

# Predictive Factors for Lip Revision Following Unilateral Cleft Lip Repair

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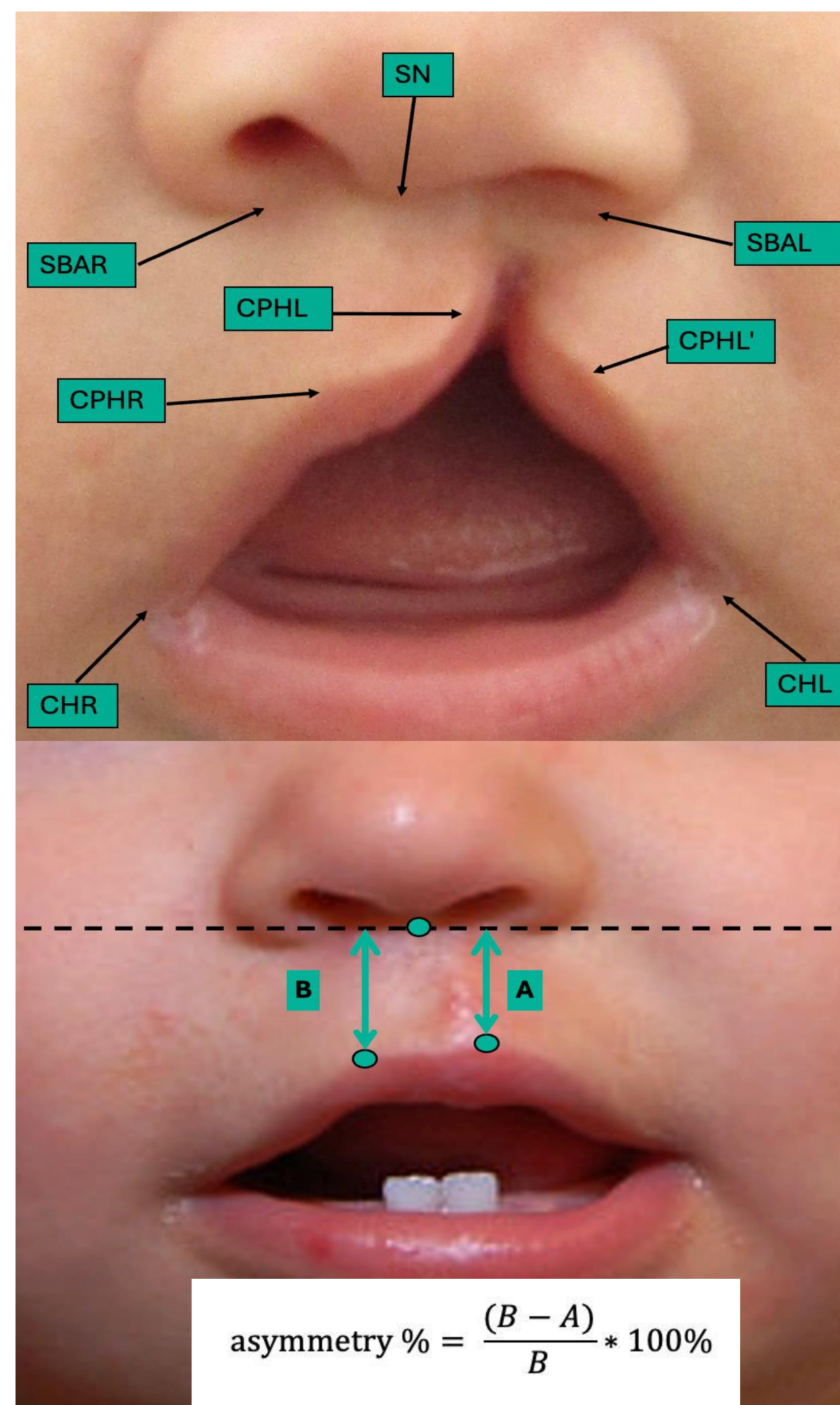


## Background & Aims

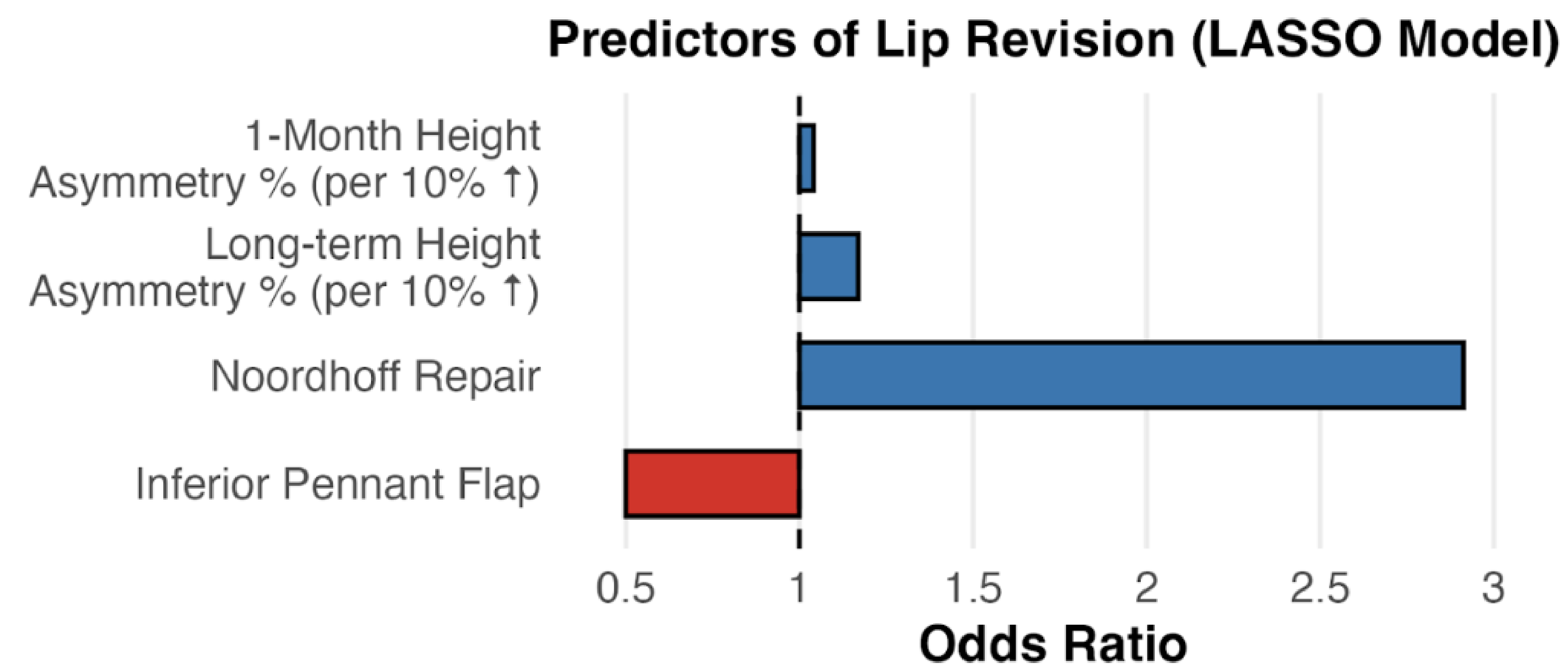
The primary goal of unilateral cleft lip repair is to achieve functional restoration and long-term aesthetic symmetry<sup>1</sup>. Despite advancements in surgical techniques, a significant subset of patients requires secondary revision surgery to address persistent asymmetry, functional impairment, or aesthetic dissatisfaction<sup>2</sup>. Currently, there is a lack of objective, early-postoperative data to help surgeons predict which patients will eventually require these secondary procedures. Identifying early anthropometric red flags and surgical risk factors is essential for refining primary repair strategies and improving patient counseling regarding the likelihood of future surgeries<sup>3</sup>. This study seeks to bridge that gap by utilizing digital morphometry and machine learning to identify specific clinical and surgical predictors of lip revision.

## Methods

- **Study Design:** Retrospective review of 139 patients treated by a single surgeon.
- **Data Collection:** Standardized frontal photographs were captured at specific intervals: preoperative, immediate postoperative, 1-month postoperative, and long-term (minimum 1-year follow-up).
- **Digital Morphometry:** Serial morphometric measurements were performed using **ImageJ** software to quantify vertical lip height and asymmetry.
- **Outcome:** Lip revision was defined as any subsequent surgical intervention intended to improve the form or function of the lip following the primary repair (n = 24, 17%).
- **Statistical Analysis:** **LASSO (Least Absolute Shrinkage and Selection Operator)** regression was utilized to identify the most significant predictors of revision while controlling for multiple variables (AUC = 0.83).



## Results



**Figure 1: LASSO Regression Model – Predictors of Lip Revision.** The LASSO model (AUC = 0.83) identified four key clinical and surgical variables that significantly influence the likelihood of a secondary lip revision. The use of an **inferior pennant flap** was the only significant protective factor, reducing the odds of revision by 50%. Conversely, the **Noordhoff technique** and **vertical height asymmetry**—measurable as early as one month post-operatively—were identified as the primary drivers of secondary surgical intervention.

**Table 1. Statistical Predictors of Secondary Revision**

| Variable                             | Odds Ratio (OR) | Clinical Interpretation                 |
|--------------------------------------|-----------------|-----------------------------------------|
| 1-Month Height Asymmetry (per 10%)   | 1.04            | Significant early warning metric        |
| Long-term Height Asymmetry (per 10%) | 1.17            | 17% increase in risk per 10% asymmetry  |
| Noordhoff Repair                     | 2.91            | Highest risk factor for revision        |
| Inferior Pennant Flap                | 0.50            | Protective factor (reduces risk by 50%) |

## Conclusions

This study demonstrates that the necessity for secondary lip revision is not random but rather is significantly influenced by early postoperative morphology and the specific surgical techniques employed during primary repair. By identifying vertical lip height asymmetry as a reliable predictor as early as one month postoperatively, surgeons can more accurately identify patients at high risk for suboptimal long-term outcomes. Furthermore, the data suggests that technical modifications, specifically the inclusion of an inferior pennant flap, may actively reduce the odds of revision by 50%. These findings provide a data-driven framework for improving surgical planning, refining primary repair techniques, and setting realistic expectations for families during early postoperative counseling.

## References

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