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Redefining neck rejuvenation: pain assessment and satisfaction with calcium hydroxyapatite and polydioxanone threads

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ORIGINAL STUDY

ABSTRACT

Background: Skin aging is influenced by multiple factors, with collagen loss being the most significant due to its progressive physiological decline. Recent trends favor minimally invasive rejuvenation techniques. This study assessed the pain and satisfaction after collagen stimulation treatments using calcium hydroxylapatite (CAHA) and polydioxanone (PDO) threads in the neck region. **Methods:** Two groups of four participants each were formed: CAHA and PDO. Outcomes were assessed pre- and post-treatment at six months via data collection, photography, and a structured satisfaction questionnaire. The CAHA group comprised four females aged 30–74 years, while the PDO group included three females and one male aged 37–58 years. **Results:** Both treatments contributed to safe skin improvement in the neck, enhancing participant satisfaction. No major adverse effects were reported, with minimal downtime. **Conclusion:** CAHA and PDO threads are effective, minimally invasive options for neck rejuvenation, improving flaccidity, texture, and overall appearance.

Keywords: Polydioxanone threads; Calcium hydroxylapatite; Collagen stimulation; Rejuvenation; Neck.



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1 INTRODUCTION

Collagen production is abundant during childhood but declines after the third decade, becoming progressive and halting in old age (1,2). Cutaneous aging results from intrinsic (genetic) and extrinsic (environmental, e.g., UV exposure, smoking, stress) factors, leading to wrinkles, expression lines, ptosis, and fat pad atrophy (3,4).

Psychological and social perceptions of aesthetic procedures in aging have been explored, with elderly and middle-aged women associating them with improved health and quality of life (5,6). Appearance influences self-esteem and social interactions (1,2,5,6).

Neck skin flaccidity is a common aesthetic concern (7). Collagen biostimulators like CAHA and PDO threads promote neocollagenesis without surgery (8–10).

PDO threads, synthetic absorbable sutures used surgically for decades, are biocompatible, non-allergenic, and resorbed via hydrolysis in 4–6 months, stimulating fibroblasts for collagen and elastin production (8,9). They offer minimal complications, simple application, low pain, and quick recovery (9).

CAHA, used esthetically for over two decades, is injected as a gel for filling, then diluted for subdermal biostimulation in areas like the neck (11–13). Its biodegradable microspheres in a carboxymethylcellulose gel induce fibroblastic response, enhancing skin support (14,15).

Surgical neck lifts risk necrosis, pigmentation changes, ischemia, and scarring (7,16). Minimally invasive options are preferred (17,18).

Literature lacks direct comparisons of PDO threads and CAHA for neck rejuvenation. Thus, the objective of this study was to assess the pain and satisfaction of the patient following collagen stimulation treatments in the neck region, using calcium hydroxyapatite (CAHA) and polydioxanone (PDO) threads, to fill a gap in the literature regarding these approaches.

2 METHODOLOGY

This study adhered to CNS Resolution No. 466/2012 and 501/2016, approved by the Ethics Committee (Opinion No. 6.061.965; CAAE: 69231623.1.0000.8044). Participants signed informed consent for data use and publication. As inclusion criteria



were considered Males/females signing informed consent, available for follow-up, dissatisfied with neck appearance, mild-to-moderate flaccidity. As exclusion criteria were excluded pregnant/lactating women, patients with collagen degradation diseases, with prior cervicofacial surgery or recent neck aesthetics, active lesions or hypersensitivity.

Eight participants (aged 30–74 years) were randomly allocated (four per group: CAHA and PDO). Procedures were performed by a single trained professional for standardization. Assessments included pre/post-6-month photography, anthropometric data, Visual Analog Scale (VAS) for pain (0–10), and a Likert-scale satisfaction questionnaire (1–5: 1=very satisfied/important to 5=very dissatisfied/unimportant). Questions covered self-esteem, appearance, texture, wrinkles, social limitations, and intent to repeat (post-6 months). Self-reported social downtime, medications, and adverse events were noted.

Participants avoided other neck treatments pre/post-procedure.

- **CAHA Procedure:** Four females (aged 30, 44, 46, 74 years). Topical 4% lidocaine (Dermomax®) for 40 minutes, skin antisepsis (70% alcohol). Infiltrative 2% lidocaine with 1:100,000 epinephrine (DFL®; ~0.8 mL per entry). Planning: five circles (entry points) with five vectors each (two lateral, one submental; Figure 1). Each vector received 0.2 mL diluted CAHA (Diamond Rennova; 1.25 mL CAHA + 3.75 mL 0.9% saline; 1:3 dilution; total 5 mL). Injected subdermally via 22G/50 mm cannula. Post-injection massage. Duration: ~25 minutes. Instructions: analgesia if needed, Hirudoid® ointment for bruising, daily massage (Figure 1).
- **PDO Procedure:** Three females, one male (aged 37, 42, 56, 58 years). Similar anesthesia and antisepsis. Planning identical to CAHA. 25 smooth monofilament i-Thread PDO threads (26G/50 mm needle) placed subdermally at 45° angle (five per design). Started submentally, then laterals. Post-placement drying if bleeding. Instructions as above (Figure 1).

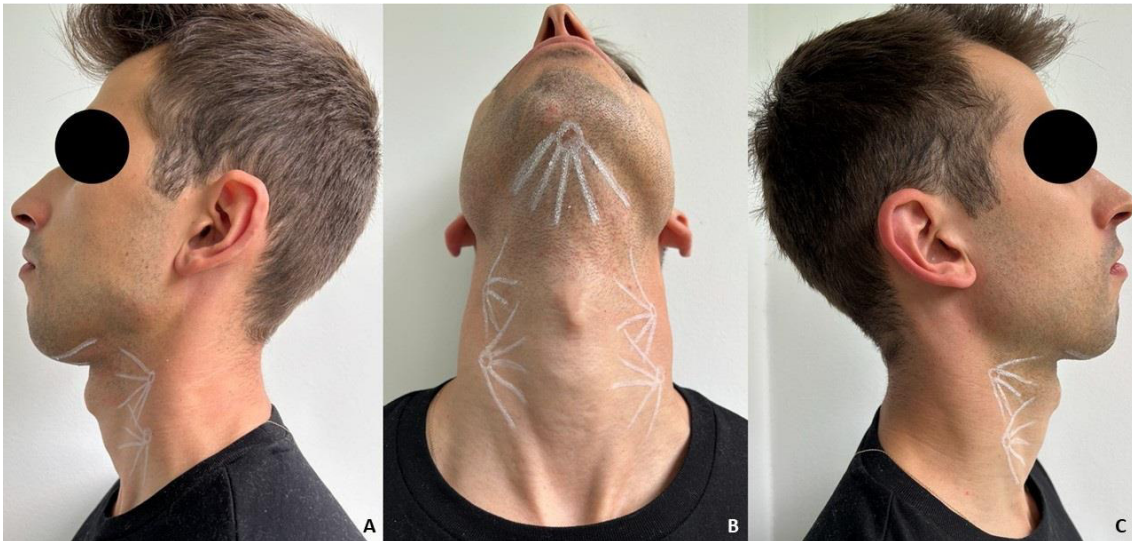


Figure 1. Representative model of the standardized protocol. A. Right profile view. B. Front view with the head tilted upward. C. Left profile view.

CAHA cases reports

The first CAHA case was a 74-year-old mixed-ethnicity female, in good health (blood pressure 120/80 mmHg; BMI 27), complained of moderate flaccidity that limited her clothing choices and social interactions. She had previously undergone basic facial treatments, such as peels and Botox. On examination, irregular skin texture, an "orange peel" appearance, and platysmal bands were noted. She rated her discomfort as 2 on the Visual Analog Scale (VAS). At the six-month follow-up, there was an improvement in flaccidity, skin thickness, and texture. She expressed satisfaction with the results, stated that she would undergo the procedure again, and reported no downtime or need for medication (Figure 2).



Figure 2. Representative figure of a participant who underwent CAHA treatment. A. Before the procedure, mild flaccidity and a slight accumulation of subcutaneous adipose tissue in the central submental region of the neck can be seen, along with well-defined lines. B. Six months after the treatment, an improvement in irregularities of the superficial skin layer is observed, along with a slight increase in dermal thickness.

The second comprised a 44-year-old white female, in good health (blood pressure 110/80 mmHg; BMI 22), presented with mild flaccidity and submental fat. She had previously undergone facial treatments including Botox, hyaluronic acid fillers, microfocused ultrasound, and bichectomy. Her discomfort was rated as 1 on the Visual Analog Scale (VAS). At the six-month follow-up, she exhibited firmer and more vibrant skin, expressed satisfaction with the results, stated she would repeat the procedure, and reported no issues.

The third was a 46-year-old white female, in good health (blood pressure 110/80 mmHg; BMI 23), presented with mild flaccidity, thin skin, transverse sulci, and platysmal bands. She expressed fear of surgery and reported adhering only to basic skincare. Her discomfort was rated as 2 on the Visual Analog Scale (VAS). At the six-month follow-up, she showed improvements in skin flaccidity and texture, expressed satisfaction with the results, and stated she would repeat the procedure. She used Hirudoid® for an 8-day hematoma but experienced no downtime.

The fourth and last CAHA case was of a 30-year-old mixed-ethnicity female, in good health (blood pressure 100/80 mmHg; BMI 20), presented with mild flaccidity and thin skin. She had previously undergone facial treatments, including Botox and hyaluronic acid fillers. Her discomfort was rated as 3 on the Visual Analog Scale (VAS). At the six-month follow-up, she showed increased dermal thickness and a firmer skin

texture. She expressed satisfaction with the results, stated she would repeat the procedure, and reported no issues.

PDO Series

The first PDO threads case comprised a 42-year-old white female, in good health (blood pressure 110/80 mmHg; BMI 20), presented with moderate flaccidity, irregular skin texture, sulci, thin skin, and platysmal bands. She reported following only basic skincare routines. Her discomfort was rated as 1 on the Visual Analog Scale (VAS). At the six-month follow-up, she showed reduced flaccidity and sulci, with firmer skin. She expressed satisfaction with the results, stated she would repeat the procedure, and reported no issues (Figure 3).

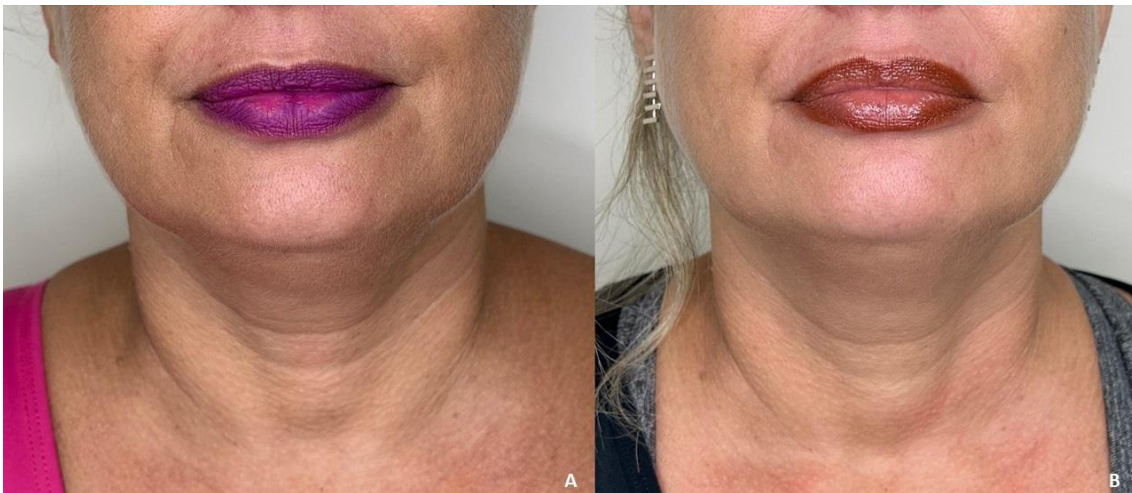


Figure 3. Representative figure of a participant who underwent PDO thread treatment. A. Before the procedure, the participant presented with mild flaccidity and a slight accumulation of subcutaneous adipose tissue in the central submental region of the neck, along with well-defined lines. B. Six months after the treatment, an improvement in the irregularities of the superficial skin layer was observed, along with a slight increase in dermal thickness.

The second case was a 58-year-old pardo male, in good health (blood pressure 110/80 mmHg; BMI 23), presented with moderate flaccidity, thin and dry skin, an "orange peel" texture, and platysmal bands. He is a runner and had no previous aesthetic treatments. His discomfort was rated as 3 on the Visual Analog Scale (VAS). At the six-month follow-up, there was an improvement in skin flaccidity and texture, although the skin remained dry. His skin appeared firmer, but he remarked that it "needs more." He expressed satisfaction with the results, stated he would repeat the procedure, and reported no issues.

The third case was assessed a 37-year-old white female, in good health (blood pressure 130/80 mmHg; BMI 27), presented with mild flaccidity, thin skin, and submental fat. She had previously undergone facial treatments, including Botox, hyaluronic acid (HA), and calcium hydroxylapatite (CAHA) fillers. Her discomfort was rated as 1 on the Visual Analog Scale (VAS). At the six-month follow-up, she showed a firmer skin texture, particularly in the submental area. She expressed satisfaction with the results, stated she would repeat the procedure, and reported no issues.

The fourth was of a 56-year-old white female, in good health (blood pressure 120/80 mmHg; BMI 24), presented with mild flaccidity, irregular skin texture, submental fat, and thin skin. She had no history of aesthetic treatments and used sunscreen irregularly. Her discomfort was rated as 1 on the Visual Analog Scale (VAS). At the six-month follow-up, she showed improved flaccidity and skin vitality and had adopted a consistent skincare routine. She expressed satisfaction with the results, stated she would repeat the procedure, and reported no issues.

3 RESULTS AND DISCUSSION

Table 2 presents the quantitative and qualitative data pre- and post-treatment for eight participants undergoing minimally invasive procedures for neck rejuvenation: four in the Calcium Hydroxyapatite (CAHA) group and four in the Polydioxanone Threads (PDO) group. Results were evaluated using the Visual Analog Scale (VAS) for pain, post-procedure medication use, and a seven-item satisfaction questionnaire (Q1 to Q7), completed before and after six months. Responses employed a 1–5 Likert scale, where 1 indicates positive responses (e.g., very satisfied, important) and 5 negative (e.g., very dissatisfied, unimportant). Complementary graphs (1 to 4) illustrate trends, with pre-treatment responses in green (predominantly negative) and post-treatment in blue (positive).

Regarding pain, all participants reported "mild discomfort" during the procedure (approximate VAS mean of 2), regardless of group, indicating good tolerance with topical and infiltrative anesthesia. Post-treatment, there was complete absence of pain in all cases, reinforcing the low invasiveness of the methods. As for medication, only one patient in the CAHA group (Patient 3) required topical ointment (Hirudoid®) for

hematoma, resolved in eight days without additional complications. The remaining seven participants reported no medication use or interventions, and nonexperienced disruption to routine activities, highlighting the safety and short recovery time (zero social downtime).

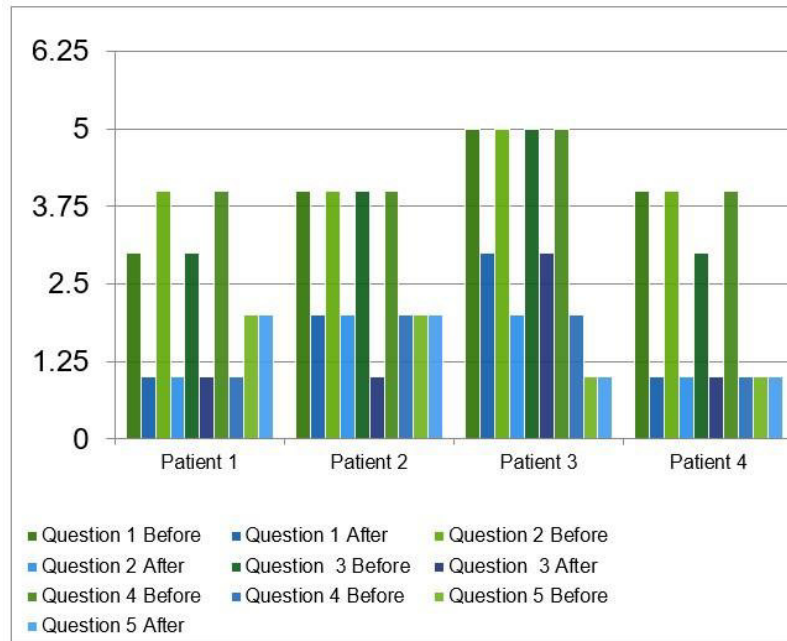
The satisfaction questionnaire revealed consistent improvements in both groups. For Q1 ("Regarding your neck appearance, how do you feel?"), pre-treatment, the PDO group showed 1 dissatisfied and 3 very dissatisfied (mean 4.25), while CAHA had 2 dissatisfied, 1 neutral, and 1 very dissatisfied (mean 3.75). After six months, PDO progressed to 2 neutral and 2 satisfied (mean 2.5), and CAHA to all very satisfied (mean 1). Similarly, for Q2 (texture), pre: PDO/CAHA with 3 dissatisfied and 1 very dissatisfied each (mean 4.25); post: PDO with 3 neutral and 1 satisfied (mean 2.75), CAHA all very satisfied (mean 1). Q3 (wrinkles and lines) followed a similar pattern: pre mean 3.75–4; post PDO mean 2.5 (2 satisfied, 2 neutral), CAHA mean 1.5 (2 very satisfied, 2 neutral) (Table 1, figure 4 and 5).

Table 1. Pre- and post-treatment data with pdo and caha regarding postoperative pain occurrence (vas) and satisfaction with the treatment.

VAS and Satisfaction	CAHA Patient 1	PDO Patient 1	CAHA Patient 2	PDO Patient 2	CAHA Patient 3	PDO Patient 3	CAHA Patient 4	PDO Patient 4
VAS (during)	Mild discomfort	Mild discomfort	Mild discomfort	Mild discomfort	Mild discomfort	Mild discomfort	Mild discomfort	Mild discomfort
VAS (after)	Absence of	Absence of	Absence of	Absence of	Absence of	Absence of	Absence of	Absence
Medication	No	No	Yes	No	No	No	No	No
Q1 (pre)	Neither	Dissatisfied	Dissatisfied	Very dissat	Very dissat	Very dissat	Dissatisfied	Very diss
Q1 (post)	Very satisfi	Neither	Satisfied	Neither	Neither	Satisfied	Very satisfi	Satisfied
Q2 (pre)	Dissatisfied	Dissatisfied	Dissatisfied	Very dissat	Dissatisfied	Dissatisfied	Dissatisfied	Dissatisfied

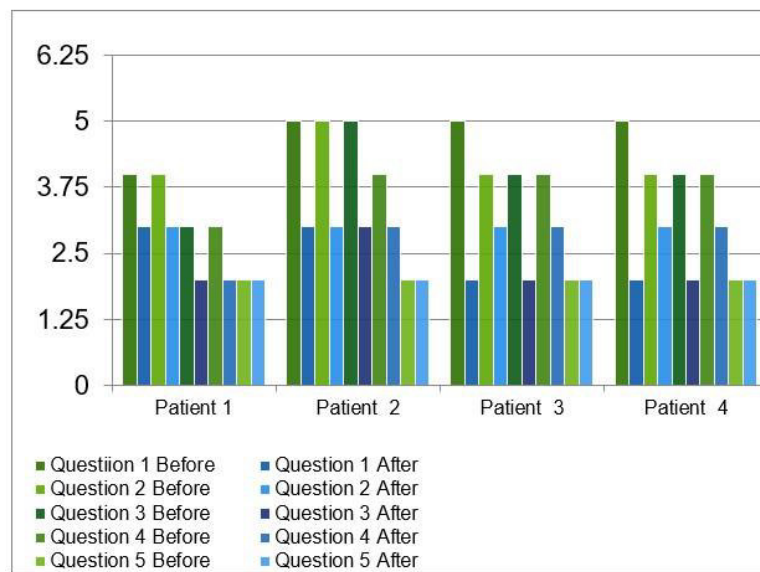
Q2 (post)	Very satisfi	Neith er	Satisfi ed	Neith er	Satisfi ed	Neith er	Very satisfi	Neit her
Q3 (pre)	Dissat isfied	Neith er	Dissat isfied	Very dissat	Very dissat	Dissat isfied	Neith er	Diss atisfi
Q3 (post)	Very satisfi	Satisfi ed	Very satisfi	Neith er	Neith er	Satisfi ed	Very satisfi	Satis fied
Q4 (pre)	Dissat isfied	Neith er	Dissat isfied	Dissat isfied	Very dissat	Dissat isfied	Dissat isfied	Diss atisfi
Q4 (post)	Very satisfi	Neith er	Satisfi ed	Satisfi ed	Satisfi ed	Satisfi ed	Very satisfi	Satis fied
Q5 (pre)	Impor tant	Impor tant	Impor tant	Impor tant	Very impor	Impor tant	Very impor	Imp orta
Q5 (post)	Impor tant	Impor tant	Impor tant	Impor tant	Very impor	Impor tant	Very impor	Imp orta
Q6 (pre)	Disag ree	Stron glv	Agree	Agree	Stron glv	Stron glv	Agree	Agree
Q6 (post)	Disag ree	Disag ree	Disag ree	Disag ree	Disag ree	Neith er	Agree	Disa gree
Q7 (post)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Self-esteem (Q4) improved from pre-treatment dissatisfaction (mean 3.75–4) to post-treatment satisfaction (PDO mean 2; CAHA mean 1.5). Q5 (importance of neck appearance) was consistently positive pre- and post-treatment (all "important" or "very important"; mean 1.5), confirming aesthetic motivation. For Q6 (social limitation due to appearance), pre-treatment showed predominant agreement (mean 2.75–3, indicating perceived limitation); post, a shift to disagreement (PDO/CAHA mean 2–3, with neutrals and disagreements). Finally, Q7 (would you do it again?) was unanimous: all "Yes" post-treatment (Table 1, figure 4 and 5).



Note: Data from the PDO series before and after treatment. Responses 5 and 4 = (negative responses) Very Dissatisfied or Dissatisfied; Strongly Disagree or Disagree. Response 3 = (Neutral) Median/Indifferent. Responses 1 and 2 = (positive responses) Very Satisfied or Satisfied; Strongly Agree or Agree. Questions: before in green, after in blue.

Figure 4. Answers to the questions from the presented case series before and after treatment for CAHA collagen stimulator.



Note: Data from the PDO series before and after treatment. Responses 5 and 4 = (negative responses) Very Dissatisfied or Dissatisfied; Strongly Disagree or Disagree. Response 3 = (Neutral) Median/Indifferent. Responses 1 and 2 = (positive responses) Very Satisfied or Satisfied; Strongly Agree or Agree. Questions: before in green, after in blue.

Figure 5. Answers to the questions from the presented case series before and after treatment for PDO threads.

Graphs 1 (PDO) and 2 (CAHA) visualize this transition: negative responses (4–5) drop from ~80% pre to <20% post, while positive (1–2) rise to >60%. These findings



indicate efficacy in improving flaccidity perception, texture, and self-esteem, with CAHA showing more robust gains (all very satisfied in appearance/texture). Despite the small $n=8$, results suggest safe options for cervical rejuvenation, aligned with literature on biostimulators (Goldie *et al.*, 2018; Cobo, 2020). Limitations include subjectivity and lack of objective measures (e.g., elastometry). Larger studies would validate these satisfaction improvements, enhancing clinical applications.

This case series elucidates the clinical outcomes of two minimally invasive collagen biostimulatory treatments—calcium hydroxyapatite (CAHA) and polydioxanone (PDO) threads—for neck rejuvenation in eight participants with mild-to-moderate skin flaccidity (10). The results demonstrate notable improvements in patient-perceived appearance, texture, wrinkles, self-esteem, and social confidence, as evidenced by the pre- and post-treatment satisfaction questionnaire (Table 2; Figures 1–4). Both interventions were well-tolerated, with mild procedural discomfort (VAS mean ≈ 2) resolving completely post-treatment and minimal adverse events (only one instance of self-resolving hematoma treated topically with Hirudoid®). No participants reported social downtime, underscoring the safety and practicality of these approaches for outpatient settings.

The progressive decline in collagen and elastin production, exacerbated by intrinsic genetic factors and extrinsic stressors like UV exposure, leads to dermal thinning, fat atrophy, and flaccidity, particularly in the delicate neck region (1–4). Participants' pre-treatment dissatisfaction (e.g., Q1–Q4 means 3.75–4.25, indicating "dissatisfied" to "very dissatisfied") aligns with common aesthetic concerns, where neck laxity impacts self-esteem and social interactions (5–7). Post-treatment shifts were pronounced: negative responses [Likert 4–5] dropped from $\sim 80\%$ to $< 20\%$, while positives [1–2] rose to $> 60\%$ across domains.

The CAHA group exhibited more robust gains, with all participants rating appearance and texture as "very satisfied" (Q1–Q2 means=1), compared to PDO's mixed satisfaction/neutrality (means=2–2.75). This suggests CAHA's diluted subdermal injection (1:3 ratio) may provide superior neocollagenesis and dermal thickening, as observed in case reports (e.g., increased firmness in Cases 1–4) and supported by histological evidence of fibroblastic stimulation (10–14).

PDO threads, placed subdermally in a standardized vector pattern (25 units per



participant), yielded moderate improvements (e.g., Q3–Q4 means=2–2.5 post-treatment), consistent with their mechanism of controlled inflammation and collagen remodeling over 4–6 months (8,9). Case outcomes, such as reduced sulci and firmer texture (PDO Cases 1–4), echo experimental models showing sustained bioestimulatory effects in porcine tissue (19,20). However, the male participant (Case 2) noted residual dryness, potentially due to lower baseline subcutaneous fat in athletic individuals, highlighting variability in response based on demographics (20,21). Both treatments' unidimensional application (single session, no adjuncts) limits direct comparability but avoid confounding, unlike combined protocols (16–18,20).

Safety profiles were exemplary: procedural VAS scores reflected effective anesthesia, and the single hematoma (CAHA Case 3) resolved without intervention, aligning with low complication rates for biostimulators (15,20). Subdermal plane and cannulas use mitigated risks to platysmal and vascular structures (22) contrasting surgical lifts' higher morbidity (7). Unanimous intent to repeat (Q7: all "Yes") and consistent importance of neck aesthetics (Q5: means=1.5) affirm psychological benefits, enhancing quality of life (5,6).

Limitations include the small sample (n=8), subjective Likert assessments prone to bias, and lack of objective metrics (e.g., elastometry, ultrasound for dermal thickness). Ex vivo homogeneity (mild-moderate flaccidity) restricts generalizability to severe cases or diverse ethnicities. Single-session design precludes evaluating maintenance protocols, as multi-sessions may amplify neocollagenesis (23). Future randomized controlled trials (RCTs) with larger cohorts, blinded evaluators, and long-term follow-up (>12 months) are essential to quantify durability and compare against alternatives like fractional CO₂ laser or hyaluronic acid (16,18).

In summary, CAHA and PDO threads offer safe, effective neck rejuvenation, with CAHA edging in satisfaction gains. These findings advance minimally invasive aesthetics, emphasizing patient-centered outcomes in collagen restoration (1,11,20).

4 CONCLUSION

This case series demonstrates the efficacy of calcium hydroxylapatite (CAHA) and polydioxanone (PDO) threads in neck rejuvenation for eight participants with mild-



to-moderate flaccidity. Both treatments yielded significant improvements in perceived appearance, texture, wrinkles, and self-esteem, with satisfaction scores shifting from predominantly dissatisfied to satisfied/very satisfied. Procedural pain was minimal, resolving completely post-treatment, with no downtime and only one self-resolving hematoma. CAHA showed more robust gains, highlighting these as safe, minimally invasive options. Future RCTs are recommended to assess long-term durability and broader applicability.

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