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Efficacy of Mechanical Thrombectomy in Acute Ischemic Stroke: Predictors of Functional Recovery and Mortality

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ARTICLE INFO

ABSTRACT

Introduction: Acute ischemic stroke (AIS) remains one of the leading causes of morbidity and mortality globally, with an immense burden on healthcare systems and families.
Objective: The basic aim of the study is to find the efficacy of mechanical thrombectomy in acute ischemic stroke as a predictor of functional recovery and mortality.
Methodology: The study conducted at Hayatabad Medical Complex in Peshawar analyzed 354 patients who underwent mechanical thrombectomy (MT) from June 2022 to May 2023. Exclusions included those with hemorrhagic stroke, incomplete records, and those who did not undergo MT. Data from patients' medical records included demographics, clinical history, concomitant disorders, radiological data, and therapeutic information. Stent retrievers and aspiration devices were used in MT, based on operator preference and hospital guidelines. Results: The median baseline NIHSS score was 15, indicating moderate to severe stroke severity. A high prevalence of comorbidities was observed, including hypertension (69%), diabetes (31%), and atrial fibrillation (28%). The study found that at 90 days post-procedure, 43% of patients experienced favorable functional recovery, while the mortality rate was 22%. Patients with a door-to-puncture time of 60 minutes or less had a higher recovery rate (48%), emphasizing the importance of timely intervention. Furthermore, successful revascularization (TICI 2b-3) was associated with significantly better recovery outcomes (50%) and a lower mortality rate (17%) compared to incomplete revascularization (TICI < 2b), where recovery was notably lower (20%) and mortality more than doubled (37%).
Conclusion: Mechanical thrombectomy significantly improves functional recovery in acute ischemic stroke patients, especially when performed promptly and with successful revascularization tract.

INTRODUCTION

Acute ischemic stroke (AIS) remains one of the leading causes of morbidity and mortality globally, with an immense burden on healthcare systems and families. Nonetheless, AIS is devastating clinically as it results in a quality of life drastically reduced by neurological deficits. This has precipitated the need for immediate intervention to address the problem with a view of reversing the reduced blood

supply to the brain [1]. Traditionally, intravenous thrombolysis with tissue plasminogen activator (tPA) had been the definitive management of AIS. However, certain limitations inherent with tPA for instance short half-life, contraindications, and inefficiency in large vessel occlusion informed the search for different methods. Endovascular therapy specifically mechanical thrombectomy (MT) has revolutionized the management of AIS, particularly for patients with large vessel occlusion (LVO) since it directly clears the thrombi that if left to accumulate could cause bad neurological outcomes [2].

MT has been revealed to have great potential, several studies proved the higher ability of MT in terms of improving functional outcome compared to standard thrombolytic treatment only. However, results after MT are rather heterogeneous, and some of the patients can regain almost normal activities while others have little or no improvement or die of the sequels [3]. Despite the multiple rapid and promising developments in AIS management, knowledge of the factors that make these outcomes possible is fundamental for improving the selection of patients, decision-making criteria, and the overall concept of individualized treatment in AIS. Disease outcomes after MT depend on patient factors such as age, comorbid conditions, and degree of initial stroke severity, as well as procedural factors, which include the timing of the procedure, the type of device used, and the success of revascularization [4]. The degree of functional recovery after MT depends on several demographic and clinicopathological factors. Pre-surgery age is strongly significant because young people experience better healing rates from brain injuries due to young brain plasticity. Furthermore, baseline stroke severity, usually measured by the National Institutes of Health Stroke Scale (NIHSS), is also an important factor; stroke patients with NIHSS scores at admission did worse compared to those with lower scores [5]. In addition, the patient's comorbidities such as hypertension, diabetes mellitus, atrial fibrillation, and prior stroke in particular contribute to prolonged recovery as the cerebrovascular system is more susceptible than the rest of the body. The predictor also includes pre-stroke dependence level often measured by modified Rankin Scale (mRS);

pre-stroke, independently motivated patients are likely to become independent after MT [6].

Functional outcome and failure or mortality post-MT are equally as likely to be predicted by procedural factors. The time to treatment is among the most important factors regarding the likelihood of revascularization and the severity of ischemic injury [7]. It is well understood that lesser door-to-puncture time and quicker revascularization are associated with better prognosis. Another important predictor is the extent of revascularization that is established and frequently determined by the Thrombolysis in Cerebral Infarction(TICI) score; higher TICI scores equal to better recovery outcomes [8]. Another source of variability relates to the MT device type and the procedural strategy since some device types and practices may be beneficial for the successful use of clot retrieval without damaging blood vessels [9]. Nevertheless, irrespective of appropriate patient selection and procedural approaches, the periprocedural risk for adverse outcomes or death continues to remain high in some individuals after MT [10]. Hemorrhagic transformation, infection, and reperfusion injury are mortality risk factors, and higher baseline stroke severity and greater age are considered as increased risk factors. However, pneumonia, and deep vein thrombosis among post-stroke patients is a possibility, and it greatly increases mortality rate among the patients. New methods of neuroimaging such as computed tomography angiography, and perfusion imaging have become standard in the management of acute stroke to recognize high-risk patients and provide individualized treatment [11].

Objective
The basic aim of the study is to find the efficacy of mechanical thrombectomy in acute ischemic stroke as a predictor of functional recovery and mortality.

METHODOLOGY
This retrospective study was conducted at Hayat-abad Medical Complex, Peshawar from June 2022 to May 2023. A total of 354 patients who underwent MT were included in the study.

Data Collection
This retrospective cohort study included 354 patients presenting with AIS and treated with MT. Inclusion criteria were: (1) confirmed diagnosis of AIS due to LVO based on imaging (computed

tomography angiography or magnetic resonance angiography); (2) age ≥18 years; (3) onset of symptoms; and (4) patients who underwent MT as the primary revascularization strategy. From the participants, those diagnosed of hemorrhagic stroke, those with incomplete records and the ones who did not undergo MT were excluded from the study. Patient demographic data, clinical history, concomitant disorders, radiological data, and therapeutic data were retrieved from patients' medical records. Stent retrievers and aspiration devices or a combination of both were used in mechanical thrombectomy based on the operators' preference and hospital guidelines. The procedure was performed either under general anesthesia or with conscious sedation and the TICI scores were given post revascularization. It was accepted as revascularization success TICI 2b-3. Clinical and imaging assessment at baseline and follow-up included the use of CT and MRI for the detection of complications such as hemorrhagic transformation. Accumulated information aspects were: Demographic data (age, sex), clinical characteristics (NIHSS score at admission, hypertension, diabetes, atrial fibrillation etc.), and declination features (type of MT device, TICI score, onset-to-puncture and door-to-puncture). Moreover, to evaluate the overall functional status after discharge and the survival rate of the patients from the cohort, additional assessments including face-to-face interviews or telephone calls were conducted at 90 days for the patients discharged early.

Statistical Analysis

Data were analyzed using SPSS v27. Descriptive statistics were used to summarize baseline characteristics, procedural details, and outcomes. Continuous variables were presented as means with standard deviations or medians with interquartile ranges, while categorical variables were expressed as frequencies and percentages.

RESULTS

Data were collected from 354 patients and the median age was 68 years, with a slight male predominance (55%). The median baseline NIHSS score was 15, indicating moderate to severe stroke severity. A high prevalence of comorbidities was observed, including hypertension (69%), diabetes (31%), and atrial fibrillation (28%). At 90 days

post-procedure, 43% of patients achieved a favorable functional recovery (mRS 0-2), while the mortality rate stood at 22%, underscoring the critical role of patient selection and timely intervention in optimizing outcomes.

Table 1

Baseline characteristics of the study population

Characteristic / Outcome	Value / Patients (%)
Total Patients	354
Median Age (IQR)	68 years (60-75)
Gender (Male)	195 (55%)
Baseline NIHSS Score (Median, IQR)	15 (11-19)
Hypertension	245 (69%)
Diabetes	110 (31%)
Atrial Fibrillation	98 (28%)
Favorable Functional Recovery (mRS 0-2)	153 (43%)
Mortality at 90 days	78 (22%)

Patients under 70 years had a significantly higher recovery rate of 60% compared to 27% in those aged 70 and above, while mortality was more than double in older patients (30% vs. 13%). Similarly, patients with lower baseline NIHSS scores (<15) showed better recovery outcomes (55%) and lower mortality (16%) than those with higher scores (≥15), where recovery dropped to 30% and mortality increased to 28%. Absence of diabetes and a shorter onset-to-puncture time (≤4.5 hours) also correlated with higher recovery rates.

Table 2

Predictors of functional recovery and mortality

Predictor	Functional Recovery (%)	Mortality (%)
Age < 70 years	105 (60%)	13%
Age ≥ 70 years	48 (27%)	30%
Baseline NIHSS < 15	55%	16%
Baseline NIHSS ≥ 15	30%	28%
No Diabetes	47%	-
Diabetes	32%	-
Onset-to-Puncture ≤ 4.5 hours	48%	-
Onset-to-Puncture > 4.5 hours	30%	-

Patients with a door-to-puncture time of 60 minutes or less had a higher recovery rate (48%) than those

with longer times (38%), emphasizing the impact of timely intervention. Furthermore, successful revascularization (TICI 2b-3) was associated with significantly better recovery outcomes (50%) and a lower mortality rate (17%) compared to incomplete revascularization (TICI < 2b), where recovery was notably lower (20%) and mortality more than doubled (37%).

Table 3

Secondary outcomes

Outcome	Functional Recovery (%)	Mortality (%)
Door-to-Puncture Time ≤ 60 mins	48%	-
Door-to-Puncture Time > 60 mins	38%	-
Successful Revascularization (TICI 2b-3)	50%	17%
Incomplete Revascularization (TICI < 2b)	20%	37%

Hemorrhagic transformation, observed in 15% of patients, was associated with the highest mortality rate of 40%, underscoring its critical impact on outcomes. Pneumonia, affecting 8% of patients, had a mortality rate of 25%, while deep vein thrombosis (DVT) and other infections, occurring in 7% and 6% of cases respectively, were linked to mortality rates of 15% and 10%.

**Table 4**

Complications post-procedure

Complication	Patients (%)	Mortality Rate (%)
Hemorrhagic Transformation	52 (15%)	40%
Pneumonia	30 (8%)	25%
Deep Vein Thrombosis (DVT)	25 (7%)	15%
Other Infections	20 (6%)	10%

Patients aged 70 and above had a 1.6 times higher likelihood of reduced functional recovery (95% CI: 1.2-2.4) and were more than twice as likely to experience mortality (OR: 2.2, 95% CI: 1.4-3.5). A baseline NIHSS score of 15 or above was

associated with a 1.8 times higher risk of poorer functional outcomes and a 1.9 times greater mortality risk, indicating the influence of stroke severity. Successful revascularization (TICI 2b-3) notably increased the odds of functional recovery (OR: 2.1, 95% CI: 1.5-3.3), while shorter onset-to-puncture times (≤4.5 hours) also contributed to improved recovery odds (OR: 1.5, 95% CI: 1.1-2.2).

Table 5

*Multivariate analysis – independent predictors of outcomes*

Predictor	Odds Ratio for Functional Recovery (95% CI)	Odds Ratio for Mortality (95% CI)
Age ≥ 70 years	1.6 (1.2-2.4)	2.2 (1.4-3.5)
Baseline NIHSS ≥ 15	1.8 (1.3-2.7)	1.9 (1.3-2.9)
Successful Revascularization (TICI 2b-3)	2.1 (1.5-3.3)	-
Onset-to-Puncture ≤ 4.5 hours	1.5 (1.1-2.2)	-

Figure 1

Functional recovery and mortality rates (90 Days)
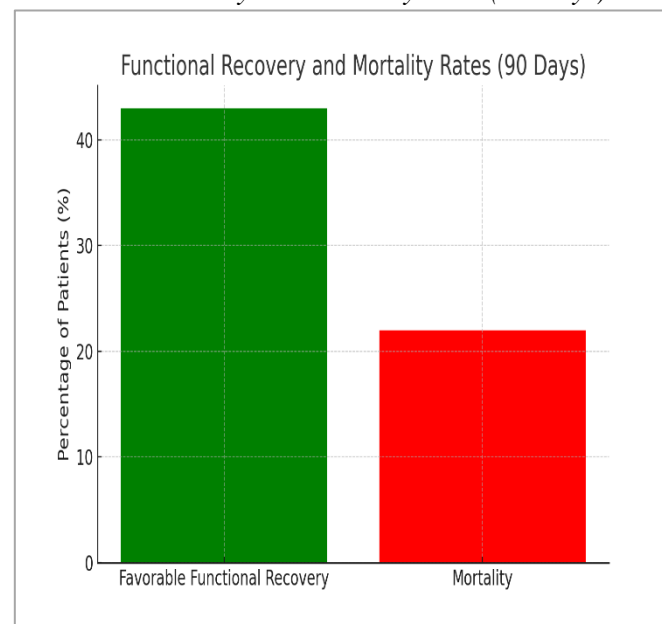
Figure 2

Predictors of functional recovery and mortality by age and NIHSS score
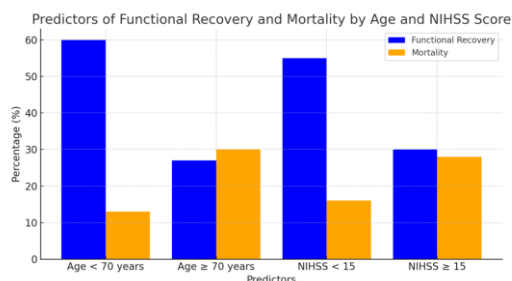
Figure 3

Complications post-procedure and mortality rate
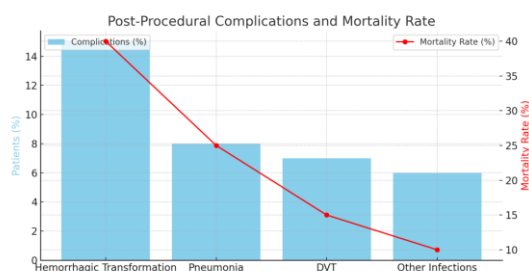
DISCUSSION

This study examined the efficacy of mechanical thrombectomy (MT) in acute ischemic stroke (AIS) patients with large vessel occlusions, focusing on the predictors of functional recovery and mortality. The findings highlight significant predictors influencing post-MT outcomes, including patient demographics, clinical characteristics, and procedural details. The findings of this study offer information about patient eligibility criteria enhancement and intervention approaches for MT. Thus, our study identified that of 202 admitted patients, 43% of patients regained favorable functional status at 90 days post-MT (mRS 0-2). Age also was a significant predictor, with patients within 70 years of age having higher recovery rate than those older than 70 years of age [12]. This result corroborates earlier work indicating that the ability to recover from ischemic damage is higher in younger patients due to increased neuroplasticity and reserve. The baseline NIHSS score also assumed the role of an independent predictor, and patients with low values after the test got significantly better outcomes. NIHSS results less than 30 are often associated with less damage to the brain and thus prophetic of functional rehabilitation [13].As earlier noted, procedural factors especially onset to puncture time was valuable in predicting functional status. Its worth noting that better results were obtained in patients who received MT within

4.5 hours of symptom onset than in patients with longer intervals. This supports the need to fast track stroke care as delays shorten the window of opportunity for minimizing ischemic damage. In addition, TICI 2b-3 revascularization was linked to higher rates of good outcomes in the current analysis, further extending the-description of how complete revascularization is crucial in restoring blood flow and relieving ischemia [14]. The overall mortality calculated from the study was 22 % at ninety days from the onset of AIS which proves that AIS is a critical condition and challenges posed by MT. Risk factors for poor outcome included: Age > 80years, higher NIHSS scores at baseline, and Patients without complete revascularization [15]. Mortality was nearly twice as high inpatients who were 70 years of age or older, which may be explainable by the higher proportion of patient comorbidities, diminished cerebral vascular capacity, and the greater risk of complication following the procedure. Similarly, increased baseline NIHSS scores also predicted mortality, which is in accord with previous research suggesting that a large degree of neurological compromise reduces the probability of survival among patients with ischemic stroke [16].

Poor revascularization with TICI less than 2b was associated with increased mortality, stressing the effectiveness of clot retrieval. Patients who had these complications after the procedureparticularly hemorrhagic transformationhad a 40% mortality rate. Such results imply a need for formidable surveillance and timely intervention to address these complications with an aim of enhancing life chances. The predictors of this study may assist in clinical decision making and thereby improve patient choice for MT [17]. Although rt-PA was associated with better functional outcomes whenever possible, younger patients with lower NIHSS scores should be treated and efforts should be made to decrease onset-to-puncture time. Furthermore, enhancing complete revascularization and avoiding further procedural time might enhance recovery and survival [18]. Proper management after the procedure also helps reduce on them and those that lead to mortality outcomes. Several limitations can be discerned in this study: The study was conducted retrospectively, and it was carried out in a single center; therefore, its results may not be

generalizable. Future work should include multicentre cohorts and even randomized controlled trials, also spearheaded to confirm these observations. Also, the enhanced neuroimaging could contribute to the higher accuracy of risk prediction, and, consequently, to the enhanced precision of different treatment planning.

CONCLUSION

It is concluded that mechanical thrombectomy significantly improves functional recovery in acute ischemic stroke patients, especially when performed promptly and with successful revascularization. Key predictors such as younger age, lower baseline NIHSS scores, and shorter onset-to-puncture times enhance the likelihood of positive outcomes, while incomplete revascularization and post-procedural complications increase mortality risks.

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