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Study of Treatment Modalities for Neonatal Pneumothorax in rural tertiary care hospital

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ABSTRACT

Introduction: Neonatal pneumothorax, characterized by the accumulation of air in the pleural cavity, is a critical condition observed in up to 9.2% of neonates in neonatal intensive care units (NICUs). It poses risks such as respiratory distress, hemodynamic compromise, intraventricular hemorrhage, and increased mortality. Management strategies include conservative observation, needle aspiration (NA), and intercostal catheter (ICC) insertion, tailored to clinical severity, radiographic findings, and available resources. This study evaluates treatment modalities for neonatal pneumothorax in a rural tertiary care hospital.

Methods: A descriptive longitudinal observational study was conducted from December 2020 to December 2022 at Dr. Balasaheb Vikhe Patil Rural Medical College, Loni. The study included 60 neonates diagnosed with pneumothorax in inborn and outborn NICUs. Exclusion criteria included neonates with major congenital malformations. Data collection encompassed clinical history, diagnostic findings, and management approaches, including observation, CPAP,NA, ICC placement. Statistical analysis evaluated treatment outcomes based on the pneumothorax's side (unilateral or bilateral) and severity.

Results: Out of 60 cases, 48.3% had right-sided pneumothorax, 28.3% left-sided, and 23.3% bilateral. CPAP was used in 61.7% of cases, particularly in less severe presentations. Ventilator support was required in 73.3%, with a significantly higher demand among outborn neonates (p=0.03). Needle aspiration was performed in 31.7% of cases, with higher use in left-sided pneumothorax (57%). Chest tube insertion was necessary in 75% of cases, predominantly for right-sided (79.3%) and bilateral pneumothorax (78.5%).

Discussion: The findings align with global studies, highlighting a higher incidence of right-sided pneumothorax due to anatomical predisposition. The study underscores the effectiveness of CPAP in mild cases and the necessity of ICC insertion in severe or bilateral cases. The outcomes advocate for individualized treatment strategies

based on clinical severity and resource availability.
Conclusion: Neonatal pneumothorax remains a significant NICU challenge, necessitating prompt diagnosis and tailored interventions. Advances in non-invasive respiratory support and judicious use of mechanical ventilation can mitigate risks. Further research on minimally invasive techniques and long-term outcomes is crucial to optimizing neonatal care and improving survival and neurodevelopmental follow-up.

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INTRODUCTION

Pneumothorax, a collection of air in the pleural space, occurs in up to 9.2% of neonates in the neonatal intensive care unit (NICU). Although most pneumothorax are associated with risk factors including hyaline membrane disease, meconium aspiration syndrome, transient tachypnoea of newborn, pulmonary hypoplasia or positive pressure ventilation (PPV), some occur spontaneously in the absence of primary lung disease. Pneumothorax can cause respiratory and haemodynamic compromise, and is associated with intraventricular haemorrhage, prolonged hospitalisation and death[1,2]. Consequently prompt recognition and management are critical. Various treatment modalities for management of neonatal pneumothorax include (1) conservative management with no drainage, (2) drainage with needle aspiration (NA) by temporary insertion of a needle into the pleural space or (3) definitive drainage by insertion of an intercostal catheter (ICC) left in situ until resolution of the air leak[3,4,5]. Clinicians decide on treatment strategy based on severity of clinical signs, radiographical features, comorbidities and level of respiratory support required. Pneumothorax can expand, so a pneumothorax initially managed conservatively could rapidly require ICC insertion. Recent evidence indicates that up to 45% of neonates with pneumothorax in NICUs can be initially managed without ICC insertion. The use of NA as initial treatment reduces the need for ICC insertion in the NICU environment. In retrieval, pneumothorax management requires additional logistic and safety considerations. Clinicians must decide on a treatment strategy during initial stabilisation, considering clinical factors, available resources and anticipated transport conditions.

The incidence of pneumothorax in preterm infants who are supported with mechanical ventilation varies from as high as 33% [7] to as low as 6%.[8,9] The risk also increases with the presence of meconium aspiration, hyaline membrane disease, pneumonia, and pulmonary hypoplasia. [7-11] Use of positive pressure ventilation during resuscitation also increases the risk of pneumothorax in the newborn. [12] Nasal continuous positive airway pressure (CPAP) at birth has recently been considered as a treatment modality in preterm infants. Multiple reports have indicated that the use of early CPAP is associated with decreased intubation, fewer oxygen days and lower rates of bronchopulmonary dysplasia (BPD). [13,14] The relationship between the early use of CPAP and pneumothorax has not been settled.

Hence, we planned this descriptive observational study to study various treatment modalities in neonatal pneumothorax in rural tertiary care hospital.

Aim

To study the treatment modalities for neonatal pneumothorax in rural tertiary care hospital.

Objective:

1. To study use of CPAP and ventilator for treatment of neonatal pneumothorax.

2. To study the various treatment modality in unilateral vs bilateral pneumothorax.

MATERIALS AND METHOD

Our study is a descriptive longitudinal observational study with all the neonates who developed pneumothorax in inborn and outborn NICU. It was conducted from 2 years from december 2020- december 2022 at Dr Balasaheb Vikhe Patil Rular Medical College, LONI after obtaining approval from the ethical committee.

Due written and informed consent was taken from the parents of neonates before including them in the study.

Inclusion Criteria

1. All neonates with pneumothorax
2. Babies whose parents are giving informed written consent for inclusion in study

Exclusion Criteria

1. Babies having major congenital malformations.

Data Collection:

All neonates with pneumothorax in inborn and outborn NICU meeting the inclusion criteria had included in the study.

Sample size

60 new born babies in Pravara hospital medical college having sign and symptoms of pneumothorax

METHODS

Method of collection of data

The data was obtained from neonates that were delivered in our hospital which were admitted in inborn NICU and referred from another hospital which were admitted in outborn NICU and met the inclusion and exclusion criteria.

As soon as we diagnosed the case of pneumothorax, we retrospectively had taken details history.We recorded all the details if the neonate had RDS and required surfactant, if they had congenital pneumonia, MAS, history of birth asphyxia.

If baby presented with small pneumothorax like pockets and with no distress then we had done observation to check spontaneous resolution of pneumothorax. If it had not resolved or increased in size causing respiratory distress then we had taken baby on CPAP followed by needle aspiration of that pneumothorax. Needle aspiration was done by 23G or 25G butterfly needle in second intercostal space in midclavicular line.

Some neonate presented with respiratory distress, cyanosis and pneumothorax who required ventilator support, so in those cases we had done chest tube insertion by French size 10 or 12 in 4th intercostal space and sutured with 3-0 silk with underwater drainage system. Chest x-ray was done to confirm the position of tube.

After collecting the data, we had analysed and result are as follows.

RESULTS

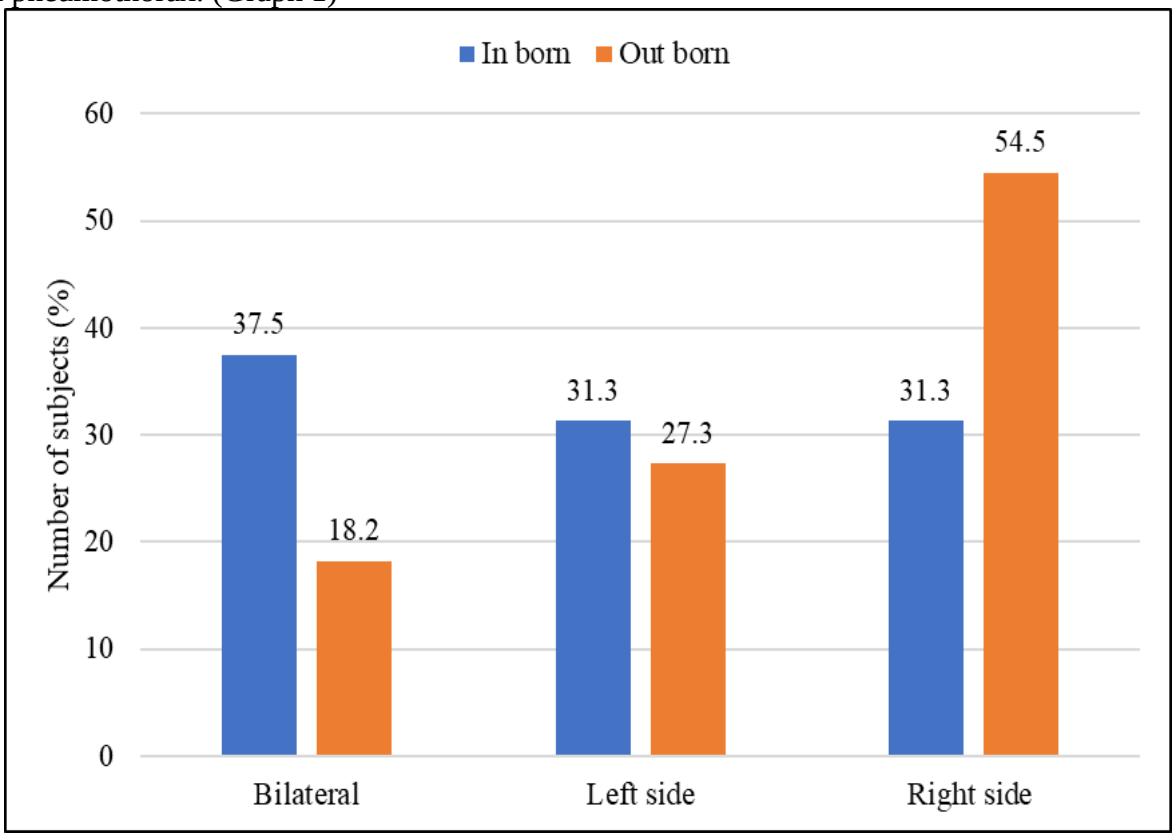
These are the results done on descriptive longitudinal study involving all neonates inborn and outborn who developed pneumothorax during hospital stay during period of December 2020 to December 2022.

Table 1: Distribution of pneumothorax cases according to side involved

		In born		Out born		Total	P
		No	%	No	%		
Side involved	Bilateral	6	37.5	8	18.2	14	0.19, Not significant
	Left side	5	31.3	12	27.3	17	
	Right side	5	31.3	24	54.5	29	
Total		16	100.0	44	100.0	60	

In this study, out of 60 babies, 29 (48.3%) had right sided pneumothorax, 17 (28.3%) left sided pneumothorax and 14 (23.3%) had bilateral pneumothorax. In inborn 6 (37.5%) babies had

bilateral pneumothorax, 5 (31.3%) each had left and right sided pneumothorax. In outborn 8 (18.2%) babies had bilateral pneumothorax, 12 (27.3%) had left sided pneumothorax and 24 (54.5%) had right sided pneumothorax. (Graph 1)



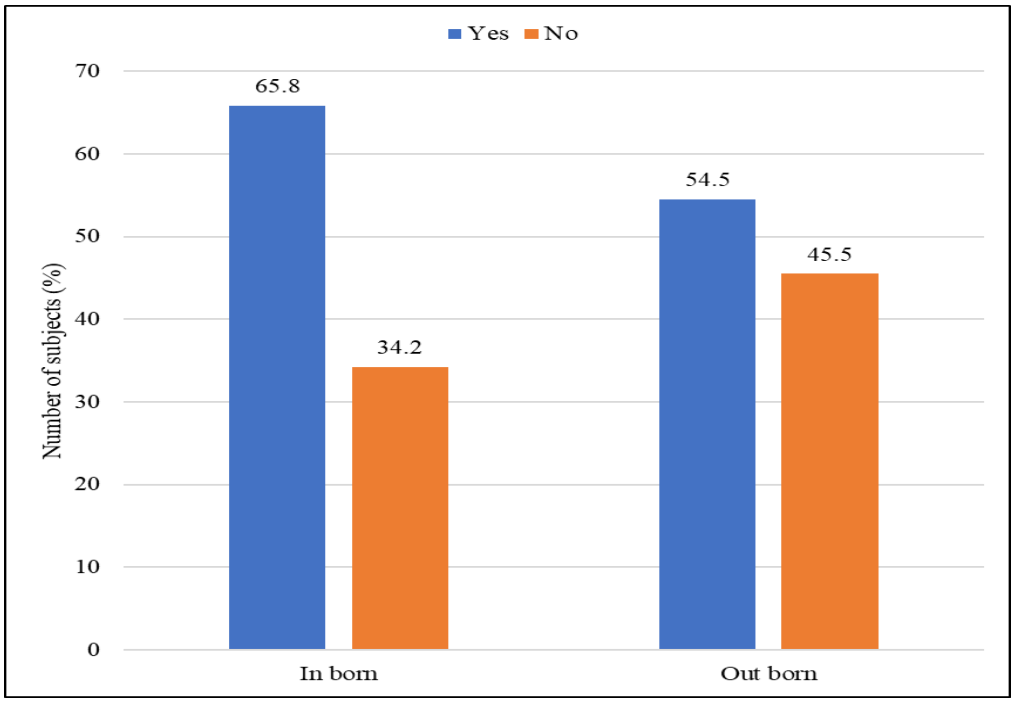
Graph 1: Bar diagram showing Distribution according to pneumothorax side involved

Table 2: distribution of use of CPAP and ventilator use

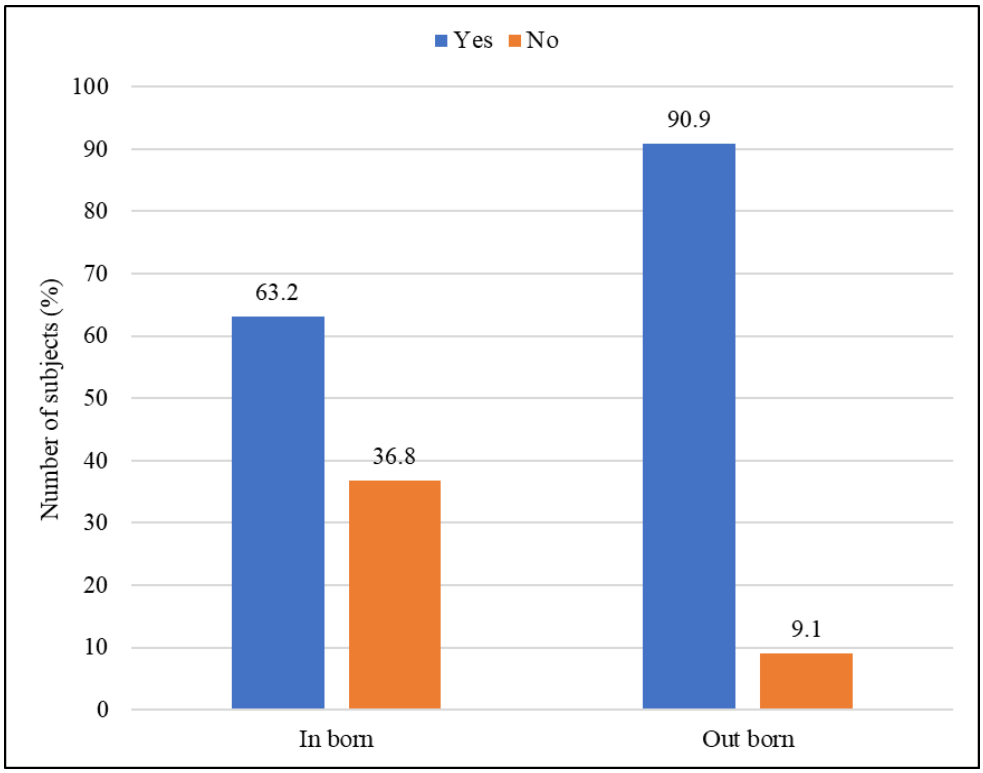
Treatment given		Inborn (n=38)	Outborn (n=22)	Total (n=60)	P value
CPAP	Yes	25 (65.78	12 (54.54	37	0.42
	No	13 (34.21	10 (45.45	23	
Use of ventilator	Yes	24 (63.15	20 (90.90	44	**0.03**
	No	14 (36.84	2 (9.09	16	

Out of total 60 cases in study, 37 (61.66%) required CPAP for respiratory support among which, 25 (65.8 %) were inborn and 12(54.5%) were outborn babies. This was found to be statistically not significant (p=0.38). (Graph 2)

Out of 60 cases, 44 (73.3%) babies required ventilator support and 16 did not required ventilator support, among 44 who required ventilator support, 24 (63.2%) were inborn and 20 (90.9%) were outborn. This found to be statistically significant (p = 0.01). (Graph 3)



Graph 2: Bar diagram showing Distribution of cases according to CPAP

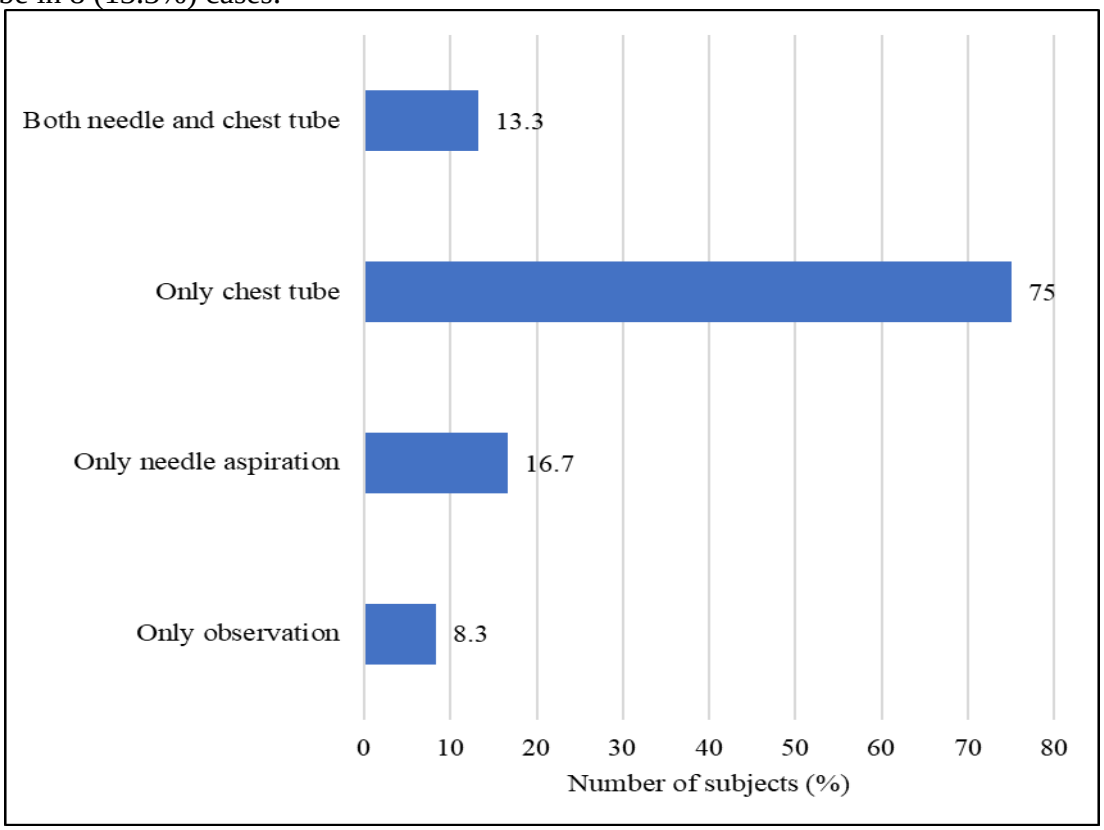


Graph 3: Bar diagram showing Distribution of cases according to use of ventilator

Table 3: Distribution according to treatment modality for pneumothorax

		Frequency	Percent
Treatment	Only observation	5	8.3
	Only needle aspiration	10	16.7
	Only chest tube	45	75.0
	Both needle and chest tube	8	13.3

Out of 60 cases, Treatment modality for pneumothorax revealed as: Only observation done in 5(8.3%), Only needle aspiration in 10(16.7%), Only chest tube in 45(75.0%) and both needle and chest tube in 8 (13.3%) cases.



Graph 4: Bar diagram showing Distribution according to treatment modality for pneumothorax

Table 4: Distribution of pneumothorax cases according to treatment given and side involved

		Left sided (n=17)	Right sided (n=29)	Bilateral (n=14)	Total (n=60)	P value
Observation	Yes	9	10	4	23	0.32
	No	8	19	10	37	
Needle aspiration	Yes	8	6	5	19	0.16
	No	9	23	9	41	
Chest tube insertion	Yes	11	23	11	45	0.51
	No	6	6	3	15	

Out of total 60 cases, 23 cases managed by observation at point of treatment duration. 19 baby required needle aspiration, out of which those babies who had left sided pneumothorax (57%)required more needle aspiration as compared to right sided (20%)and bilateral cases (35%) of pneumothorax. Out of 60, 45 baby required chest tube insertion in which right sided (79.3%) cases and bilateral side (78.5%) involved cases required more frequent chest tube insertion as compared to left side involved.

DISCUSSION

This is descriptive longitudinal study involving all neonates inborn and outborn who developed pneumothorax during hospital stay during period of December 2020 to December 2022.

Neonatal pneumothorax and pneumothorax side involved

Study	Distribution of side involved in pneumothorax		
	Right side	Left side	Bilateral
Present study	48.3%	28.3%	23.3%
Silva IS et al[23]	46.3%	43.3%	10%
APILIOGULLARI et al[20]	40%	30%	30%
Al-Anbari AJ et al[26]	65.9%	19.5%	14.6%
Jovandaric M Z et al[27]	47%	36%	16%
kim E et al[21]	63.9%	25%	4%

In present study, we found 48.3% of right sided pneumothorax, 28.3% left sided pneumothorax and 23.3% bilateral pneumothorax. Our study was comparable with Silva IS et al[23], APILIOGULLARI et al[20], Jovandaric M Z et al[27]. Al-Anbari AJ et al[26] and kim E et al[21]found right sided pneumothorax cases slightly more higher (65.9% and 63.9% respectively) than left side. It is known fact that right sided pneumothorax is more than left sided as right bronchus is straight causing more infection and meconium aspiration on right side.

Neonatal pneumothorax and use of CPAP

Study	Distribution of pneumothorax cases req CPAP
Present study	61%
Al-Anbari AJ et al[26]	56%
Jovandaric M Z et al[27]	41%
kim E et al[21]	27%
Silva IS et al[23]	18.8%

- Out of 60 cases of pneumothorax 37 (61%) patients were put on CPAP which is similar to Al-Anbari AJ et al[26]. Al-Anbari AJ et al[26] reported mean age of neonatal pneumothorax was 34.6 weeks so all are late preterm still they had less CPAP cases than present study.
- Jovandaric M Z et al[27] 2021 reported 41% cases on CPAP but he used nCPAP mode of ventilation and mean gestational age was 34.1+/- 4 days. Kim E et al[21] reported use of CPAP in 27% cases of neonatal pneumothorax which is not compatible with our study as he included neonates with >34 weeks of gestation and their sample size was only 36.As surfactant is formed after 34 weeks of gestation so there is less use of CPAP for preterm babies.
- Silva IS et al[23] had median gestational age of 37 week and only 9 (11.3%) cases were <28 weeks gestation so they had less CPAP cases than present study. Prematurity requires CPAP that means HMD is one of the cause for pneumothorax. Prematurity leads to RDS,

post-surfactant and CPAP all are high risk for developing pneumothorax.

Neonatal pneumothorax and use of ventilator

Study	Distribution of pneumothorax cases who required ventilator
Present study	73% (n=44)
Silva IS et al[23]	75%
APILIOGULLARI et al[20]	60%
Al-Anbari AJ et al[26]	36.6%
kim E et al[21]	50%

- In present study out of 60 cases, 44 babies (73%) required ventilator support, in which 24 (63.2%) were inborn and 20 (90.9%) were outborn, present finding were comparable with the Silva IS et al[23] and APILIOGULLARI et al[20] who required 75% and 60% respectively.
- Al-Anbari AJ et al[26] had studied on 41 neonates with mean gestational age of 34.6 week with more than 2 kg (49%) and with most in 31-40 week (85%) so as mature babies had mature lung, they required less ventilator support for the survival. Kim E et al[21] studied on neonates with >34 weeks of gestation with 1.1% were diagnosed with symptomatic pneumothorax who required intervention. In Jovandaric M Z et al[27] 2022, 66% preterm and 33% term required ventilator support.

Neonatal pneumothorax and treatment modality for pneumothorax

Study	Treatment modality for pneumothorax (%)			
	Observation	**Needle aspiration**	**Chest tube insertion**	**Both needle and chest tube insertion**
Present study (n=60)	8.3	16.7	75	13.3
Silva IS et al[23] (n=80)		12.5	71	3.8
Al-Anbari AJ et al[26] (n=41)			75.6	
kim E et al[21] (n=36)	22.2	2.8	63.9	
Jovandaric M Z et al[27] (n=74)	35		64	

- Present study shows, 45 (75%) patients were treated by chest tube insertion which is comparable with study done by Silva IS et al[23], Al-Anbari AJ et al[26], kim E et al[21] and Jovandaric M Z et al[27]. Also present study shows only observation was done in 5 (8.3%) cases, only needle aspiration done in 7 (12.5%) and chest tube and needle aspiration done in 8 (13.3%) cases.
- Silva IS et al[23] studied pneumothorax cases in late preterm and full term only and he did needle aspiration in 12.5% cases, chest tube insertion in 71% cases followed by both needle and chest tube insertion in 3.8 % cases. Jovandaric M Z et al[27] studied on 74 neonates and they had managed pneumothorax cases by either only observation (35%) or by only chest tube insertion (64%).
- Kim E et al[21] (n=36) and Al-Anbari AJ et al[26] (n=41) studied on less number of pneumothorax cases and their main modality was chest tube insertion. APILIOGULLARI et al[62] had done only chest tube placement in all 30 neonates.

- Regarding the distribution of pneumothorax cases according to treatment given and side involved, there should be study on large cohort for long duration and follow up to study detailed about relation of side involved and treatment strategy requiring to improve the neonatal outcome and to improve neurodevelopmental follow up among neonatal pneumothorax cases.

CONCLUSION:

1. Neonatal pneumothorax remains a significant concern in NICUs,the findings underscore the need for vigilant monitoring of neonates at risk of pneumothorax, especially those undergoing mechanical ventilation or with underlying respiratory conditions.
2. Treatment strategies should be tailored based on the severity of the condition, ranging from conservative management in mild cases to urgent interventions such as needle thoracocentesis and chest tube placement in life-threatening cases.
3. Advances in neonatal care, such as non-invasive respiratory support and the judicious use of mechanical ventilation, have shown potential in preventing pneumothorax.
4. Further research on minimally invasive techniques, use of HFOV and long-term outcomes will enhance our understanding and management of neonatal pneumothorax.

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