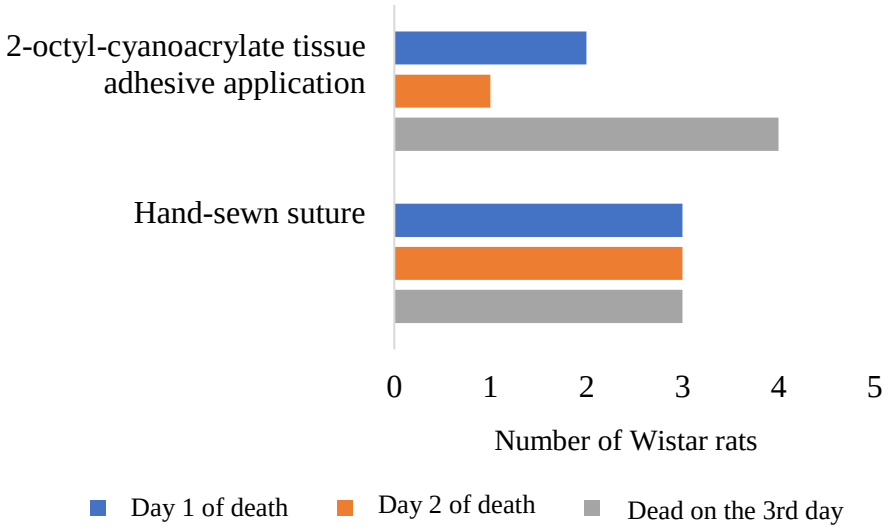

FIGURE 1: Mortality rate of Wistar rats during the study period.

TABLE 3: Comparison of Wistar rat output up to the fifth day between the hand-sewn suturing technique and the application of 2-octyl-cyanoacrylate tissue adhesive in Wistar rats.

Variable	Outcome		RR	95% IK	P value
Group	**Alive**	**Dead**			
Hand-sewn sutures	1	9	0.259	0.022 – 3.063	0.284
2-octyl cyanoacrylate tissue adhesive	3	7			

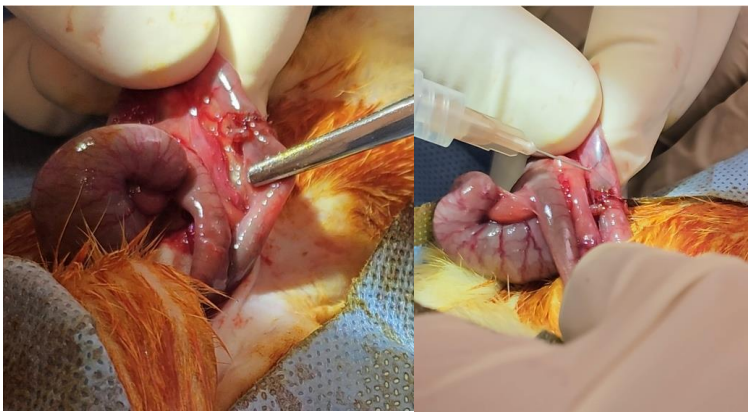

FIGURE 2: Colon anastomosis using the hand-sewn suturing technique and syringe test performed on day 0 (during surgery).

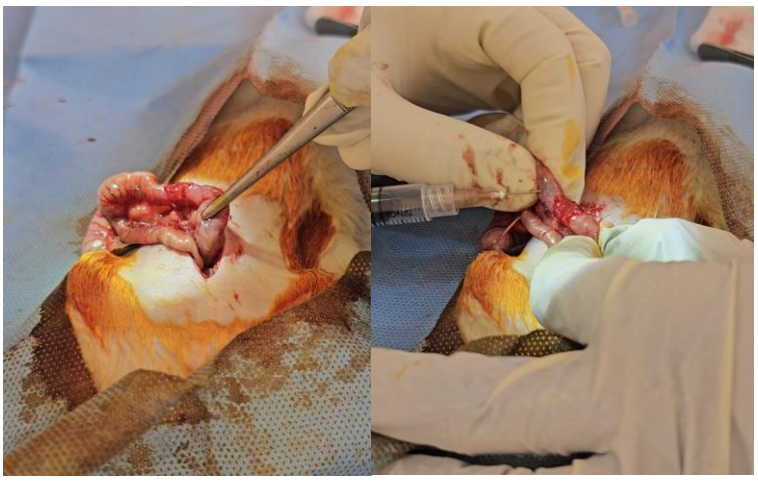

FIGURE 3: Colon anastomosis using 2-octyl-cyanoacrylate tissue adhesive and syringe test performed on day 0 (during surgery).

In the univariate analysis of anastomotic patency, good results were used as a reference, while leaky results showed an RR of 0.643 with a 95% CI between 0.101 and 4.097 and a p-value of 0.64. For clinical conditions, Wistar rats that survived until the fifth day were used as a reference, while rats that died before the fifth day showed an RR of 0.259 with a 95% CI between 0.022 and 3.063 and a p-value of 0.284. Bleeding during surgery had an RR of 0.474 with a 95% CI between 0.295 and 0.761 and a p-value of 0.305. No results for multivariate analysis were shown in this data.

TABLE 4: Results of univariate and multivariate tests of each research variable on the hand-sewn suturing technique with the application of 2-octyl-cyanoacrylate tissue adhesive in Wistar rats.

Variable Name	Univariate		Multivariate	
	RR (95% IK)	*p-value*	RR (95% IK)	*p-value*
Anastomotic patency				
Good	1	ref	-	
Leakage	0.643 (0.101 – 4.097)	0.64	-	
Clinical				
Alive until the fifth day	1	ref	-	
Dead before the fifth day	0.259 (0.022 – 3.063)	0.284	-	
Bleeding during surgery	0.474 (0.295 – 0.761)	0.305	-	

DISCUSSION

In this study, researchers found that there was no significant difference in the risk of anastomotic leakage between the group that used the hand-sewn suturing method and the group that used 2-octyl cyanoacrylate tissue adhesive (RR 0.643 [95% CI 0.101–4.097]; p-value = 0.64). Although there were incidents of leakage in both groups, statistical analysis using RR showed no significant difference between the two. For example, in a study conducted by Kanellos in 2002 evaluating colonic anastomosis in rats, they found that the anastomotic dehiscence rate was similar between groups (20%), and although adhesion formation was more extensive in the glue group, this difference was not statistically significant (p=0.074) (Kanellos et al., 2002). They concluded that 2-octyl cyanoacrylate tissue adhesive can provide effective sutureless anastomoses in experimental settings, suggesting healing outcomes comparable to traditional suturing methods. Kang et al. (2023) described that cyanoacrylate-based tissue adhesives, including 2-octyl cyanoacrylate tissue adhesive, can reduce anastomotic leakage by rapidly sealing the anastomotic site through polymerization (Kang et al., 2023).

Hand-sewn suturing techniques have long been the standard in surgical procedures due to their proven safety and effectiveness. This procedure utilizes the surgeon's skill in suturing blood vessels with thread, which provides solid mechanical strength to the anastomosis (Okafor et al., 2023; Varela et al., 2022). However, the drawbacks of this technique include longer operating times and the risk of complications such as bleeding or infection, depending on the skill and experience of the operator.

On the other hand, the use of 2-octyl cyanoacrylate tissue adhesive as an alternative to tissue adhesives offers speed and practicality in anastomosis procedures. (Soares Júnior & Souza, 2010) This adhesive can be applied quickly without the need for manual suturing, significantly reducing operating time. In line with this study, which found that the average duration of hand-sewn surgery was longer (average of 20 minutes [ranging from 17 to 30 minutes]) compared to the duration of 2-octyl cyanoacrylate surgery (average of 12.5 minutes [ranging from 10 to 15 minutes]). This is particularly advantageous in emergency medical situations or when surgery must be completed quickly. However, the long-term safety and effectiveness of 2-octyl cyanoacrylate are still under evaluation due to potential risks related to inflammatory reactions or insufficient mechanical strength for anastomosis in large blood vessels or with high blood pressure (García Cerdá et al., 2015).

The findings of this study show that the average body weight of Wistar rats in the hand-sewn group was 184 grams, ranging from 156 grams to 230 grams. Patients with higher body weights tend to have thicker layers of fat around the intestines, affecting the surgeon's ability to handle the suturing process on the intestinal wall, which may require additional skills (Yu et al., 2023). In addition, high body weight can increase the risk of complications such as bleeding or post-operative infection, especially in surgical wound closure techniques that require extra precision. The use of 2-octyl cyanoacrylate, although offering ease of application and shorter operating times, may be less effective in dealing with the pressure from additional fat in obese patients, requiring further evaluation of the strength and long-term success of the anastomosis (Yu et al., 2023). These considerations emphasize the need to adapt surgical techniques to maximize optimal surgical outcomes.

Factors such as age, body mass index, and postoperative complications such as anastomotic leakage have been identified as risk factors that affect overall survival in patients undergoing colon surgery. Current theory suggests that the difference in outcomes between 2-octyl cyanoacrylate adhesive tissue and hand-sewing techniques for colon anastomosis stems from different healing mechanisms, inflammatory responses, mechanical

stability, and risks of postoperative complications (Irkorucu et al., 2009; Nursal et al., 2004). Hand-sewing techniques provide immediate mechanical stability but trigger a strong inflammatory response, which may lead to increased scar tissue, infection, and adhesion formation. In contrast, 2-octyl cyanoacrylate tissue adhesives rapidly polymerize to seal the anastomosis site, aiming to reduce inflammation and provide faster and less invasive closure, although they may not provide the same mechanical stability as sutures (Irkorucu et al., 2009).

While 2-octyl cyanoacrylate adhesive tissue can reduce the risk of infection and adhesion, they can pose a higher risk of anastomotic leakage if the adhesive bond is not strong enough. In this study, the results between the hand-sutured group and the 2-octyl cyanoacrylate adhesive tissue group showed a significant difference in mortality rates among Wistar rats. Specifically, only one rat survived in the hand-sutured group, with nine deaths, while in the 2-octyl cyanoacrylate adhesive tissue group, three rats survived and seven died. The calculated mortality risk ratio was 0.259 (95% CI: 0.022–3.063; p = 0.284), indicating a trend toward reduced mortality with the adhesive method, although this difference was not statistically significant. Notably, the highest number of deaths in both groups occurred on the third day postoperatively, with four deaths in the group that received the anastomosis method using 2-octyl cyanoacrylate adhesive tissue and three deaths in the hand-sutured group, indicating a critical phase in postoperative recovery that may require further investigation into the underlying mechanisms affecting survival outcomes in colon anastomosis procedures.

Some limitations of this study include: a small sample size involving only 20 Wistar rats, which may limit the statistical power and external validity of the results obtained; considerable variation in rat body weight (average 191.5 grams with a range of 156 to 230 grams) which may affect sample homogeneity and research results; a wide range of operation durations (10 to 30 minutes) which may introduce variability that affects anastomosis results; a high mortality rate (80%) among rats, indicating that this model may not fully reflect clinical outcomes in humans; no significant difference in anastomosis patency risk between the two groups, and some statistical analyses showed wide confidence intervals and non-significant p-values, which may reduce the validity of these findings; the lack of multivariate analysis limits understanding of other factors that may influence anastomosis patency outcomes and mortality rates.

CONCLUSIONS

There was no significant difference in anastomosis patency risk between the hand-sewn suture group and the group using 2-octyl cyanoacrylate tissue adhesive in Wistar rats.

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