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Bronchial Artery Embolization: IS NBCA/LIPIODOL Better Than PVA?

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ABSTRACT

Introduction:

Bronchial artery embolization (BAE) is a minimally invasive interventional procedure, which is now considered the first-line management strategy and an alternative to surgery for massive and recurrent haemoptysis. The advances in embolic agents have led to a significant improvement in the success rates of the procedure, however, there has been no significant change in the recurrence rate of haemoptysis.

Methods:

This retrospective study was conducted at a tertiary care center from January 2012 to December 2020. The final analysis was performed on 123 patients [NBCA(n= 37) and PVA(n= 86)]. Technical and clinical success rates, complications and recurrence rates were compared between the two groups.

Results:

A total of 248 arteries were embolized. In the PVA group, clinical success was achieved in 84 out of 86 cases (97.6%) and with NBCA in 36 out of 37 patients (97.3%) ($p > 0.05$). Of the 120 patients in whom BAE was clinically successful, recurrence was observed in 43 patients within the 12-month follow-up period. The study showed a statistically significant association between the embolizing agent used for BAE and the recurrence of hemoptysis ($\chi 2 = 4.80$, $df = 1$, $p = 0.028$). The use of PVA particles for BAE was found to have 2.62 times higher odds (95% CI 1.10 - 6.81) of recurrence of hemoptysis as compared to the use of NBCA glue.

Conclusions:

BAE with NBCA provided higher hemoptysis-free survival rates compared with PVA particles without increasing complication rates.

Keywords: *Bronchial Arteries; Embolism; Hemoptysis; Survival Rate*

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INTRODUCTION

Bronchial artery embolization (BAE) is a minimally invasive interventional procedure, which is now considered the first-line management strategy and an alternative to surgery for massive and recurrent haemoptysis.[1,2] Since its initial descriptions, it has evolved in multiple aspects including its technique, indications as well and efficacy.[1]

The advances in embolic agents have led to a significant improvement in the success rates of the procedure, however, there has been no significant change in the recurrence rate of haemoptysis.[3]

In addition, no consensus has been reached on the best embolic agent for BAE. Polyvinyl-alcohol (PVA) and absorbable gelatin-sponge particles are the most common agents as they are easy to handle, cheap and readily available. Recently, n-butyl- 2-cyanoacrylate (NBCA) has also been shownto control bleeding from various organs. It offers certain advantages including complete and rapid occlusion of the vessels and hence, a more reliable embolization. Despite these advantages, its use has been avoided in haemoptysis control due to the concern that it may cause complications like reflux and non-target embolization(7).[1,3,4,5,6,7]

Although a few recent studies have shown that NBCA can be used successfully for BAE without major complications, most of these studies were limited by a short follow-up period and no comparison group was chosen to compare the results of the NBCA group.[3,7,8,9]

Therefore, our study aimed to retrospectively compare the effectiveness and safety of NBCA versus PVA particles for control of haemoptysis and to determine if the recurrence of hemoptysis is related to the embolizing agent used.

METHODS

This study was a retrospective study conducted at a multispecialty tertiary care centre. Institutional review board approval was waived off as it was a retrospective study. The available medical records of all the patients (age>18 years) who had undergone bronchial artery embolization for hemoptysis from January 2012 to December 2020 were reviewed. Hemoptysis was graded as mild (less than 100 mL of blood expectorated per day), moderate (100-300 mL/day) and massive (more than 300 mL/day or any amount of expectorated blood that led to hemodynamic disturbance).[10]

The exclusion criteria were as follows: patients with hemoptysis due to iatrogenic causes, prior history of bronchial artery embolization, use of neither of the two embolizing agents or both PVA and NBCAin the same patient and non-availability of follow- up data. According to our institutional protocol, CT angiography of the thorax was performed inall patients presenting with haemoptysis, before bronchial artery embolization.

Bronchial artery embolization was performed using Philips Allura Xper FD20. The right common femoral artery was accessed by retrograde puncture using the Seldinger technique. Bronchial artery embolization of the included patients was carried out with one of the two embolizing agents- NBCA or PVA. In the NBCA group, approximately 0.2 ml of NBCA (Endocryl, Samarth Life Sciences)was withdrawn from a 0.5 ml ampoule and mixed with lipiodol (Lipiodol Ultra Fluid, Guerbet) in the ratio of 15-30% in a 2-ml syringe and 0.3-1 ml of this mixture was injected depending on the calibre of the abnormal vessel and visualization of the glue-cast. Immediately before glue injection, the microcatheter was flushed with 5% dextrose (D5W). In the PVA group, the PVA particles 300-500 microns or 500-700 microns (Contour PVA Embolization Particles; Boston Scientific), from the vial were emptied into a sterile container and 10-15 ml of 100% non-ionic contrast was added till desired consistency was achieved. This mixture was filled in a 2-ml syringe and was injected into the abnormal vessel under fluoroscopy till complete stasis was seen.

Technical success was defined as the successful embolization of both bronchial as well as non-bronchial systemic collaterals. Clinical success was defined as the complete absence of haemoptysis within 24 hours of the procedure. Post embolization, the patients were followed up in the OPD for 1 year. If haemoptysis recurred, subsequent management was planned (repeat embolization, emergency bronchoscopy or surgery) as determined by the

multi-disciplinary team. However, these cases were not included in the study

Data collection and analysis were done by standard technique.

RESULTS

A total of 273 patients underwent bronchial artery embolization in the study center during the study period. Among these patients, 150 patients were excluded based on the above-mentioned exclusion criteria. Thus, the analysis was performed on 123 patients(follow-up data available), out of which NBCA was used in 37 patients and PVA was used in 86 patients.

The mean (± SD) age of the study participants was 45.34 years (±15.34). Most of them (93, 75.61%) were males. Active tuberculosis was the most common cause of hemoptysis (55, 45.08%). Most of the study patients (70, 57.85%) had massive hemoptysis on presentation. On average, the study patients had a hemoptysis duration of 12.6 (SD ± 30.8) days at the time of presentation. The right lung was more frequently involved (67, 54.92%) and most of the patients had only one lobe involvement (92, 75.41%).

A total of 248 arteries were embolized: 157 bronchial arteries (81 right, 76 left) and 91 non-bronchial systemic arteries. There was no significant difference in the number of bronchial arteries and non-bronchial systemic collaterals embolized in the 2 groups.

The right bronchial arteries alone were embolized in 56 cases (45.9%), the left bronchial arteries alonein 31 cases (25.4%) and both in 36 cases (28.7%). These characteristics did not differ significantly among the two groups (Table 1).

In both groups, technical success was achieved in all the patients. In the PVA group, clinical success was achieved in 84 out of 86 cases (97.6%), whereas, it was achieved with NBCA in 36 out of 37 patients (97.3%) (p >0.05)

Thus, haemoptysis could not be controlled in atotal of 3 patients (2 in the PVA group and 1 in the NBCA group) (p>0.05). Among these, 2 patients underwent surgery for the underlying cause and 1 patient died due to uncontrolled haemoptysis. No other major complications were observed. Minor complications were observed in 34out of 123 patients (27.6%), which included chest pain in 15 (12.2%) patients[10 in PVA group (11.6%) and 5 in NBCA group(13.5%], nausea and vomiting in 14(11.4%) patients [10 in PVA group (11.6%) and 4 in NBCA group (10.8%)] and fever in 10(8.1%) patients [7 in PVA group (8.1%) and 3 in NBCA group (8.1%)]. The complication rate did not show statistical significance when comparing the 2 groups(p>0.05). All of these complications were managed conservatively. In patients who developed fever, blood cultures were negative and fever subsided with antipyretics and a courseof empirical antibiotics. There was no procedure- related mortality.

Table 1: Characteristics of study patients

Characteristics	NBCA n = 37	PVA n = 86	Total		p-value
			N	%	
Age (Mean ± SD)	45.89 ± 14.13	45.1 ± 15.9	45.34 ± 15.34		0.786
Sex					
Male	28	65	93	75.61%	1
Female	9	21	30	24.39%	
Hemoptysis cause					
Active TB	17	38	55	45.08%	0.561
Pneumonia	8	16	24	19.67%	
Unknown etiology	3	13	16	13.11%	
Bronchiectasis	2	10	12	9.84%	

Aspergilloma	4	3	7	5.74%	
Post TB sequelae	1	3	4	3.28%	
Others	1	3	4	3.28%	
Hemoptysis severity					
Massive	19	51	70	57.85%	0.485
Moderate	14	31	45	37.19%	
Mild	3	3	6	4.96%	
Hemoptysis duration (Mean ± SD)	8.91 ± 20.40	14.26 ± 34.34	12.6 ± 30.80		0.600
The extent of lung involvement					
One lobe	24	68	92	75.41%	0.222
Two lobes	12	18	30	24.59%	
The site of the lung involved					
Right lung	22	45	67	54.92%	0.774
Left lung	9	26	35	28.69%	
Both lungs	5	14	19	15.57%	
Embolized artery					
Right bronchial artery	18	38	56	45.90%	0.326
Bilateral bronchial artery	7	28	36	28.69%	
Left bronchial artery	11	20	31	25.41%	
*NBCA n-Butyl Cyano-Acrylate glue					
**PVA Polyvinyl Alcohol Particles					

Of the 120 patients in whom BAE was clinically successful, recurrence was observed in 43 patients within the 12-month follow-up period. In the NBCA group (n=36), 7 patients (19.4%) developed recurrence of hemoptysis, whereas in the PVA group (n=84), 36 patients (42.8%) developed hemoptysis recurrence.

To test for an association of the particle embolized with the recurrence of hemoptysis, the Chi-Squared test of independence was used. It was found that there was a statistically significant association between the embolizing agent used for BAE and the recurrence of hemoptysis ($\chi 2 = 4.80$, df = 1, p = 0.028). The use of PVA particles for BAE was found to have 2.62 times higher odds (95% CI 1.10 - 6.81) of recurrence of hemoptysis as compared to the use of NBCA glue (Table 2).

Table 2: Chi-Squared test of independence for the association of embolizing agent used with hemoptysis recurrence

Embolized particle	Hemoptysis recurrence		Total	Odds Ratio	95% Confidence Interval	p-Value
	Yes	No				
n-Butyl Cyano-Acrylate glue (NBCA)	7	29	36			
Polyvinyl alcohol particle (PVA)	36	48	84	2.61	1.10 - 6.81	0.028
Total	43	77	120			

DISCUSSION

In this retrospective study, we analysed 2 embolizing agents used in bronchial artery embolization for haemoptysis (NBCA vs PVA) and evaluated the effectiveness and safety of both agents. We achieved a technical success rate of 100% in both groups. The clinical success rate was 97.6% in the PVA group and 97.3% in the NBCA group (p >0.05). These results are in accordance with the previously published studies which show that both agents are effective embolizing agents for BAE.[3,8,12,13,14]

In patients in whom BAE was clinically successful, recurrence was observed in 36 patients out of a total of 84 patients in the PVA group (42.8%) and in 7 patients out of a total of 36 patients in the NBCA (19.4%) group (p=0.028). Thus, our results show that NBCA is a better embolizing agent as compared to PVA with respect to the recurrence of haemoptysis. This result is also in accordance with a previously published study by Woo et al which showed increased effectiveness of NBCAas compared to PVA. A lower recurrence rate of hemoptysis after NBCA embolization can partly be explained by the fact that the level of embolization is different in both embolizing agents. NBCA reaches up to the distal vascular bed and occludes it, whereas, PVA particles aggregate and form plugs which causes premature embolization proximal to the level of the vascular bed.[7]

The most common etiology of hemoptysis in our study was active tuberculosis (45% of total cases). We performed a subgroup analysis (stratifiedto the cause of haemoptysis) and found that the lower recurrence rate in the NBCA group was also seen in the active tuberculosis group. Out ofa total of 55 cases of active tuberculosis, 40 were treated with PVA and 15 (37.5%) had a recurrence,whereas 15 were treated with NBCA and 3 (20%) had a recurrence, P<0.05. In the other etiologies, the difference was not significant or could not be evaluated due to the small sample size. Thestudy by Woo et al showed that even though the rate of recurrence of haemoptysis was low with NBCA use in their total study group (p<0.05) this was not the case in patients of aspergilloma and chronic tuberculosis.[12] According to them, the benefit of NBCA is reduced in these cases due to the recruitment of new feeding arteries. Our study could not support this finding as the number of cases of the above-mentioned conditions was quite less in our study group (aspergilloma-5.7% and tuberculosis sequelae-3.2%) and hence meaningful statistical analysis could not be performed in these groups and more studies are required.

In our study, the major and minor complication rates did not show statistical significance when comparing the 2 groups (p>0.05). Neurological complications (inadvertent embolization of the spinal artery) are one of the most dreaded complications of NBCA embolization. This is because the risk of non- target embolization is high with NBCA, which can occur due to uncontrolled reflux of NBCA or detachment of the polymerized NBCA that is adhered to the tip of the microcatheter during its withdrawal. Fortunately, we did not experience any such complications. However, extreme caution is advised when using NBCA during the embolization procedures. Another concern regarding NBCA is the risk of causing tissue necrosis (bronchial necrosis). However, we did not encounter any symptoms related to pulmonary ischemia or any airway abnormality in the embolized cases. In addition, the few cases who underwent follow-up CT or bronchoscopy did not show any such sign. This result is in accordance with a few recent studies which show that tissue necrosis is rare with NBCA in BAE.[7,9,12]

Our study had a few limitations. Firstly, it was a retrospective study, which has its inherent limitations. Furthermore, even though statistically not significant, there were differences in the baseline characteristics of the 2 groups. In addition, the choice of the embolizing agent was random, based on the discretion of the interventional radiologist. Thus, in this study, the indication of NBCA was not defined, and this might have caused a bias in the interpretation.

CONCLUSION

In conclusion, this study shows that BAE using NBCA has a lower recurrence rate of haemoptysis as compared to PVA particles, without any increase

in the complication rate. However, randomized controlled trials are required to confirm these advantages of NBCA over other embolizing agents.

CONFLICT OF INTEREST

None

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None

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