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Donor evaluation and the role of bronchoscopy in lung transplantation

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ABSTRACT

Introduction: This study aims to evaluate the role of bronchoscopy in the donor lung assessment process and its impact on the availability of transplantable lungs.

Materials and Methods: This single-center retrospective study includes potential lung donors presented to our clinic between January 2021 and December 2023. All donors underwent a comprehensive evaluation, including demographic data, thoracic measurements, chest imaging, and the PaO_2/FiO_2 ratio. Bronchoscopy was performed for donors deemed suitable for on-site evaluation, focusing on identifying airway secretions, foreign bodies, and signs of infection. Clinical and demographic data were analyzed, and reasons for rejection were documented.

Results: A total of 109 donors were presented to our clinic, with 24 undergoing on-site evaluation. Among these, 19 were accepted for transplantation, while 5 were rejected. Common reasons for rejection included compromised lung function, such as insufficient oxygenation, infection, and radiological abnormalities such as pulmonary artery thrombosis and interstitial lung changes. Bronchoscopy identified crucial factors like purulent secretions and poor lung collapse, contributing significantly to the decision to reject certain donor lungs.

Conclusion: This study highlights the importance of a comprehensive donor evaluation process, including the critical role of bronchoscopy in assessing donor lung suitability. Identifying infections and airway abnormalities through bronchoscopy can help prevent the transplantation of unsuitable organs, thus improving post-transplant outcomes. Optimizing donor selection criteria, including advanced imaging and bronchoscopy, could increase the availability of suitable organs for lung transplantation.

Keywords: Donor evaluation, fiberoptic bronchoscopy, lung transplantation

Introduction

Lung transplantation is considered a life-saving treatment for patients with end-stage lung disease.[1] The first successful lung transplant was performed in 1983 by Dr. Joel Cooper and his team, and since then, more than 42,000 patients worldwide have benefited from this procedure. In recent years, advancements in surgical techniques, postoperative care, and immunosuppressive therapy have significantly improved both short- and long-term survival rates following lung transplantation. However, one of the most critical limiting factors in lung transplantation remains the shortage of suitable donor organs.

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The lack of organ donation poses a major challenge for all solid organ transplantation programs, but this issue is particularly pronounced in lung transplantation. Compared to other organs, lungs are more susceptible to structural and functional deterioration in brain-dead donors. As a result, the disparity between the number of patients awaiting transplantation and the number of available donor lungs continues to widen. According to conventional donor evaluation criteria, only about 20% of brain-dead donors have one or both lungs deemed suitable for transplantation. This highlights the necessity of a meticulous donor lung assessment process.

Brain-dead donors typically suffer from traumatic or anoxic brain injury.[2] The causes of brain death, as well as its consequences such as aspiration, pulmonary edema, and infection can negatively impact lung function. Additionally, intensive care interventions, including mechanical ventilation, fluid overload, atelectasis, and aspiration pneumonia, may further compromise lung viability for transplantation. However, with appropriate medical management, initially unsuitable donor lungs may be rehabilitated and rendered viable for transplantation.

This study aims to emphasize the increasing importance of donor evaluation in overcoming donor shortages in lung transplantation. In particular, it focuses on the critical role of bronchoscopy in assessing donor lung suitability, with the goal of improving donor quality assessment and increasing the availability of transplantable lungs.

Materials and Methods

This single-center study includes patients who were presented as cadaveric donors to our Lung Transplant Clinic by the Turkish Tissue and Organ Transplant Information System (TDIS) and were deemed eligible for on-site evaluation after the initial assessment. Patients who were accepted for on-site evaluation between January 2021 and December 2023 were included in the study. Ethical approval was obtained from the local ethics committee (No: 2025/01/1027), and the study was conducted in accordance with the principles of the Helsinki Declaration. Written informed consent was obtained from all participants, and patient privacy was strictly maintained.

All donors were allocated through the Turkish Tissue and Organ Information System (TDIS) after confirming that they met neurological death criteria.[3,4] All potential donors proposed to our Lung Transplant Unit were initially evaluated by our transplant team, and general donor data provided by the National Transplant Coordination were recorded and discussed in detail. During the evaluation, parameters such as age, gender, weight, height, thoracic measurements, cause of death, ABO blood group, chest radiography findings, PaO_2/FiO_2 ratio, serological status, and comorbidities were considered.

After determining the initial eligibility of the donor and verifying the availability of a suitable recipient, the donor surgical team was dispatched to the respective hospital for on-site evaluation and management.

If the donor lung was found suitable during the preliminary assessment, a bronchoscopic examination was performed at the donor hospital by the transplant surgeon. During this procedure, the presence of an aspiration history was visually assessed, and any particulate matter, foreign bodies, or bile-like materials were investigated. Additionally, the amount and characteristics of bronchial secretions were examined in detail.

Following the bronchoscopic evaluation, the donor's overall condition was assessed through median sternotomy. The lungs were examined for nodules or pathological formations via manual palpation. A recruitment test was performed with anesthesia support, and intrathoracic blood gas samples were collected from the right and left pulmonary veins. Based on all obtained data, a decision was made regarding organ acceptance.

In this study, the clinical and demographic characteristics of cases rejected on-site at the donor hospital and the reasons for rejection were analyzed. Donors presented to our clinic by TDIS within the specified dates were examined, and cases rejected during the preliminary evaluation, accepted cases, and subsequently rejected cases on-site were identified. The clinical and demographic characteristics of on-site rejected cases were analyzed in detail.

Data obtained from donor records were analyzed to identify trends and outcomes related to the evaluation of lungs that were rejected on-site. The analysis included comparisons of donors' demographic and clinical characteristics, bronchoscopic and radiological findings, oxygenation parameters, and intraoperative evaluation results. Additionally, the effectiveness of preoperative assessment processes and the key factors leading to organ rejection were examined to derive insights for improving donor selection criteria.

Results

During the study period, a total of 109 potential donors were presented to our lung transplant clinic by TDIS, with 45 (41%) belonging to 2023 and 64 (59%) to 2024. Of these, 85 donors were rejected during the preliminary assessment stage, while 24 were deemed suitable for further evaluation, leading to a decision for on-site assessment. In 2023, an on-site evaluation was conducted for 9 of the 45 presented donors, with 2 being rejected on-site. Similarly, in 2024, 15 out of 64 donors underwent on-site evaluation, and 3 were rejected. Among all donors evaluated on-site, 19 were accepted, whereas 5 were rejected (Fig. 1).

The five donors examined were between 34 and 55 years of age, with two diagnosed with brain death due to traumatic subarachnoid hemorrhage (SAH) and three due to spontaneous SAH. The PaO_2/FiO_2 ratios of the donors ranged from 258 to 528. A history of cardiac arrest was identified in two donors, while two donors had a history of smoking. The longest recorded intubation duration was 10 days, and this donor also had a history of cardiac arrest.

Radiological evaluations revealed pathological findings in four donors, including an interstitial pattern, nodular structures, pulmonary artery thrombosis, and bullous changes. Despite the application of a recruitment maneuver, two donors exhibited inadequate oxygenation under PEEP 8 and FiO_2 100 conditions, leading to the rejection of the organs. In one donor, the lung transplantation process was terminated intraoperatively due to the detection of pulmonary artery thrombosis. In another case, significant loss of elasticity and low compliance were observed, and as the lung progressively stiffened, the organ was deemed unsuitable for transplantation.

Despite normal findings in some cases, the reasons for rejection were closely tied to pathological conditions identified through imaging and fiberoptic bronchoscopy. Among the five evaluated cases, rejection was primarily attributed to pathological findings identified through imaging and fiberoptic bronchoscopy. In the first case, a donor with traumatic SAH exhibited poor lung collapse and low intrathoracic pulmonary vein pO_2, indicating inadequate lung function for transplantation. In the second case, another donor with SAH had purulent secretions detected during fiberoptic bronchoscopy, suggestive of infection or inflammation, which posed a significant risk to transplant success and led to organ rejection. In the third case, a donor with SAH demonstrated an interstitial pattern and suspicious micronodules on computed tomography (CT), along with poor lung collapse. These findings, coupled with the inability to achieve optimal lung collapse, contributed to the rejection of the lungs for transplantation. In the fourth case, a donor with traumatic SAH was found to have a thrombus in the right pulmonary artery, a critical finding that resulted in rejection (Fig. 2). Pulmonary artery thrombi can obstruct circulation, leading to severe complications in transplant recipients. In the fifth case, a donor with SAH developed postoperative pulmonary edema following cardiac arrhythmia, which significantly compromised lung viability for transplantation. This organ could not be assessed due to the unavailability of an ex vivo lung perfusion system in Türkiye.

Overall, the primary reasons for rejection were related to compromised lung function, such as infection, thrombotic events, and insufficient lung collapse. These findings emphasize the importance of comprehensive donor evaluations using imaging techniques and clinical assessments to determine the viability of lungs for transplantation.

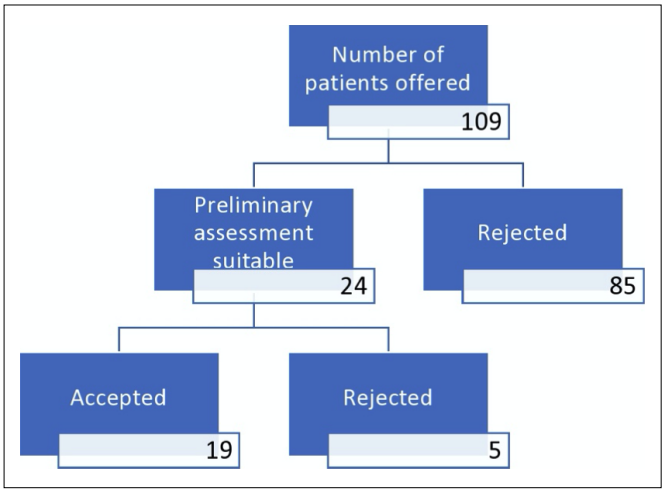

Figure 1. Lung donor pre-evaluation, on-site evaluation, and acceptance numbers.

Figure 2. (a) Purulent secretion aspirated by fiberoptic bronchoscopy **(b)** Thrombus removed from the right pulmonary artery.

Discussion

In the evaluation of lung donors, the PaO_2/FiO_2 (P/F) ratio, a fundamental criterion, showed a wide distribution among donors, ranging from 289 to 528. While the importance of the PaO_2/FiO_2 ratio is well recognized, the cut-off value is still debated (Table 1). In a study by Whitford et al.[5], which examined 93 lung donors, no significant differences were found between recipients of donor lungs with ICU P/F ratios <300 and ≥300 in terms of extubation time, primary graft dysfunction, lung function at 6 and 12 months, and 12-month survival. They also noted that if a donor P/F threshold of 300 had been applied, 13% of donors would have been rejected.

Lung donor evaluation is critical for determining suitability for transplantation, with radiological and bronchoscopic assessments playing key roles. Radiological evaluation, including chest X-rays and CT scans, helps identify structural abnormalities, infections, and conditions like interstitial lung disease or pulmonary thromboembolism, which can affect lung viability. A study utilizing CT for the radiographic assessment of pulmonary abnormalities found that many lungs deemed unsuitable for transplantation based on CT scans did not exhibit significant signs of disease or injury that would preclude their use. This finding highlights the need for additional assessment tools to critically evaluate donor organ quality before transplantation.[6] Bronchoscopy, particularly fiberoptic bronchoscopy, provides a direct view of the airways, helping to detect obstructions, secretions, or inflammation that may indicate infection or other issues, further impacting transplant success. Together, these evaluations offer a comprehensive assessment of lung health, helping to ensure better post-transplant outcomes by identifying potential risks early on.

In bronchoscopy, purulent secretions can be a strong indicator of infection, making it essential to carefully assess such findings. Identifying infections and determining appropriate treatment protocols are crucial steps in preventing post-transplant complications. In this context, the effective use of bronchoscopy and careful monitoring of secretions play a key role in evaluating lung donors. In a study by the Leuven Lung Transplant Group conducted between 1991 and 1992, 116 of 141 multiorgan donors (82.3%) were dismissed as potential lung donors. The lungs were turned down because of purulent secretions or evidence of aspiration in 20 patients (17.2%) and because of prolonged ventilation in another 11 patients (9.5%).[7] The identification of infection, along with culture studies and the formulation of antibiotic treatment plans, can enhance the safety of the transplantation process. These assessments and tests are crucial to ensure that each donor lung is free from potential complications, thereby minimizing risks during the transplant procedure.

These findings emphasize that donor evaluation in lung transplantation should not be confined solely to oxygenation parameters but should also include radiological, bronchoscopic, and intraoperative assessments, which play a critical role. In particular, bronchoscopy allows for a detailed examination of airway secretions and pathologies, facilitating the early identification of risks such as infection and aspiration. Bronchoscopy is advocated as a screening measure in multiorgan donors to select potential lung donors. This test is a prerequisite for most transplant teams to accept a donor lung offer especially when aspiration of gastric content and/or infection is suspected. The presence of gross inflammation or purulence usually precludes use of the lungs. Riou et al.[8] reported that only 33% of all brain-dead donors and 62% of ideal donors, based on CXR and arterial blood gas analysis, had normal fiber-optic bronchoscopy.

One of the most significant limitations faced in this study was the lack of access to ex vivo lung perfusion (EVLP) technology.[9] EVLP is a promising technique that allows for the assessment and preservation of donor lungs outside the body, potentially reviving organs that may otherwise be rejected. In the cases of the donor who developed postoperative pulmonary edema following cardiac arrhythmia and had pulmonary artery thrombosis, the absence of EVLP meant that the lungs could not be further evaluated or treated outside the body, which would have been critical in preserving their viability. The unavailability of EVLP technology in Türkiye highlights the limitations of current donor lung management practices and the potential for more organs to be successfully transplanted if such technologies were more widely accessible.

Conclusion

This study demonstrates that the most common issues encountered in rejected lung donors are inadequate oxygenation, radiological and pathological abnormalities, loss of pulmonary compliance, and intraoperative thrombotic complications. Furthermore, early application of bronchoscopy in donor lung evaluation can facilitate the identification of organs unsuitable for transplantation,

Table 1. Donor characteristics, clinical findings, and reasons for rejection

	Gender	Age (years)	Height (cm)	Cause of death	PaO_2/FiO_2 ratio	Cardiac arrest	Smoking history	Intubation Duration (day)	Microbial Reproduction	Antibiotic	Pathological findings in CT	Bronchoscopic findings	Reason for rejection
1	M	37	174	Traumatic SAH	351	No	Yes	2	No	Yes	Yes	Normal	Poor lung collapse, Low intrathoracic pulmonary vein pO_2
2	F	45	168	SAH	528	No	No	3	No	Yes	Yes	Continuing purulent secretions	Purulent secretion in FOB
3	F	55	168	SAH	394	No	No	1	No	No	Yes	Normal	CT interstitial pattern suspicious, Micronodules on palpation, Poor lung collapse
4	F	34	162	Traumatic SAH	377	Yes	No	8	No	Yes	No	Secretions containing blood	Thrombus in the right pulmonary artery
5	M	43	175	SAH	289	No	Yes	3	No	No	No	Normal	Peroperative pulmonary edema after cardiac arrhythmia, Poor lung collapse

PaO_2/FiO_2 ratio; arterial oxygen partial pressure / ınspired oxygen fraction ratio; CT; computed tomography; m; male; f; female; SAH; subarachnoid hemorrhage; pO_2; partial pressure of oxygen; FOB; fiberoptic bronchoscopy.

thereby preventing unnecessary procedures. The findings emphasize the critical importance of comprehensive hemodynamic, radiological, bronchoscopy, and functional assessments in the early stages of donor evaluation. Optimizing donor lung acceptance criteria and strengthening donor management protocols could contribute to an increased rate of suitable organs for transplantation.

Disclosures

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Ethichs Committee Approval: The study protocol was approved by the Ethical Committee of Clinical Research of Kartal Kosuyolu High Specialization Education & Research Hospital (No: 2025/01/1027, Date: 04/02/2025). This study was conducted according to the Helsinki principles, patients signed informed consent for participation, and nothing invasive of patients' privacy was done.

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