Use of Chin Strap to Maintain FRC

The use of a chin strap during nasal CPAP in extremely preterm infants is not a standard guideline-endorsed recommendation, and there is no robust clinical trial evidence specifically evaluating chin straps in this population. However, the physiological rationale for mouth closure during nasal CPAP is well established, and chin straps are used in some units as one of several strategies to minimize mouth leak.

Physiological Rationale: Nasal CPAP maintains functional residual capacity (FRC) by delivering continuous distending pressure through the nares.[1][2][3] Because preterm infants are preferential nasal breathers, CPAP is generally well tolerated via the nasal route.[1] However, mouth opening during nasal CPAP creates a significant pressure leak, reducing the effective distending pressure delivered to the lungs. Oropharyngeal and esophageal pressures during nasal CPAP demonstrated that closing the mouth is advisable during nasal CPAP to achieve appropriate oropharyngeal pressure transmission.[4] Without mouth closure, the distending pressure may not be effectively transmitted to the lower airways, undermining the primary CPAP therapy goal.

Available Evidence in Neonates: A study of preterm infants receiving nCPAP described using "a baby chin strap" or gently keeping the mouth shut as strategies to minimize mouth leak during CPAP delivery, though this was a methodological detail rather than a formal evaluation of the chin strap itself.[5]

The ToNIL trial demonstrated that large interface leakages are common during both prongs and nasal masks neonatal CPAP, and that simple "leak-corrective manoeuvres" (including repositioning and ensuring mouth closure) significantly reduced leakage for both interface types.[6]

A recent randomized trial (FONDUE) of face mask vs. nasal mask CPAP in very preterm infants explicitly noted that clinicians were discouraged from manually closing the mouth during nasal CPAP to avoid stimulating the trigeminocardiac reflex (trigeminal nerve reflex), which can cause bradycardia and apnea. This raises an important safety consideration for any device applying pressure to the jaw or chin in preterm infants.[7]

Chin Strap Evidence in Adults (for Context): The existing chin strap literature is almost entirely from adult sleep medicine. In adults, chin straps reduce mouth leak during CPAP and may improve adherence, but they can also increase snoring and, in rare cases, worsen the respiratory disturbance index.[8][9] These findings are not directly translatable to the neonatal population.

Key Considerations for Extremely Preterm Infants

Skin fragility: Extremely preterm infants have extremely thin, fragile skin that is highly susceptible to pressure injury and adhesive-related trauma. Any chin strap device must be carefully designed to avoid skin breakdown.

Trigeminocardiac reflex: Pressure on the face and jaw can stimulate the trigeminal nerve, potentially causing bradycardia and apnea, a concern explicitly raised in recent neonatal CPAP trials.[7]

Nasal septum and facial injury: Nasal CPAP interfaces already carry a significant risk of nasal trauma in preterm infants; adding a chin strap introduces additional contact points and potential for injury.[10]

Alternative strategies: Ensuring proper interface fit (binasal prongs may leak less than nasal masks), using appropriate CPAP pressure levels (5–8 cmH_2O), and employing simple repositioning maneuvers are evidence-based approaches to reducing leak without the risks associated with chin straps.[6][10][11]

Summary

While maintaining mouth closure during nasal CPAP is physiologically sound and improves pressure delivery in neonates, the use of a chin strap specifically in extremely preterm infants lacks formal clinical trial evidence and is[4] not endorsed by major neonatal guidelines (AHA/AAP 2025, Cochrane reviews).[12] Some units use chin straps or gentle manual mouth closure as part of routine CPAP care, but concerns about skin injury, the trigeminocardiac reflex, and lack of efficacy data in this fragile population warrant caution.[7] Optimizing interface selection, fit, and positioning remains the primary evidence-based approach to minimizing CPAP leak and maintaining FRC.

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Maintaining FRC without Chinstrap Use

Several evidence-based alternatives and complementary strategies exist to maintain FRC in extremely preterm infants receiving nasal CPAP, without relying on a chin strap. These span interface optimization, ventilatory mode selection, positioning, and pressure management.

Optimizing the CPAP Interface: The most direct approach to maintaining effective distending pressure (and FRC) is selecting an interface that minimizes leak. A Cochrane review found that nasal masks may reduce CPAP treatment failure by ~25% compared with binasal prongs, likely due to a more efficient seal and lower intrinsic resistance.[1] Nasal masks also reduce moderate-to-severe nasal injury.[2] A bench-to-bedside study measuring oropharyngeal pressures in preterm infants on bubble CPAP demonstrated that nasal masks delivered the most accurate distending pressure, with nearly all infants receiving pressures within 1 cmH_2O of the set level, compared with significant pressure loss with RAM cannulae and intermediate loss with Hudson prongs.[3]

Proper **sizing and positioning** of the interface is critical. Incorrect sizing and positioning of CPAP prongs are independent risk factors for severe nasal trauma and pressure loss.[4] Simple leak-corrective maneuvers (repositioning the interface, adjusting headgear) were shown in the ToNIL trial to significantly reduce leakage for both prongs and masks.[5]

Nasal Intermittent Positive Pressure Ventilation (NIPPV)

NIPPV superimposes cycled peak inspiratory pressures over baseline CPAP, providing additional lung recruitment and FRC maintenance beyond what CPAP alone achieves.[6] A Cochrane review found that early NIPPV likely reduces respiratory failure and the need for intubation compared with CPAP in infants ≥28 weeks, and may slightly decrease chronic lung disease.[6] A 2026 multicenter RCT (24–29 weeks) was stopped early because NCPAP was inferior to NIPPV, with NIV failure within 72 hours occurring in 26.1% vs. 13.2% (adjusted risk difference 12.8%).[7] However, data specifically in infants <28 weeks remain limited.[6]

Prone Positioning

Prone positioning is a well-established, non-device strategy to improve FRC and oxygenation in preterm infants on respiratory support. Key evidence includes:

In oxygen-dependent preterm infants recovering from RDS, **FRC and oxygen saturations were significantly higher in the prone position**.[8] Prone positioning improves ventilation-perfusion matching, reduces intrapulmonary shunting, and decreases alveolar dead space in ventilated neonates. Enhanced oxygenation has also been demonstrated in preterm infants receiving CPAP, with improved thoracoabdominal synchrony in the prone position.[9]

A Cochrane review found a small but statistically significant improvement in oxygenation (~2% higher SpO_2) with prone positioning in hospitalized infants with respiratory distress.[8] A prospective physiological study confirmed that 6-hour pronation improved gas exchange and lung aeration without hemodynamic side effects in neonates on CPAP or mechanical ventilation.[10]

The AAP notes that during the acute phase of respiratory illness, the benefits of prone positioning may outweigh the importance of modeling safe sleep positioning, though transition to supine must occur well before discharge.[8]

CPAP Pressure Optimization

Ensuring adequate CPAP pressure levels (typically **5–8 cmH_2O**) is fundamental to maintaining FRC.[11][12] Higher pressures may improve lung recruitment in under-recruited lungs, but excessive pressure risks overdistension, impaired gas exchange, and air leak syndromes. An individualized approach, titrating pressure based on clinical assessment, oxygenation, and work of breathing is recommended.[11]

High-Flow Nasal Cannula (HFNC)

HFNC (2–8 L/min) generates distending pressure through loosely fitting nasal prongs, reducing nasal trauma (~50% reduction) and improving comfort compared with CPAP.[4] However, HFNC has a higher treatment failure rate than CPAP when used as primary support, particularly in the most immature infants, and is generally not recommended as first-line therapy for ELBW infants (<28 weeks).[13][14] It may be considered as step-down support once infants are more stable.

Summary of Alternatives

Strategy	Mechanism for FRC Maintenance	Key Evidence	References
Nasal mask interface	Better seal, lower resistance, less pressure loss	~25% reduction in CPAP failure vs. prongs	[1], [2], [3]
Interface repositioning	Reduces leak without additional devices	Significant leak reduction in ToNIL trial	[4]
NIPPV	Cycled PIP over CPAP augments lung recruitment	Reduces intubation need vs. CPAP	[5], [6]
Prone positioning	Improves V/Q matching, increases FRC, reduces shunt	Higher FRC and SpO_2 in prone position	[7], [8], [9]
CPAP pressure optimization (5–8 cmH_2O)	Adequate distending pressure prevents atelectasis	Individualized titration recommended	[10], [11]
HFNC (step-down only)	Generates distending pressure with less nasal trauma	Higher failure rate than CPAP in primary support	[12]

In practice, a combination of these strategies, particularly nasal mask interface with proper sizing, prone positioning during acute illness, and adequate CPAP pressure, provides the most evidence-based approach to maintaining FRC without the risks associated with chin straps in extremely preterm infants.

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CPAP Interface Rotation

The evidence on rotating CPAP interfaces is **mixed and somewhat conflicting**, with the strongest data supporting **preferential use of nasal masks** and **prophylactic hydrocolloid dressings** as the most effective strategies to prevent nasal injury, while the benefit of interface rotation itself remains uncertain. The French Neonatal Society recommends rotation as part of a multimodal prevention bundle.[1]

Evidence on Interface Rotation
The concept of rotating between nasal masks and nasal prongs aims to redistribute pressure points and reduce sustained contact on any single area of the nasal anatomy. However, the two key RCTs evaluating this strategy reached different conclusions:

Bashir et al. (2018) - a 3-arm RCT in 175 infants ≤30 weeks found that **continuous nasal mask use was superior to both rotation and continuous prongs**. Nasal injury rates were 33.3% (mask only) vs. 56.9% (rotation) vs. 91.6% (prongs only), with significantly lower injury scores in the mask-only group ($p < 0.0001$). In this study, rotation was better than prongs alone but worse than continuous mask use.[2]

Gautam et al. (2023) - a 3-arm RCT in 57 infants <35 weeks rotating every **8 hours** found that on adjusted analysis, **rotation significantly reduced nasal injury compared with continuous prongs** (AOR 0.10, 95% CI 0.01–0.69, $p = 0.02$), with a trend toward benefit over continuous mask use (AOR 0.15, $p = 0.06$). This study concluded rotation may reduce injury even further than either interface alone.[3]

A **2025 meta-analysis** (Gong et al., 12 studies, 1,271 infants) found that the pooled effect of alternating interfaces on nasal injury was **not statistically significant** (RR 0.95, 95% CI 0.27–3.29, $p = 0.093$), in contrast to the significant benefit seen with nasal masks alone (RR 0.62) and hydrocolloid dressings (RR 0.40).[4]

Rotation Frequency: When rotation is practiced, the most commonly studied intervals are:

Every 4 hours - used as routine care in the study by Poets et al. (2021), which found no difference in leak, intermittent hypoxia, or bradycardia between mask and prong segments, suggesting that frequent alternation is at least safe and does not compromise pressure delivery.[5]

Every 8 hours - used in the Gautam et al. RCT, showed benefit on adjusted analysis.[3]

Every 10–12 hours - referenced in the Newnam et al. trial, which found that the rotation group had significantly less erythema and excoriation than either continuous interface alone.[6]

There is no consensus on the optimal rotation interval.

French Neonatal Society Recommendations (2023) - The French Neonatal Society issued the most comprehensive society-level guidance on this topic, identifying three key strategies for preventing nasal injury in preterm infants on non-invasive ventilation:[1]

1. **Prophylactic hydrocolloid dressing** applied at the initiation of respiratory support
2. **Preferential use of nasal masks** over nasal prongs
3. **Rotation of ventilation interfaces**

A large prospective multicenter study (SEPREVEN, 806 infants <32 weeks) confirmed that nasal skin trauma

occurred in **51% of cases**, sometimes as early as day 1. Use of a mask and alternating mask/cannula were associated with fewer lesions than cannula alone ($p < 0.01$), and skin protection (hydrocolloid dressings) reduced injury risk (40.2% vs. 51.2%, $p < 0.05$).[7]

Other Key Prevention Strategies

Strategy	Evidence	Effect Size	References
Nasal mask (vs. prongs)	Cochrane review, 12 RCTs, 1,604 infants	~45% reduction in moderate-severe nasal injury (RR 0.55)	[1]
Hydrocolloid dressing	RCT (108 infants) + meta-analysis	34% vs. 56% injury rate (NNT = 5); pooled RR 0.40	[2], [3]
Interface rotation (mask ↔ prongs)	3 RCTs, conflicting results	Benefit uncertain on meta-analysis (RR 0.95)	[2], [4], [5]
Proper interface sizing	Observational data	Incorrect sizing is independent risk factor for severe trauma	[6]
RAM cannula with Cannulaide (vs. Hudson prongs)	RCT, 229 infants	5.4% vs. 26.4% any nasal injury ($p = 0.0001$)	[7]

Practical Summary

The strongest evidence supports **using nasal masks as the primary interface** (RR 0.55 for moderate-severe injury vs. prongs) combined with **prophylactic hydrocolloid dressings from the start of CPAP** (NNT = 5).[8][4][9] Interface rotation between masks and prongs every **4–8 hours** is widely practiced and recommended by the French Neonatal Society as part of a prevention bundle, though the meta-analytic evidence for rotation alone is not statistically significant.[1][4] When rotation is used, it should be viewed as an adjunct to and not a substitute for preferential mask use and barrier dressings. Regular nasal assessment (at least every nursing shift) is essential, as cutaneous lesions can appear within the first 1–2 days of CPAP therapy.[1][7]

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