



# Neck Circumference As A Simple Tool For Identifying Patients At Risk For Skin Graft Failure

Rohan C. Thakur, MS<sup>1</sup>; Rachel N. Rohrich, BS<sup>2</sup>; Karen R. Li, BBA<sup>2</sup>; Christopher E. Attinger, MD<sup>2</sup>; Medhat S. Hannallah, MD<sup>3</sup>

<sup>1</sup>Gerogetown University School of Medicine; <sup>2</sup>Department of Plastic and Reconstructive Surgery, Medstar Georgetown University Hospital; <sup>3</sup>Department of Anesthesia, Medstar Georgetown University Hospital.



## Introduction

- Neck circumference (NC) serves as an accessible measure of subcutaneous and visceral adiposity in addition to being a clinical marker for cardiovascular diseases, metabolic syndrome, obstructive sleep apnea, insulin resistance, and hypertension.<sup>1</sup>
- Chronic lower extremity (LE) wounds pose a significant clinical challenge and may require a split-thickness skin grafts (STSG). However, STSG success in patients with chronic wounds can be compromised by poor perfusion, infection, and systemic conditions like diabetes and cardiovascular diseases.<sup>2,3</sup>
- NC could also serve as a marker for wound healing outcomes as an increased NC may indicate a higher risk for poor surgical wound healing due to its association with systemic conditions that adversely affect microvascular function and tissue perfusion.

## Study Aim

Our study aims to determine if NC impacts split-thickness skin graft (STSG) outcomes in patients with chronic lower extremity (LE) wounds.

## Methods

- A retrospective review of patients receiving STSG for atraumatic LE wounds between 2014 and 2022.
- Patients with a NC  $\geq$  42cm (NC-42) were compared to patients with a NC < 42cm. Data on patient demographics, wound characteristics, and skin graft outcomes were collected.
- Primary outcome was graft failure.

## Results

**Table 1.** Patient Demographics

|                                        | Total           | Neck < 42       | Neck $\geq$ 42  | p-value           |
|----------------------------------------|-----------------|-----------------|-----------------|-------------------|
|                                        | No. (%)         | No. (%)         | No. (%)         |                   |
|                                        | 145 (100.0)     | 83 (57.2)       | 62 (42.8)       |                   |
| Demographics                           |                 |                 |                 |                   |
| Age (years), mean $\pm$ SD             | 62.0 $\pm$ 15.6 | 62.1 $\pm$ 16.1 | 61.8 $\pm$ 15.1 | 0.933             |
| Sex                                    |                 |                 |                 | <b>0.005*</b>     |
| Male                                   | 86 (59.3)       | 41 (49.4)       | 45 (72.6)       |                   |
| Female                                 | 59 (40.7)       | 42 (50.6)       | 17 (27.4)       |                   |
| BMI (kg/m <sup>2</sup> ), median [IQR] | 28.2 [8.3]      | 26.2 [6.5]      | 32.8 [9.3]      | <b>&lt;0.001*</b> |
| Comorbidities                          |                 |                 |                 |                   |
| CCI, median [IQR]                      | 4 [3]           | 4 [5]           | 4 [3]           | 0.864             |
| Diabetes                               | 79 (54.5)       | 37 (44.6)       | 42 (67.7)       | <b>0.006*</b>     |
| Peripheral Artery Disease              | 55 (37.9)       | 32 (38.6)       | 23 (37.1)       | 0.858             |
| COPD                                   | 6 (4.1)         | 6 (7.2)         | 0 (0.0)         | <b>0.038*</b>     |
| Hypertension                           | 116 (80.0)      | 58 (69.9)       | 58 (93.6)       | <b>&lt;0.001*</b> |

\*Bold-face values indicate statistical significance, p < 0.05.

Abbreviations: IQR: interquartile range; BMI, body mass index; kg, kilogram; m<sup>2</sup>, square meters; CCI, Charlson comorbidity index; COPD, chronic obstructive pulmonary disease.

**Table 2.** Anesthesia Characteristics

|                                                     | Total          | Neck < 42      | Neck $\geq$ 42 | p-value           |
|-----------------------------------------------------|----------------|----------------|----------------|-------------------|
|                                                     | No. (%)        | No. (%)        | No. (%)        |                   |
|                                                     | 145 (100.0)    | 83 (57.2)      | 62 (42.8)      |                   |
| Neck Circumference, cm <sup>2</sup> (mean $\pm$ SD) | 40.6 $\pm$ 4.6 | 37.4 $\pm$ 2.7 | 44.8 $\pm$ 2.9 | <b>&lt;0.001*</b> |
| ASA Class                                           |                |                |                | 0.097             |
| Class I                                             | 3 (2.1)        | 3 (3.6)        | 0 (0.0)        |                   |
| Class II                                            | 10 (6.9)       | 5 (6.0)        | 5 (8.1)        |                   |
| Class III                                           | 117 (80.7)     | 70 (84.3)      | 47 (75.8)      |                   |
| Class IV                                            | 15 (10.3)      | 5 (6.0)        | 10 (16.1)      |                   |
| Mallampati score                                    |                |                |                | 0.446             |
| Class I                                             | 8 (6.6)        | 6 (8.6)        | 2 (3.9)        |                   |
| Class II                                            | 91 (74.6)      | 53 (75.7)      | 38 (73.1)      |                   |
| Class III                                           | 23 (18.9)      | 11 (15.7)      | 12 (23.1)      |                   |
| Preoperative Oxygen Saturation (%), median [IQR]    | 98 [3]         | 99 [4]         | 98 [3]         | 0.711             |

Abbreviations: OSA, obstructive sleep apnea; ASA, American Society of Anesthesiologists; IQR, interquartile range.

\*Bold-face values indicate statistical significance, p < 0.05.

**Table 4.** Multivariate Regression on Graft Failure

| Variable          | Odds Ratio (95% CI) | p-value       |
|-------------------|---------------------|---------------|
| Neck $\geq$ 42    | 2.3 (1.0, 5.0)      | <b>0.042*</b> |
| Diabetes Mellitus | 1.4 (0.6, 3.5)      | 0.440         |
| Plantar Surface   | 2.9 (1.2, 7.3)      | <b>0.022*</b> |

Abbreviations: CI, confidence interval.

\*Bold-face values indicate statistical significance, p < 0.05.

**Table 3.** Postoperative Outcomes.

|                                                | Total       | Neck < 42  | Neck $\geq$ 42 | p-value       |
|------------------------------------------------|-------------|------------|----------------|---------------|
|                                                | No. (%)     | No. (%)    | No. (%)        |               |
|                                                | 211 (100.0) | 117 (55.5) | 94 (44.6)      |               |
| Time to final follow-up (months), median [IQR] | 8.5 [22]    | 8 [24]     | 9.5 [21]       | 0.232         |
| Graft Failure                                  | 33 (15.6)   | 12 (10.3)  | 21 (22.3)      | <b>0.016*</b> |
| Time to graft failure (days), mean $\pm$ SD    | 41.5 [37.5] | 33 [27]    | 54.5 [44]      | <b>0.010*</b> |
| Infection                                      |             |            |                |               |
| Anytime                                        | 23 (10.9)   | 9 (7.7)    | 24 (24.9)      | 0.095         |
| POV-30 <sup>1</sup>                            | 7 (3.5)     | 1 (0.9)    | 6 (6.8)        | <b>0.045*</b> |
| POV-60 <sup>2</sup>                            | 8 (4.4)     | 3 (3.0)    | 5 (6.0)        | 0.473         |
| Final follow up <sup>3</sup>                   | 12 (6.0)    | 7 (6.3)    | 5 (5.6)        | 1.000         |
| Deemed Clinically Healed                       |             |            |                |               |
| POV-30 <sup>4</sup>                            | 76 (40.4)   | 47 (44.3)  | 29 (35.4)      | 0.214         |
| POV-60 <sup>5</sup>                            | 93 (52.5)   | 58 (59.2)  | 35 (44.3)      | <b>0.049*</b> |
| Final follow up <sup>6</sup>                   | 136 (75.6)  | 81 (81.8)  | 55 (67.9)      | <b>0.031*</b> |
| Reoperation at Original Wound Site             | 66 (31.9)   | 34 (29.6)  | 32 (34.8)      | 0.423         |
| Mortality                                      | 19 (13.1)   | 11 (13.3)  | 8 (12.9)       | 0.951         |

<sup>1</sup>POV-30 infection available for 202 overall: 114 Neck < 42, and 88 Neck  $\geq$  42.

<sup>2</sup>POV-60 infection available for 183 overall: 99 Neck < 42, and 84 Neck  $\geq$  42.

<sup>3</sup>Final follow-up infection available for 201 overall: 112 Neck < 42, and 89 Neck  $\geq$  42.

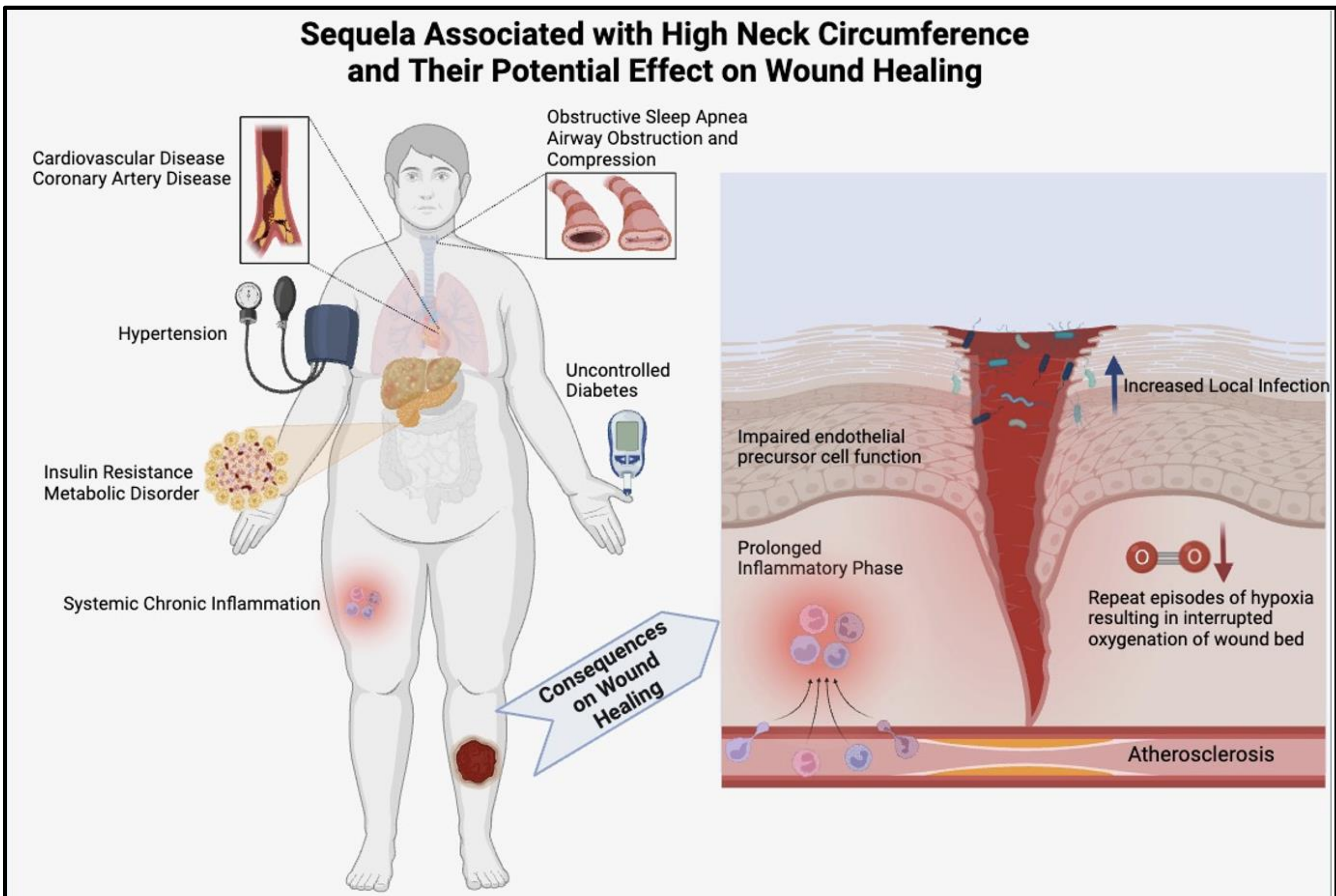
<sup>4</sup>POV-30 healing available for 188 overall: 106 Neck < 42, and 82 Neck  $\geq$  42.

<sup>5</sup>POV-60 healing available for 177 overall: 98 Neck < 42, and 79 Neck  $\geq$  42.

<sup>6</sup>Final follow-up healing available for 180 overall: 99 Neck < 42, and 81 Neck  $\geq$  42.

Abbreviations: IQR, interquartile range; SD, standard deviation; POV, postoperative visit at 30 (-30) and 60 (-60) days postoperatively.

\*Bold-face values indicate statistical significance, p < 0.05.



## Discussion

- This study identifies NC as an independent predictor of STSG failure in patients with chronic LE wounds.
- NC  $\geq$  42 cm was associated with a 2.3 times greater risk of graft failure**, even after controlling for other comorbid conditions.
- NC being an independent predictor may be due to the relationship between large NC and metabolic conditions like diabetes, hypertension, and obesity, all of which impair wound healing through mechanisms such as systemic inflammation and poor tissue perfusion.<sup>4,5,6</sup>
- NC is linked to obstructive sleep apnea (OSA), which exacerbates oxidative stress and endothelial dysfunction, further compromising healing.<sup>7</sup>
- Given the ease of NC measurement, it could be a valuable risk assessment tool and help guide preoperative and postoperative management as well as improve surgical outcomes.

## Conclusions

In a highly comorbid population, a neck circumference  $\geq$  42 cm is a significant risk factor for LE STSG failure. For patients undergoing LE reconstruction for chronic wounds, neck circumference should be considered as a preoperative assessment tool to identify patients at risk of surgical complications.

## References

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