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INTERVENTIONAL BRONCHOSCOPY

The Effect of Using Different Types of Forceps in the Efficacy of Transbronchial Lung Biopsy

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Abstract

Background Transbronchial lung biopsy (TBBX) is a common respiratory diagnostic procedure performed to investigate several lung diseases. There are different types of forceps used to perform this procedure. The alligator and cupped (oval) forceps are most commonly used ones. To date, there are few studies that have compared the efficacy of these two types of forceps. This study compares the two types of forceps relating to the rate of complications and diagnostic value.

Methods In this retrospective observational study, 40 patients who underwent TBBX using the alligator forceps were compared to a previous group of 40 patients who underwent the same procedure using the cupped forceps. The two groups were compared with respect to the rate of complications (bleeding and pneumothorax), diagnostic value and size of biopsies.

Results The rate of complications was higher in patients who underwent TBBX using alligator forceps, in which seven patients (17.5%) had significant bleeding in the group that used alligator forceps versus three patients (7.5%) in cupped forceps group. Pneumothorax developed in three patients, all of whom were in the alligator forceps group. While there was no significant difference in the adequacy and size of the samples, the diagnostic yield was higher in the cupped forceps group.

Conclusions The results of the study showed that using cupped forceps in performing TBBX had fewer complications (pneumothorax and bleeding) and a higher diagnostic yield in comparison with alligator forceps, but the difference did not reach a statistical significant value.

Keywords Bronchoscopy · Transbronchial biopsy · Forceps · Interventional pulmonology

Introduction

Transbronchial lung biopsy (TBBX) is one of the common procedures performed during flexible bronchoscopy. It is used to obtain peripheral lung tissue to investigate lung masses, nodules, and focal or diffuse lung infiltrates. The TBBX is useful for diagnosing lung cancer, fungal or mycobacterial lung infections, unexplained infiltrates in immunocompromised hosts, specific types of interstitial lung disease (cryptogenic organizing pneumonia, hypersensitivity pneumonitis, non-specific interstitial pneumonia, and pulmonary sarcoidosis) and different other lung conditions. In addition, TBBX has an important role in the assessment of rejection or infectious complications following lung transplantation. However, TBBX is not useful for histological diagnosis of idiopathic pulmonary fibrosis and it has suboptimal diagnostic yield in lung nodules smaller than 2 cm in diameter [1].

Flexible bronchoscopy and transbronchial biopsy are considered as safe procedures with reported low complication rates. Complications are usually minor and are procedure

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related and/or sedation related. Common complications are transient mild hypotension or hypoxemia, nasal discomfort, sore throat, and mild hemoptysis for a day or two after bronchoscopy. In addition, fever and pneumonia can arise as late complications of the procedure [1, 2]. The most significant complications in transbronchial biopsy procedure are bleeding (0.58–2.8%) and pneumothorax (0.97–4%), where in the latter most cases are minor with tension pneumothorax being rare [2–4].

There are different types of forceps used in the TBBX procedure; the alligator (teethed) forceps and the cupped (oval) forceps are the most commonly used ones. However, there are no robust data suggesting the superiority of one type over the other and the choice is usually dependent on the operator's preference [1]. There are two studies compared the effect of using different types of forceps in performing transbronchial lung biopsies [5, 6]. Based on these studies, as they showed lower complication rates when using alligator forceps, we substituted the use of the cupped forceps in performing TBBX in our practice and performed the procedure using the alligator forceps. After performing 40 cases of TBBX using alligator forceps, we decided to compare the two types of forceps (alligator and cupped) in relation to the rate of complications (significant bleeding and pneumothorax), sizes of the biopsies, adequacy and the diagnostic yield of the obtained samples.

Methods

This study is a retrospective cohort observational study. The study was conducted at the University Hospital Limerick, and it was approved by the ethical committee in the Hospital. The 40 patients that underwent blind transbronchial biopsy with alligator forceps were compared with the preceding 40 patients who had undergone the procedure with the cupped forceps. With regard to the patient selection, we included all cases that underwent TBBX using alligator forceps (40 patients) and compared them with the previous 40 cases who had had the same procedure using the cupped forceps, without any exclusions. All patients were adult. A CT chest performed before the procedure to define the site of the pathology and a Chest X-ray done subsequent to the procedure to check for pneumothorax. Coagulation profile and platelet count were checked before the procedure and were identified as normal for all patients. Antiplatelet and/or anticoagulation drugs were stopped as per protocols.

The procedures were performed while the patients were in a supine position. Local anesthesia was administered by using 2% Lidocaine nebulization and Lidocaine spray. Midazolam was used as sedation, and the dose was dependent on the patient's age and response to the sedation. The segment of the TBBX was based on the CT finding, by selecting the areas that were most affected and avoiding areas with severe bullous changes. The types of scopes used were Olympus scope size 6.2 mm with working channel of 2.8 mm or size 5.5 mm with working channel of 2 mm. During the procedure, the forceps were advanced slowly into the airway of the selected segment until resistance was encountered. The forceps were then pulled back by approximately 1–2 cm. At this point, the patient was instructed to take a deep breath inward (in the case where the patient can follow commands) and the forceps were opened. The patient was then instructed to exhale, and at the end of exhalation, the forceps will were closed. If no pain was reported, the forceps were briskly pulled back. If the patient reported pain, the forceps were opened and retracted by about 1–2 cm and the whole process was repeated. Multiple blind (without fluoroscopy guidance) transbronchial biopsies were taken from each patient. The type of the forceps used was the Olympus single-use alligator jaw biopsy forceps (FB-211D.A) or the Olympus single-use standard oval (cupped) biopsy forceps (FB-231D.A). The sizes of the alligator and the cupped forceps were similar (1.9 mm). The procedures were performed by the same operators in the both groups. All included cases had bronchoscopy and TBBX performed in the bronchoscopy unit under sedation, none of them had the procedure in the ICU or under general anesthesia.

The two groups were summarized and compared in relation to the complications rate, adequacy, diagnostic yield and samples size. Differences between groups were tested using Fisher's exact test (FET) for categorical variables and Mann–Whitney *U* tests for the scalar variables which were all distributed non-normally.

The possible complications were assessed for each case. The bleeding was considered as significant if it did not stop spontaneously and required lavage with cold saline and adrenaline to be stopped. Bleeding volume was not recorded as the study is retrospective, and the amount of the bleeding was not recorded routinely.

Pneumothorax was assessed by post-bronchoscopy chest X-ray. In addition, any other documented complications related to the procedure were recorded.

In regard to the sample adequacy and the diagnostic yield, the biopsies were considered as adequate if they contained alveoli and parenchymal lung tissue, and diagnostic if there was a specific pathological diagnosis. The size of the samples was checked according to the pathology report, and the largest sample in each case was selected.

Results

A total of 80 patients were included in the study. Forty patients had the procedure using the cupped forceps and the other 40 underwent the same procedure using the alligator forceps.

The median age of the patients was 68.5 years (IQR 57.3–74.8). Age was not significantly different between the forceps groups ($p=0.174$) as per the Mann–Whitney U test. The median age was 66.5 years (IQR 57.0–72.5) for the alligator forceps group and 70.5 years (IQR 62.0–76.0) for the cupped forceps group. There were 50 males (62.5%) and 30 females (37.5%). Gender was not significantly different between forceps type ($p=0.489$) as per the FET (Table 1). Among the study population, no patient had bleeding disorder.

There were 40 patients who underwent the procedure to investigate lung mass or nodule and 40 patients had the procedure for parenchymal lung changes investigation (Table 1). These figures were not significantly different between the forceps group types ($p=0.503$) as per the FET. In the cupped forceps group, 55% had the procedure to investigate lung mass or nodule and 45% had it for parenchymal lung changes, while the indications were lung mass or nodule in 45% and parenchymal lung changes in 55% of the cases in the alligator forceps group. In patients with parenchymal lung changes as indication for the procedure, 28 of the cases (70% of 40) were unexplained infiltrates and 12 (30%) were suspected interstitial lung diseases. These were not significantly different between the forceps types ($p=0.491$). In the case of lung mass or nodule as indications of the procedure, the size of nodules was not significantly different in comparison with that in the forceps types ($p=0.761$). None of the included patients was post-lung transplant case.

A total of 210 biopsies were obtained with a median of 2.5 (IQR 2.0–3.0), of which 116 biopsies were taken by the cupped forceps versus 94 biopsies by the alligator forceps ($p=0.054$) on the basis of Mann–Whitney U test. The median number of the biopsies in the alligator forceps group was 2 (IQR 2–3), and in the cupped forceps group, it was 3 (IQR 2–3) (Fig. 1).

The median size of the biopsies was 0.2 cm (IQR 0.1–0.2 cm). The median for the alligator forceps group was 0.2 cm (IQR 0.1–0.3 cm) and for the cupped forceps group was 0.2 cm (IQR 0.1–0.2 cm). The cupped group tended to have smaller sizes as seen from the boxplot; however, it was not statistically significant different ($p=0.727$) according to Mann–Whitney U test (Fig. 2).

The total number of incidences of pneumothorax and significant bleeding were higher in alligator forceps group but did not reach statistical significant value ($p=0.061$), as per FET. Cramer's v was 0.55, which means there was quite a strong difference although not actually statistically significant. There was a total of 10 cases (12.5%) who developed significant bleeding (requiring lavage with adrenalin and cold saline), from whom seven (17.5%) were in the alligator forceps group versus three (7.5%) in the cupped forceps group. Among these patients, five were under investigation for lung mass or nodule and five for parenchymal lung disease. The number of the biopsies in the patients who developed bleeding was ranging between one and three biopsies. Regarding the biopsy site for the patients whom had bleeding as complication, three cases had the biopsy from the right upper lobe, one case from right middle lobe, two cases from the right lower lobe, two cases from the left upper lobe, one case from the left lower lobe and one case from the lingual.

Pneumothorax developed in three cases in total (3.75%), all of whom were in the alligator forceps group (7.5%) and were in patients under investigation for parenchymal lung disease. Among these patients, two had the procedure to investigate unexplained persistent consolidation and one for

Table 1 Baseline characteristics of the patients and the obtained biopsies

	Alligator forceps	Cupped forceps	Total	p value
Patients characteristics				
Age (years)	64.43 ± 11.75	67.2 ± 11.76	65.81 ± 11.77	0.174
Male sex	27 (67.5%)	23 (57.5%)	50/80 (62.5%)	0.489
Indication of the TBBX				
Lung mass or nodule	18/40 (45%)	22/40 (55%)	40/80 (50%)	0.503
<2 cm	10/18 (55.5%)	11/22 (50%)	21/40 (52.5%)	
≥2 cm	8/18 (44.4%)	11/22 (50%)	19/40 (47.5%)	
Parenchymal lung changes	22/40 (55%)	18/40 (45%)	40/80 (50%)	0.503
Suspected interstitial lung disease	8/22 (36.4%)	4/18 (22.2%)	12/40 (30%)	
Unexplained infiltrate	14/22 (63.6%)	14/18 (77.8%)	28/40 (70%)	
Biopsies characteristics				
Mean biopsies size (mm)	2.1 ± 1.12	1.9 ± 0.84	2 ± 0.99	0.727
Mean biopsies number	2.35 ± 0.83	2.9 ± 1.30	2.63 ± 1.12	0.054

Plus–minus values are means ± SD

There were no significant differences between the studied groups, on the basis of FETs (or Mann–Whitney U test, as appropriate) for the categorical variables

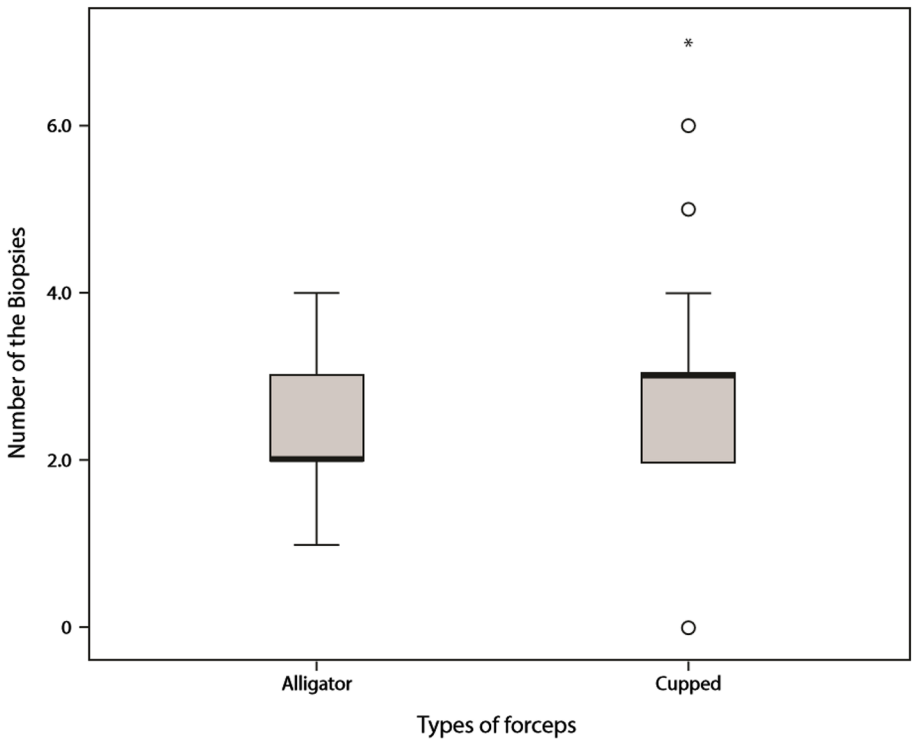

Fig. 1 Boxplot showing differences in numbers of biopsies between the different groups

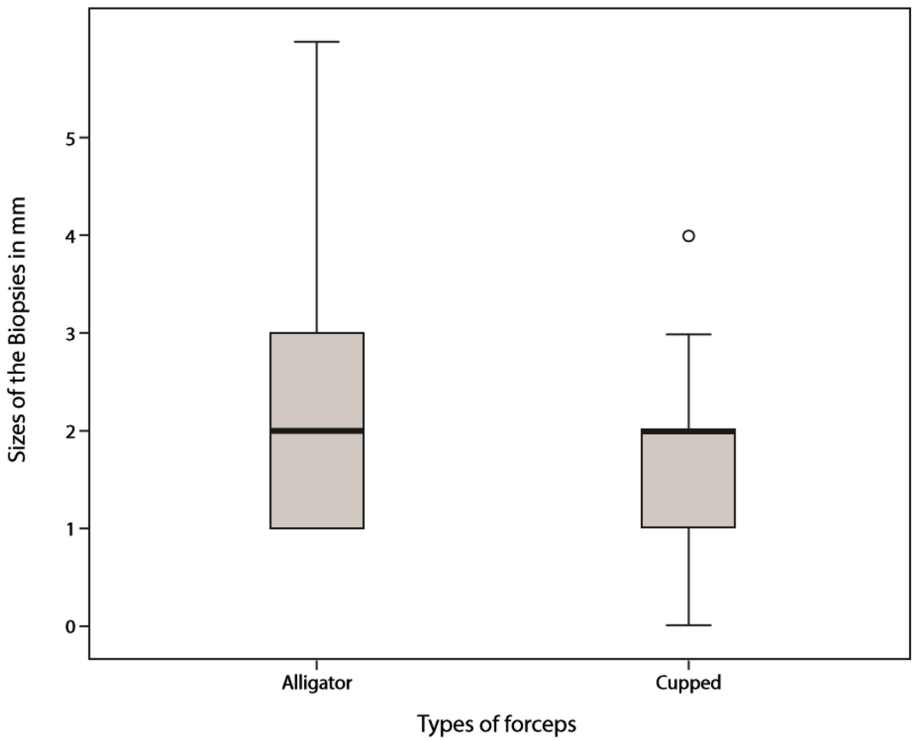

Fig. 2 Boxplot showing differences in size of biopsies between the two groups

patchy ground glass changes. The number of the biopsies for the patients that had developed pneumothorax ranged between one and three biopsies. Other complications seen were pneumonia or new lung infiltrate post-bronchoscopy which were seen in eight cases of the total 80 patients (10%), from whom six cases (15%) were in the cupped forceps group and two cases (5%) in the alligator forceps group (Table 2).

Regarding the diagnostic value of the biopsy, six patients (7.5%) had a non-adequate sample. This was not significantly

different between the two types of forceps, as three cases in each group had non-adequate sample. Normal lung parenchyma seen in 46 (62.2%) of the 74 patients with adequate samples, and 28 patients (37.8%) had specific pathological changes (Table 2). These were not significantly different between the two groups ($p = 0.231$), based on FET. The most reported histopathological diagnoses were interstitial fibrosis, non-small cell lung cancer, small cell lung cancer and sarcoidosis (Table 3).

Table 3 Histopathological diagnosis of the obtained biopsies

	Alligator forceps	Cupped forceps	Total
Non-small cell lung cancer	2	2	4
Small cell lung cancer	1	3	4
Sarcoidosis	3	1	4
Organizing pneumonia	0	3	3
Pneumonia	2	0	2
Interstitial fibrosis	2	3	5
pneumonitis	0	2	2
Others[a]	1	3	4

[a]Other diagnoses seen were foreign body giant cells reaction, neuroendocrine tumor, lipoid pneumonia and atypical adenomatous hyperplasia

Discussion

There are different types of forceps used in the TBBX procedure; the alligator forceps and the cupped forceps are the most commonly used ones. There are two studies compared the effect of using different types of forceps in performing transbronchial lung biopsies. The first was a prospective observational double blinded study that included 44 patients. Results showed complications (pneumothorax and bleeding) occur less frequently when using alligator forceps, but the difference in this regard was not statistically significant and no significant difference was seen in the diagnostic yield between the two types of forceps [5]. The second study was a prospective randomized controlled trial comparing the efficacy and safety of cup versus alligator forceps for performing TBBX in patients with sarcoidosis. It involved 150 patients, and the results of the study indicate that using alligator forceps would result in fewer incidences of significant complications [6].

TBBX can be performed with or without fluoroscopy, ultrasound, or navigation guidance (virtual or electromagnetic) [1, 7]. There is a study done by Rittirak and Sompradeekul compared the diagnostic yield and complication of the TBBX with and without fluoroscopy guidance. Result showed a significant increase in the diagnostic yields using fluoroscopy-guided TBBX of non-endobronchial lung masses or focal infiltrates compared to non-fluoroscopy-guided TBBX. There was no significant difference in the rate of pneumothorax between the two groups [8]. There are other studies compared the effect of forceps' size and number of biopsies on the diagnostic value of the sample. The result showed a better diagnostic yield with larger forceps and more biopsies [1, 9].

In our study, 80 patients underwent TBBX using either cupped or alligator forceps with 40 patients in each group. Out of the total of 210 biopsies taken, 116 biopsies were taken with the cupped forceps and 94 biopsies with the alligator forceps. Although the number of the biopsies was higher in the cupped forceps group, the complication rate was lower but was not statistically significance deference. Among the 10 patients that developed significant bleeding, seven cases (17.5%) were in the alligator forceps group, while only three patients (7.5%) were in the cupped forceps group (Table 2). Pneumothorax developed in three cases, all of whom had undergone the procedure with the alligator forceps (7.5%) (Table 2). Additionally, all the patients who developed pneumothorax had the procedure to investigate parenchymal lung disease. Only one patient required insertion of a chest drain for the pneumothorax, whereas the other two patients had minor pneumothorax (< 2 cm rim of air at level of hilum) and were treated conservatively. The published rate of pneumothorax in TBBX ranged between 1 and 4%. In our study, the overall pneumothorax rate was 3.75% and in the alligator forceps group it was 7.5%. The higher rate of pneumothorax might be a result of doing the procedure blindly, or/and it might be

Table 2 Complications and histopathological results of the biopsies in the studied groups

	Alligator forceps	Cupped forceps	Total	*p* value
Complication				
Significant bleeding	7/40 (17.5%)	3/40 (7.5%)	10/80 (12.5%)	
Pneumothorax	3/40 (7.5%)	0/40	3/80 (3.75%)	
Total	10/40 (25%)	3/40 (7.5%)	13/80 (16.25%)	0.061
Histopathology				
Adequate	37/40 (92.5%)	37/40 (92.5%)	74/80 (92.5%)	
Diagnostic	11/40 (27.5%)	17/40 (42.5%)	28/80 (35%)	0.231

the effect of using the alligator forceps, as all cases of pneumothorax were in the alligator forceps group.

The size of the biopsies was comparable in the two groups. In addition, the adequacy of the samples was corresponding in both groups as the biopsies of 37 patients in each group contained alveoli and lung tissue. However, the cupped forceps group had a better diagnostic yield. Specific pathological changes were seen in 17 patients (42.5%) who underwent the procedure using the cupped forceps versus 11 patients (27.5%) in the alligator forceps group (Tables 2 and 3). This could be due to the effect of the forceps' design as the cupped forceps cut through the tissue, while the alligator forceps crushed the tissue. Additionally, in our study the biopsies were taken blindly, which can affect the diagnostic yield in either group as the proper placement of the forceps cannot be assured.

From the results of this study, it can be concluded that using cupped forceps in TBBX is associated with fewer complications (pneumothorax and bleeding) and a higher diagnostic yield in comparison with the alligator forceps. However, the differences in these variable factors were not statistically significant. Hence, larger prospective studies are needed to support these findings more conclusively.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest. The authors whose names are listed have no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript.

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