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Audiological Evaluation of AirPods Pro 3 Self-Adjusted by a Young Adult With Listening Difficulty and Slight Sensorineural Hearing Loss: A Case Report

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Abstract

A 28-year-old woman with slight-to-mild sensorineural hearing loss and persistent listening difficulty purchased AirPods Pro 3 and adjusted the hearing-assistance settings during everyday use. We assessed sound-field thresholds, Japanese monosyllabic speech recognition, bilateral real-ear responses, and patient-reported experiences after approximately three weeks of use. In quiet, speech recognition scores increased from 45% unaided to 65% aided at 30 dB HL and from 90% to 100% at 40 dB HL. With her usual settings and without clinician-directed target matching, the real-ear aided responses visually approximated portions of the NAL-NL2 target contours at input levels of 50, 65, and 80 dB SPL, with frequency-specific deviations. She and her family reported easier communication, and the hearing-difficulty score decreased from a retrospective pre-use score of 25 to a post-use score of 18. Aided testing at a signal-to-noise ratio of +10 dB lacked an unaided comparison in noise and therefore could not establish a benefit in noise. Cost and concerns about wearing earphones in public were barriers to purchase and use. This case illustrates the value of combining objective verification with everyday experiences when evaluating self-adjusted hearables in selected patients.

Categories: Otolaryngology
Keywords: audiometry, auditory rehabilitation, hearing aids, hearing loss, sensorineural, speech perception

Introduction

Mild sensorineural hearing loss can be accompanied by communication difficulties, even when pure-tone thresholds are only slightly elevated. Nevertheless, some individuals do not adopt conventional hearing aids because of factors such as cost, perceived need, comfort, and social acceptability. Perceived need may be particularly low among individuals with slight or mild hearing loss, even when they experience persistent listening difficulties in everyday life. JapanTrak 2025 documents financial and perceived-need barriers to hearing-aid uptake in Japan [1]. Practical guidance published in this journal discusses smartphone-based hearing aid applications and personal sound amplification devices as options for selected adults under appropriate conditions with mild hearing loss, while emphasizing the importance of clinical assessment and the limitations of these devices [2]. AirPods Pro 3 are user-adjustable hearable devices distinct from those categories, so evidence concerning those devices cannot be directly applied to this product.

AirPods Pro 3 combine self-administered hearing assessment with user-adjustable hearing assistance, including amplification, tonal balance, and noise-reduction controls [3]. Studies involving earlier AirPods Pro generations have reported improvements in speech recognition in selected participants, while other investigations have examined real-world use and electroacoustic performance [4,5]. Real-ear studies of AirPods Pro 2 indicate that output can differ from NAL-NL2 prescriptive targets and vary with the input level and user-adjustable settings [6,7].

Existing studies have primarily addressed group-level performance or controlled acoustic measurements of earlier AirPods Pro generations. However, less is known about the measured performance of a current-generation hearable after a user adjusts its settings during everyday use. We therefore evaluated the performance of AirPods Pro 3 with patient-selected settings after approximately three weeks of use in a young adult with slight sensorineural hearing loss and persistent listening difficulty. The evaluation included sound-field and speech recognition testing, real-ear measurements, and patient-reported experiences.

Case Presentation

History of present illness and device use

A 28-year-old woman was followed intermittently for several years after undergoing audiometric testing for tinnitus and episodes of dizziness. Serial examinations showed small fluctuations in hearing thresholds without clear progression, and the degree of sensorineural hearing loss generally remained in the slight-to-mild range. She had no history of conventional hearing-aid use. Despite the absence of substantial audiometric deterioration, she reported persistent difficulty understanding speech, particularly during family conversations and when listening to speech from the rear seat of a vehicle. These difficulties affected everyday communication and sometimes required requests for repetition.

During a routine outpatient visit, AirPods Pro 3 (Apple Inc., Cupertino, CA, USA) were discussed as a possible option to support hearing. She subsequently purchased the device with financial support from a family member because she considered the cost of AirPods relatively high. She used the device mainly at home for approximately three hours each evening during family conversations. Both the patient and her family perceived easier communication, including fewer requests for repetition. Concerns about how others would perceive her wearing earphones continuously limited her use of the device outside the home.

Twenty days after purchase, she voluntarily participated in an additional audiological evaluation outside of routine clinical care.

Device configuration

The AirPods Pro 3 were paired with an iPhone running iOS 26.6.2. The patient adjusted the hearing-assistance settings according to her listening preferences. According to the recorded settings, Amplification was set to 82, Ambient Noise Reduction to 87, Tone was shifted toward the brighter end of the range, Balance was shifted toward the left ear, Conversation Boost was enabled, and Own Voice Amplification was set at a low level. The values 82 and 87 are displayed in the interface and do not represent decibel levels. No clinician-directed adjustments were made to match a prescriptive target for the evaluation.

Audiological evaluation

Sound-field testing was performed with a loudspeaker-to-participant distance of 1 m and at least 1 m of clearance from surrounding walls, following the spatial arrangement described in the Japanese hearing-aid fitting guidelines [8].

The assessment combined selected tests used in the Japanese hearing-aid fitting evaluation with real-ear output measurements and patient-reported information to characterize the benefits and limitations of device use in this patient [8].

Repeat conventional pure-tone audiometry showed air-conduction thresholds of approximately 5-25 dB HL in the right ear and 10-30 dB HL in the left ear. The greatest threshold elevation was at 2 kHz in the left ear. Bone-conduction findings were consistent with the clinical diagnosis of sensorineural hearing loss (Figure *1A*). The AirPods Hearing Test displayed average hearing levels of 18 dB HL in the right ear and 23 dB HL in the left ear. The overall audiometric configuration was broadly similar to that obtained with conventional audiometry, with relatively close agreement at low frequencies, although differences were observed at individual frequencies (Figure *1B*).

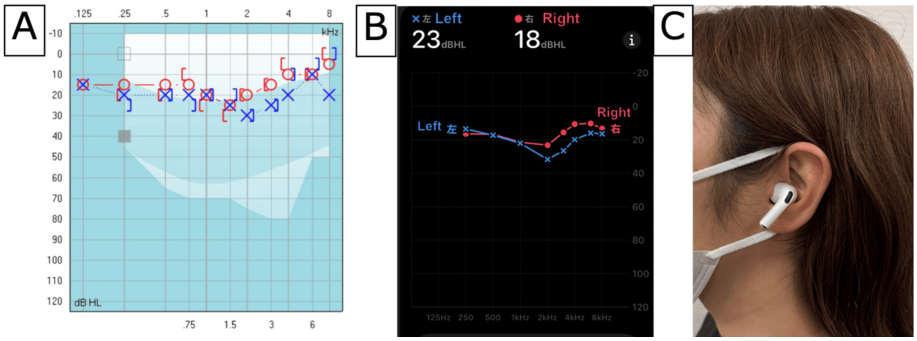

FIGURE 1: Baseline Audiological Findings and AirPods Pro 3 Use

(A) Conventional pure-tone audiogram. (B) Hearing thresholds obtained with the AirPods Pro 3 Hearing Test. Low-frequency thresholds were relatively close to those obtained with conventional audiometry, with frequency-specific differences elsewhere. Device-displayed average hearing levels were 18 dB HL on the right and 23 dB HL on the left. (C) Cropped photograph showing device use.

dB HL, decibels hearing level.

In the initial sound-field assessment, unaided thresholds were approximately 20-30 dB HL, whereas aided thresholds were approximately 15-20 dB HL across the displayed frequencies. The observed functional gain was modest, with larger differences observed in the mid-frequency region (Figure 2A).

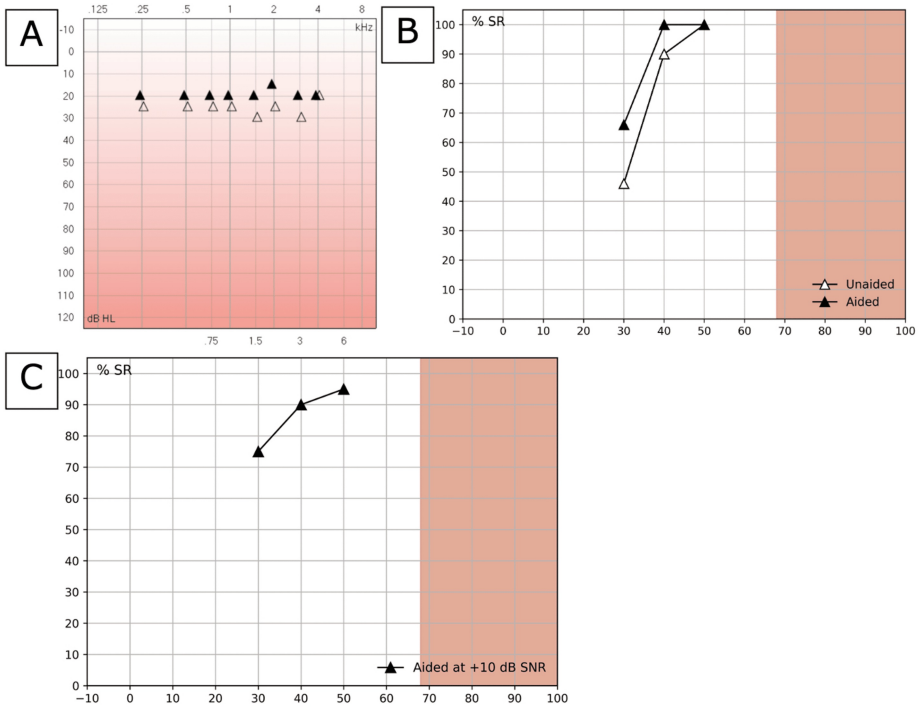

FIGURE 2: Sound-Field Thresholds and Speech Recognition With AirPods Pro 3

(A) Unaided and aided sound-field thresholds.

(B) Speech recognition in quiet using the Japanese 67-S monosyllabic word list. Unaided/aided scores were 45%/65% at 30 dB HL, 90%/100% at 40 dB HL, and 100%/100% at 50 dB HL.

(C) Aided speech recognition in background noise at an SNR of +10 dB. Scores were 75% at 30 dB HL, 90% at 40 dB HL, and 95% at 50 dB HL.

SNR, signal-to-noise ratio; dB HL, decibels hearing level.

Speech recognition

Sound-field speech recognition was assessed using the Japanese 67-S monosyllabic word list. In quiet, the unaided and aided scores were 45% and 65%, respectively, at 30 dB HL and 90% and 100%, respectively, at 40 dB HL. At 50 dB HL, both scores reached 100% (Figure 2B). Speech presentation levels are reported in dB HL, as displayed by the instrument.

Aided speech recognition was also assessed in background noise at a nominal signal-to-noise ratio (SNR) of +10 dB. Scores were 75% at 30 dB HL, 90% at 40 dB HL, and 95% at 50 dB HL, compared with 65%, 100%, and 100%, respectively, under the corresponding aided conditions in quiet (Figures 2B, 2C). These results are presented descriptively as a comparison of aided performance in quiet and noise.

Real-ear measurements

Bilateral probe-microphone measurements were obtained using the International Speech Test Signal (ISTS) at input levels of 50, 65, and 80 dB SPL. The NAL-NL2 targets were generated from the repeat conventional audiogram using the inexperienced-user setting. Real-ear unaided responses (REURs) were also recorded. The device was evaluated with the patient-selected settings, without clinician-directed target matching.

Visual inspection showed that the bilateral real-ear aided responses (REARs) broadly tracked the NAL-NL2 target contours across much of the speech-frequency range at the three input levels, with localized frequency-specific deviations. Local elevations around 1.5 and 3 kHz were noted in the aided traces, and elevated responses were also visible in the corresponding unaided traces (Figure 3).

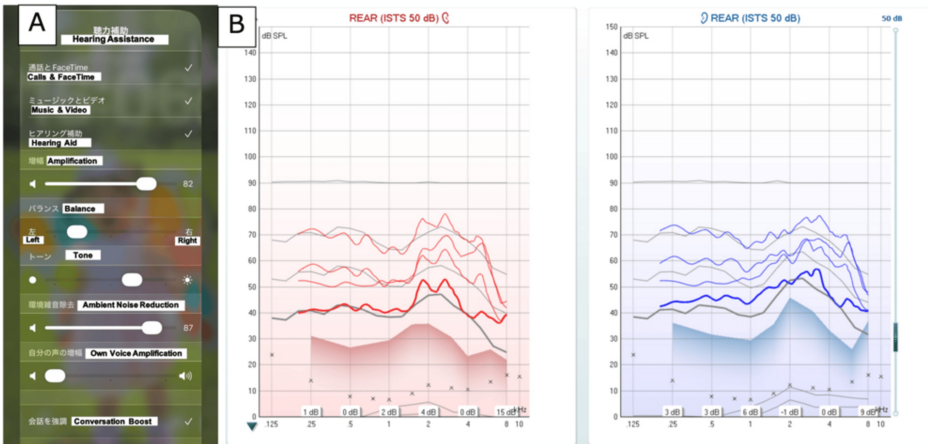

FIGURE 3: Patient-Selected AirPods Pro 3 Settings and Bilateral Real-Ear Measurements

(A) Patient-selected hearing-assistance settings on the paired iPhone at the time of evaluation. Amplification was set to 82, Ambient Noise Reduction to 87, Tone was shifted toward the brighter end of the range, and Conversation Boost was enabled.

(B) Bilateral probe-microphone real-ear measurements obtained with the patient's usual self-selected AirPods Pro 3 settings without clinician-directed target matching. REARs were measured using the ISTS at input levels of 50, 65, and 80 dB SPL and compared with NAL-NL2 targets generated using the inexperienced-user setting. Right-ear responses are shown in red and left-ear responses in blue. REURs were also recorded.

dB SPL, decibels sound pressure level; ISTS, International Speech Test Signal; NAL-NL2, National Acoustic Laboratories Nonlinear 2; REAR, real-ear aided response; REUR, real-ear unaided response.

Subjective outcomes

Subjective hearing difficulty was assessed using the 10 hearing-difficulty items selected from the Questionnaire on Hearing 2002 for hearing-aid fitting evaluation [9]. Higher item scores indicate greater difficulty. The descriptive sum of the scores for these 10 items decreased from 25 before use to 18 after use. The respective pre-use and post-use domain sums were 7 and 6 for speech under favorable conditions, 2 and 2 for environmental sounds, and 16 and 10 for speech under unfavorable conditions (Table *1*). Both forms were completed on the same day after device use had begun; therefore, the pre-use assessment relied on recall.

Domain	Pre-use	Post-use	Change
Speech under favorable conditions (A-C)	7	6	-1
Environmental sounds (D-E)	2	2	0
Speech under unfavorable conditions (F-J)	16	10	-6
Sum of the 10 hearing-difficulty items	25	18	-7

TABLE 1: Descriptive Scores for the 10 Hearing-Difficulty Items of the Questionnaire on Hearing 2002 Before and After AirPods Pro 3 Use

Higher item scores indicate greater hearing difficulty. Change = post-use minus pre-use. Both questionnaires were completed on the same day after device use had begun; the pre-use rating was retrospective. Values are descriptive sums of the scores for the selected hearing-difficulty items. The questionnaire source is Suzuki et al. [9].

The patient reported easier family conversations and better understanding of speech from the rear seat of a vehicle. Her family members noted fewer requests for repetition. She also reported that the sound of a ventilation fan was more noticeable, whereas vacuum cleaner noise seemed so much quieter that she initially wondered whether the appliance was malfunctioning. Concerns about the social acceptability of continuous earphone use continued to limit her use of the device outside the home.

Discussion

Overview of the clinical findings

The principal observation in this case is that patient-selected AirPods Pro 3 settings, established during everyday use without clinician-directed target matching, yielded real-ear responses that visually approximated portions of the NAL-NL2 target contours. The improved recognition of softer speech was accompanied by perceived improvements in communication with family members. These observations do not establish fitting accuracy or generalizable effectiveness, and the device was not compared with a conventional hearing aid.

Conventional audiometry and the AirPods Hearing Test

Sasaki et al. compared the AirPods Pro 2 Hearing Test with conventional pure-tone audiometry in 140 participants and identified frequency-dependent discrepancies, particularly at 250 and 500 Hz. They considered the test a supplementary tool rather than a replacement for conventional audiometry in people with hearing-related symptoms [10]. Notably, despite these reported low-frequency discrepancies, the low-frequency thresholds obtained using AirPods Pro 3 closely matched those obtained with conventional audiometry in our patient, whose low-frequency hearing was relatively preserved. Whether this agreement relates to her audiometric configuration or individual measurement characteristics cannot be determined from this case.

The comparison focused on frequency-specific thresholds rather than differences between the device-reported averages and conventional weighted averages because the averaging methods had not been established as equivalent.

Speech recognition benefit in quiet

Kim et al. studied 35 participants with mild-to-moderate hearing loss and reported higher scores for word and sentence recognition in noise with AirPods Pro than without a device [4]. In the present case, the differences between aided and unaided scores in quiet were 20 percentage points at 30 dB HL and 10 percentage points at 40 dB HL; scores in both conditions reached 100% at 50 dB HL. The concentration of benefit at 30 and 40 dB HL suggests that AirPods Pro 3 primarily improved access to softer speech in this patient, whereas no additional benefit could be demonstrated once unaided speech recognition had reached the ceiling. From a clinical perspective, improved recognition of lower-level speech may be relevant to the patient's everyday listening difficulties, consistent with the patient- and family-reported improvements in communication. However, given the variability associated with short monosyllabic word lists and the single-case design, these differences should be interpreted cautiously and do not establish a reproducible or clinically significant improvement on their own.

Speech recognition in background noise

The noise assessment compared aided speech recognition in quiet with aided performance at a nominal SNR of +10 dB. Scores in noise were 75% at 30 dB HL, 90% at 40 dB HL, and 95% at 50 dB HL. Previous practical guidance has noted limitations of smartphone-based hearing aid applications and personal sound amplification devices in noisy settings [2], while Valderrama et al. reported improved speech-in-noise performance with AirPods Pro under different experimental conditions [5]. However, the devices and test conditions are not directly comparable. Although our results do not demonstrate a device-specific benefit for speech recognition in noise, they indicate that aided speech recognition was relatively well maintained at the tested SNR of +10 dB.

Real ear verification and prescriptive target matching

NAL-NL2 is intended to support speech intelligibility while controlling overall loudness [11]. Hentona et al. found that amplification with AirPods Pro 2 varied with the input level and differed from NAL-NL2 and DSL v5 targets [6]. In our patient, bilateral REARs broadly tracked the NAL-NL2 target contours across much of the speech-frequency range at 50, 65, and 80 dB SPL, despite localized deviations. Although these findings do not establish an optimal fit, the responses were obtained using the patient's usual self-selected settings without clinician-directed target matching.

Outer ear acoustics and patient adjustments

Both individual outer-ear acoustics and the patient-selected device configuration may have contributed to the response contour. Natural outer-ear gain is generally small below approximately 1.5 kHz, with a main resonance around 2.6-3.0 kHz [12]. Valente et al. found considerable interindividual variability in REUR amplitude and peak frequency [13]. The corresponding elevations in the REURs and REARs around 3 kHz support a possible contribution from the patient's individual outer-ear acoustics to the observed response contour. A similar correspondence was observed around 1.5 kHz, although this is less typical of the primary adult outer-ear resonance.

Using an acoustic manikin, Huang et al. showed that the Amplification and Tone controls of AirPods Pro 2 altered the overall output and spectral balance, and that researcher-directed adjustments could bring output closer to NAL-NL2 targets [7]. The relatively high Amplification setting and brighter Tone selected by our patient may likewise have influenced the response at mid and high frequencies. These settings and individual ear acoustics may therefore both have contributed to the observed response. Because earbud insertion changes ear-canal acoustics and the controls were not manipulated separately, their relative contributions to the response contour and target deviations cannot be isolated.

Patient reports of benefit and everyday experience

The 10 hearing-difficulty items selected from the Questionnaire on Hearing 2002 provide structured information about perceived listening difficulty [9]. The descriptive sum of their scores decreased from 25 to 18, with the largest reduction in difficulty understanding speech under unfavorable conditions (16 to 10). The improvement in questionnaire scores, the patient's everyday experiences and continued device use, and her family's observation of fewer requests for repetition together provide evidence of meaningful benefit in everyday life for this patient.

The patient used the device for approximately three hours per day during family conversations, and she also reported improved understanding of speech from the rear seat of a vehicle. Her descriptions of more noticeable ventilation fan noise and markedly reduced vacuum cleaner noise illustrate how the experience of hearing assistance can vary across everyday sound environments. A combination of amplification and signal processing may account for these experiences, although the contributions of the individual functions were not tested.

Financial and social barriers to access and use

The retail price of AirPods Pro 3, as listed by Apple Japan, was JPY 42,800 when the manuscript was prepared [14]. JapanTrak 2025 reports that, among 333 respondents who obtained hearing aids through retail staff, 43% paid JPY 100,000 to less than 200,000 per hearing aid and 16% paid JPY 200,000 to less than 300,000 [1]. These figures represent price bands, not a mean purchase price. Comparing a pair of earbuds with a hearing aid also requires consideration of fitting, follow-up services, smartphone ownership, and longer-term costs.

The lower purchase cost did not eliminate financial barriers in this case. The patient still considered AirPods expensive and received financial support from her family to purchase them. This case illustrates that the relative affordability of consumer hearing technology does not necessarily make it affordable in practice for a young adult with slight hearing loss.

The device's appearance also affected its use. Despite the perceived hearing benefit, she was reluctant to wear earphones continuously outside the home. Valderrama et al. likewise identified discomfort, limited benefit, and stigma among barriers to continued use of AirPods [5]. The design of consumer devices therefore does not necessarily remove social barriers to wearing a hearing-support device.

Relationship to previous studies of self-fitting

Kruger et al. evaluated 25 adults after independently setting up the AirPods Pro 2 Hearing Aid feature. Usability and satisfaction were high, whereas real-ear gain did not consistently match NAL-NL2 targets and the group-level speech-in-noise benefit was not statistically significant [15]. In contrast, our patient had used AirPods Pro 3 for approximately three weeks and had adjusted several hearing-assistance settings according to her preferences before real-ear testing. The relatively close agreement with the targets observed in this case raises the possibility that iterative user fine-tuning during daily use may meaningfully alter real-ear output. Prospective studies are needed to test whether repeated user adjustments affect agreement with prescriptive targets or listening outcomes. Consumer hearables may be discussed as additional hearing-support options for selected patients, with clinical assessment of their individual benefits and limitations.

Limitations

This report describes a single young adult with slight sensorineural hearing loss, includes no comparison with conventional hearing aids, and includes only short-term follow-up. The initial speech recognition testing and questionnaire assessments, along with the subsequent audiometry and real-ear measurements, were not all performed in one session. Physiological and measurement variability, acclimatization, and any unrecorded setting changes may therefore affect comparisons across assessments.

The exact test order and word-list allocation could not be verified from the available records, and possible learning or list effects cannot be excluded. Score variability associated with short word lists and ceiling effects also limit the interpretation of speech recognition results. The comparison of aided performance in quiet and in noise was exploratory and did not establish equivalence or a device-specific benefit in noise. Responses to the retrospective pre-use questionnaire may have been influenced by recall bias, expectations, or changes in the patient's internal standards for judging hearing. Agreement between real-ear responses

and prescriptive targets was assessed qualitatively, and the acoustic effects of individual controls were not measured separately. Most previous studies evaluated earlier AirPods Pro generations; differences in hardware and software limit direct extrapolation to AirPods Pro 3. Although these limitations preclude generalization, the concordance of speech testing, real-ear findings, questionnaire scores, and everyday observations provides a clinically coherent picture of the benefits and limitations in this individual.

Conclusions

This case demonstrates that self-adjusted AirPods Pro 3 can provide measurable and meaningful hearing support in selected listening situations for a young adult with slight sensorineural hearing loss and persistent listening difficulty. Improved recognition of softer speech was accompanied by patient- and family-reported improvements in everyday communication. Without clinician-directed target matching, the patient's usual settings produced bilateral real-ear responses that broadly tracked NAL-NL2 targets, with localized deviations. A specific speech-in-noise benefit was not established, and cost, the perception of environmental sounds, and device appearance remained relevant to its use. Hearable devices may therefore broaden the hearing-support options discussed with selected individuals, while objective measurements and everyday experience provide complementary information about their benefits and limitations.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Kota Hiraoka, Shingo Umemoto, Seiki Nobe, Takashi Hirano

Acquisition, analysis, or interpretation of data: Kota Hiraoka, Shingo Umemoto

Drafting of the manuscript: Kota Hiraoka

Critical review of the manuscript for important intellectual content: Shingo Umemoto, Seiki Nobe, Takashi Hirano

Supervision: Shingo Umemoto, Seiki Nobe

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. The Ethics Committee of Kunisaki City Hospital issued approval R8-12. **AI use statement:** The authors used ChatGPT, GPT-5.6, OpenAI as follows: language polishing, structure or formatting, drafting summaries in Manuscript organization, English-language editing, and refinement of the Abstract, Introduction, Case Presentation, Discussion, Conclusions, and figure legends. All AI-generated content was reviewed by the authors. Clinical facts, numerical and statistical data were verified against the original records and source data, and references were checked against the original publications. All interpretations and the final manuscript were independently reviewed by the authors. The authors confirm that they have reviewed and verified all AI-assisted content and take full responsibility for the work. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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