Does the Administration Environment of Intra-Articular and Radiofrequency Procedures Affect Treatment Response in Patients with Frozen Shoulder? A Retrospective Study

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Abstract

Aim: This study aims to investigate the effects of intra-articular injection and suprascapular nerve pulsed radiofrequency (PRF) procedures on clinical, psychological, and functional outcomes in patients with frozen shoulder based on the treatment setting (operating room vs. outpatient clinic).

Methods: Data from 40 patients diagnosed with frozen shoulder were retrospectively reviewed. Procedures were performed under fluoroscopy in the operating room or ultrasonography in the outpatient clinic. Before treatment and at 1 and 3 months after treatment, patients were evaluated using the Numerical Rating Scale (NRS), Shoulder Pain and Disability Index (SPADI), Beck Anxiety Inventory (BAI), Beck Depression Inventory (BDI), Pittsburgh Sleep Quality Index (PSQI), and Central Sensitization Inventory (CSI). Patient satisfaction was also recorded. Statistical analyses included repeated measures ANOVA, t-tests, Pearson correlation, and regression modelling.

Results: All scores significantly improved over time in both groups ($p < 0.001$). However, improvements in NRS, SPADI, BAI, and PSQI were greater in the operating room group ($p < 0.05$). No significant differences were found in BDI and CSI scores. Regression analysis showed that higher initial depression scores and female gender were linked to less reduction in pain. Patient satisfaction was also higher in the operating room group.

Conclusions: Although both settings provided clinical benefit, procedures performed with sedation and fluoroscopic guidance in the operating room led to more pronounced improvements in pain, function, anxiety, and sleep. These results indicate that setting and psychosocial factors such as depression and gender may influence treatment outcomes.

Keywords: *Frozen shoulder; suprascapular nerve; pulsed radiofrequency; intra-articular injection; treatment environment; pain management*

1. Introduction

Frozen shoulder (adhesive capsulitis) is a musculoskeletal disease that causes pain and movement restriction as a result of inflammation and fibrosis in the joint capsule.[1] This entity, which causes functional loss with its long-term nature, can reduce the quality of life with both physical and psychological consequences. Physical therapy, medical treatment, intra-articular steroid injections, suprascapular nerve blocks, suprascapular nerve pulsed radiofrequency (PRF), and arthroscopic approaches are used in the treatment.[2-4] In pain management practice, intra-articular injections and interventions targeting the suprascapular nerve are frequently used for pain palliation and functionality gain.[2,3] In clinical practice, these interventions can be performed under both ultrasonography (USG) guidance and fluoroscopy guidance (FG).[5] However, how psychological parameters (anxiety, depression, central sensitization, etc.) and sleep disorders affect the results of the interventional treatment application environment (outpatient clinic vs. operating room) has not been investigated sufficiently. In some studies conducted on frozen shoulder patients, it has been reported that pre-procedure anxiety and depression levels may affect treatment success.[6,7] In addition, it has been reported that the parameters that most affect the response

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to any interventional treatment modality in pain treatment are anxiety, sleep disturbance, depression, and pain acceptance.[8,9] Therefore, in frozen shoulder treatment, neurophysiological and psychological components of pain should also be evaluated along with physical findings.[10] This study was designed to test the hypothesis that pain palliation methods applied in the operating room or outpatient clinic environment in frozen shoulder patients may make a difference in terms of patients pain level, functionality, sleep quality, psychological status, and central sensitivity. Therefore, this study was designed to evaluate the impact of the procedural setting on clinical outcomes in patients with frozen shoulder. Specifically, we compared intra-articular injections and suprascapular PRF performed either in the operating room or outpatient clinic, assessing changes in pain (by NRS), function (by SPADI), psychological symptoms (by BAI and BDI), sleep quality (by PSQI), and central sensitization (by CSI).

2. Materials and Methods

Local ethics committee approval was obtained for this retrospective observational study (date: 29.04.2025, no: 419). Data of patients who applied to our outpatient clinic with shoulder pain between October 1, 2024, and April 10, 2025, were examined. Inclusion criteria for the study were: i) age 18 years and above, ii) clinical and radiological diagnosis of frozen shoulder, iii) shoulder injection and suprascapular nerve PRF with USG or FG during treatment, and iv) pain for ≥ 3 months. Exclusion criteria were incomplete file data, lack of regular outpatient clinic follow-up, and shoulder surgery. Before treatments, Numeric Rating Scale (NRS), Shoulder Pain and Disability Index (SPADI), Beck Anxiety Inventory (BAI), Beck Depression Inventory (BDI), Pittsburgh Sleep Quality Index (PSQI), and Central Sensitization Inventory (CSI) scales were recorded as patients' own reports. These scale data were requested from the patients again at 1 and 3 months after the treatments and recorded. In addition, patient satisfaction (satisfied, undecided, not satisfied) was recorded at 1 and 3 months after the treatments. Furthermore, gender, pain duration, and age data of the patients were recorded. Scale data, anamnesis information, and demographic information were obtained from the Hospital Information Management System (HIMS) and the researchers' manuscript data. Within the scope of the study, the patients were then divided into 2 groups according to the application of treatment in the operating room and outpatient clinic environment. Patient data were anonymized before statistical analysis in accordance with the ethics committee policies. Full compliance with the Declaration of Helsinki was demonstrated. A detailed anamnesis was taken from all patients and a physical examination was performed before suprascapular PRF and intra-articular injection. Imaging (plain radiographs, magnetic resonance images) and additional tests (blood tests, pathology reports, cytology, etc.) were examined to confirm the diagnosis of frozen shoulder. Informed consent was obtained from patients who were suitable for intra-articular injection and suprascapular PRF treatment, explaining the benefits and risks of the procedure. Blood tests (CBC, PT, aPTT) were evaluated in all patients before interventional treatment. Intravenous (IV) vascular access was established in all patient groups and standard monitoring (ECG, pulse oximetry, non-invasive blood pressure) was provided. The shoulder area to be treated was painted with an iodine-based solution and sterile draping was performed.

In the operating room environment, before shoulder block and suprascapular PRF with FG, minimal sedation (midazolam 0.05–0.1 mg/kg) was provided by the anesthesia team via IV access. The acromioclavicular joint area was determined with a radiopaque rod, 2% prilocaine was applied to the skin of the area to be treated to reduce pain. For the shoulder block procedure, a 22 G x 10 cm spinal needle was inserted into the acromioclavicular joint in the supine position, first into the glenohumeral joint, then the needle was withdrawn to reach the subacromial space. The glenohumeral joint and subacromial space were confirmed with contrast material (iomeprol). 3 ml of 0.5% bupivacaine (2.5 ml) + 16 mg dexamethasone + 0.9% saline mixture was applied to the subacromial space, and 4 ml of 0.5% bupivacaine (2.5 ml) + 16 mg dexamethasone + 0.9% saline mixture was applied to the glenohumeral joint. Afterwards, the suprascapular notch area of the patients was determined after local infiltration of the procedure area, and a 22 G x 10 cm x 5 mm active tip radiofrequency (RF) hybrid cannula (Diros Technology Inc., Canada) was advanced until bone contact was achieved. Then, the needle tip was slightly retracted and aspiration was performed. The suprascapular nerve area was confirmed with sensory stimulation (≤0.5 V at 50 Hz) and motor stimulation (1.5× sensory threshold at 2 Hz). Suprascapular PRF procedure was applied for 4 minutes with 20 ms width and 45 Volts. A fluoroscopy device (GE OEC 9900 C-Arm, GE Healthcare, USA) was used in the procedures in the operating room environment.

The procedure, which was performed under USG (HD11XE, Philips Medical Systems, Bothell, WA, USA) guidance in the outpatient clinic environment, was performed using a 5–12 MHz linear transducer. After identifying the glenoid edge, articular cartilage of the humeral head, and posterior glenoid labrum with a posterior approach while in the lateral decubitus position, 2% prilocaine was applied to the skin of the area to be treated. The above-mentioned amount and solution were applied to the glenohumeral joint with a 22 G x 10 cm spinal needle. Then, the patients were placed in the supine position and the subacromial space in the form of a thin liquid strip was determined under the deltoid muscle, above the supraspinatus tendon. 3 ml of the above-mentioned mixture was applied to this area. Then, the patients were placed in a sitting position and the suprascapular notch area was determined with the USG probe. The steps after this point, the needle used, and the PRF application method are as in fluoroscopy guidance. All procedures were performed by an experienced pain specialist. IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA) program was used for data analysis. Mean, standard deviation, number, and percentage were used in descriptive statistics. The conformity of continuous variables to normal distribution was tested with kurtosis and skewness values [11]. In the comparison between groups, independent sample t-test was used for continuous variables and Repeated Measures ANOVA was used for dependent measurements. Chi-square (χ^2) test was used for categorical variables, and two-way repeated measures ANOVA was used for measurement times and changes in group means. Relationships between variables were evaluated with Pearson correlation analysis. Multiple linear regression analysis was performed to analyse the effect of independent variables on dependent variables. The significance level was determined as $p<0.05$. Autocorrelation and multicollinearity problems were tested with the Durbin-Watson coefficient. Eta-square (η^2) coefficient was used for effect size calculations. Post-hoc power analysis, based on the smallest effect size (time × group interaction for PSQI; $\eta^2=0.080$; Cohen's $f=0.294$), was conducted using repeated-measures ANOVA (within-between interaction) in G*Power. With $\alpha=0.05$, three measurements, repeated measures correlation of 0.5, nonsphericity correction $\varepsilon=1$, and $n=40$, the calculated power was approximately 98.5%.

Table 1

Demographic Characteristics According to Intervention Setting

Variable	Operating Room (n=19)	Outpatient Clinic (n=21)	Total (n=40)	p
Age	41.74 ± 11.34	42.43 ± 11.56	42.10 ± 11.31	0,850*
Pain Duration (months)	22.47 ± 7.11	12.29 ± 4.94	17.13 ± 7.89	<0.001*
Sex (Female)	10 (52.6%)	13 (61.9%)	23 (57.5%)	0,554⁺
Sex (Male)	9 (47.4%)	8 (38.1%)	17 (42.5%)	

*Age, pain duration, and sex variables were evaluated based on the operating room and outpatient clinic settings. *: Independent samples T-test, ⁺: Pearson's Chi-square test*

Table 2

Comparison of Clinical Outcomes by Treatment Setting

Outcome Measure	Timepoint	Operating Room Mean ± SD	Outpatient Clinic Mean ± SD	pᵀ
NRS	Baseline	7.84 ± 0.69	7.43 ± 0.87	0.048
	Month 1	4.68 ± 2.38	5.24 ± 1.81	0.309
	Month 3	5.00 ± 2.33	5.90 ± 1.67	0.091
SPADI	Baseline	66.14 ± 10.52	62.48 ± 11.88	0.211
	Month 1	49.72 ± 17.38	50.91 ± 14.00	0.771
	Month 3	50.32 ± 17.52	54.33 ± 14.13	0.333
BAI	Baseline	17.11 ± 3.26	12.62 ± 3.83	<0.001
	Month 1	11.47 ± 6.16	9.24 ± 4.47	0.114
	Month 3	11.21 ± 6.33	9.76 ± 5.15	0.334
BDI	Baseline	17.00 ± 6.20	18.71 ± 5.11	0.248
	Month 1	15.11 ± 6.07	16.62 ± 5.30	0.309
	Month 3	15.74 ± 7.76	16.95 ± 6.21	0.507
PSQI	Baseline	10.05 ± 3.32	9.67 ± 2.56	0.620
	Month 1	5.79 ± 3.17	7.24 ± 3.35	0.090
	Month 3	6.26 ± 3.45	7.52 ± 3.49	0.165
CSI	Baseline	48.89 ± 9.67	42.57 ± 7.58	0.006
	Month 1	43.37 ± 9.58	39.10 ± 7.35	0.058
	Month 3	40.84 ± 9.10	37.14 ± 8.84	0.115

Variables included Numerical Rating Scale (NRS), Shoulder Pain and Disability Index (SPADI), Beck Anxiety Inventory (BAI), Beck Depression Inventory (BDI), Pittsburgh Sleep Quality Index (PSQI), and Central Sensitization Inventory (CSI). These measurements were performed pretreatment and at 1 month and 3 months post-treatment. Values are presented as mean ± standard deviation (SD). Comparisons were made for two different treatment environments: outpatient clinic and operating room. Although improvements were seen over time in both groups, pain, anxiety, sleep and central sensitization scores were higher in the operating room group at baseline. NRS, SPADI, BAI, and PSQI values showed more significant improvements in the operating room group at time points. ᵀ: Each group variable was compared using an independent samples t-test.

3. Results

In this study, data of 40 frozen shoulder patients were analysed. Demographic information of the patients is presented in Table 1 according to the application environment. When the variables of age, gender, and pain duration were compared according to the environment groups with the independent sample t-test, a significant difference was found only in the operating room group for pain duration (t-test = 5.307, p < 0.001). Table 2 presents the mean, standard deviation (SD), and p-values from independent samples t-tests for NRS, BAI, BDI, SPADI, PSQI, and CSI scores at baseline, as well as at 1 and 3 months after treatment. When the pre-treatment and post-treatment 1st and 3rd month values of NRS, BAI, BDI, SPADI, PSQI, and CSI scores were evaluated with two-way repeated measures ANOVA according to time interaction, all scores showed significant improvement and decreased in both groups over time (p < 0.001). However, when the time * group interaction was evaluated, the operating room group showed significantly greater improvement over time in NRS, SPADI, BAI, and PSQI scores compared to the outpatient clinic group (p < 0.05). No difference was observed between the two groups in BDI and CSI scores. The results of the ANOVA test are presented in Table 3. When patient satisfaction (satisfied, undecided, not satisfied) was evaluated with the independent sample t-test, higher satisfaction was observed in the operating room group (t-test = 2.106, p = 0.042). The relationship between baseline satisfaction level and 1st month NRS, BAI, and SPADI scores with Pearson correlation analysis is presented in Table 4.

Table 3

Time, Group, and Interaction Effects for Clinical Outcomes in Operating Room vs. Outpatient Clinic Groups

Outcome Measure	Effect Type	Test (F test)	p	η²
NRS	Time Effect (All Participants)	112.467	<0.001	0.747
	OR vs. OC	0.516	0.477	0.013
	Time × Group Interaction	3.308	0.023	0.080
SPADI	Time Effect (All Participants)	63.534	<0.001	0.626
	OR vs. OC	0.036	0.850	0.001
	Time × Group Interaction	3.533	0.017	0.085
BAI	Time Effect (All Participants)	56.088	<0.001	0.596
	OR vs. OC	2.939	0.095	0.072
	Time × Group Interaction	4.270	0.007	0.101
BDI	Time Effect (All Participants)	19.549	<0.001	0.340
	OR vs. OC	0.605	0.442	0.016
	Time × Group Interaction	0.284	0.753	0.007
PSQI	Time Effect (All Participants)	43.519	<0.001	0.534
	OR vs. OC	0.712	0.404	0.018
	Time × Group Interaction	3.302	0.042	0.080
CSI	Time Effect (All Participants)	32.393	<0.001	0.460
	OR vs. OC	3.435	0.072	0.083
	Time × Group Interaction	1.308	0.276	0.033

Table 3 evaluates the effects of time, group (Operating Room vs. Outpatient Clinic), and time×group interaction across all time points (baseline, 1 month, and 3 months) for the Numerical Rating Scale (NRS), Shoulder Pain and Disability Index (SPADI), Beck Anxiety Inventory (BAI), Beck Depression Inventory (BDI), Pittsburgh Sleep Quality Index (PSQI) and the Central Sensitization Inventory (CSI). Repeated-measures ANOVA and two-way ANOVA analyses were used for these outcomes. For statistically significant findings, the partial eta squared (η²) value represents the effect size. OR vs OC: Operating Room vs. Outpatient Clinic Groups

Table 4

Correlation Between Patient Satisfaction and 1st-Month Clinical Scores

Variable	Group	r (Correlation Coefficient)	p-value
NRS	Operating Room	–0.956**	<0.001
	Outpatient	–0.900**	<0.001
	All Participants	–0.915**	<0.001
BAI	Operating Room	–0.910**	<0.001
	Outpatient	–0.844**	<0.001
	All Participants	–0.745**	<0.001
SPADI	Operating Room	–0.909**	<0.001
	Outpatient	–0.760**	<0.001
	All Participants	–0.809**	<0.001

Pearson correlation analysis was performed. Negative correlations indicate *that higher satisfaction scores are associated with lower NRS, BAI, and SPADI scores. **p < 0.01** indicates statistical significance*

In multiple linear regression analysis, independent variables BAI, BDI, CSI scores, and pretreatment and posttreatment 1st month NRS change were taken as dependent variables. The model was found to be significant in the analysis ($F = 27.217$, $p < 0.001$). Independent variables explain 66.9% of the change in NRS ($R^2 = 0.669$). Among the independent variables, only the BDI score was found to be a statistically significant predictor (β = –0.192, Cl: -0.294 to -0.090, p = 0.001). When the BDI score increases by 1 point, the decrease in NRS is 0.192 points less. Multiple linear regression analysis was performed to determine demographic, clinical, and psychological variables that could be predictors of NRS change (pretreatment and posttreatment change). The model was found to be statistically significant ($F = 2.792$, $p = 0.022$). This model explained 24.3% of the variance in NRS ($R^2 = 0.243$). Among the independent variables, only gender had an effect on NRS change (β = 0.629; Cl: 0.268 to 0.990; p = 0.002). Male gender was found to be associated with a greater decrease in pain score. No significant effect was observed in the model for other variables such as age, CSI, BAI, BDI, PSQI, and treatment environment (operating room vs. outpatient clinic) ($p > 0.05$). No autocorrelation was detected in the model. No patient reported any complications during our follow-up period.

4. Discussion

Our study compared the effects of interventional pain palliation treatments in frozen shoulder on patients' pain, functionality, psychological status, sleep quality, and central sensitivity according to the application environment (operating room vs. outpatient clinic). In line with our hypothesis, we observed more significant improvements in pain (NRS), functionality (SPADI), anxiety (BAI), and sleep quality (PSQI) scores, and higher patient satisfaction, especially in the operating room group. However, we did not observe this difference in depression (BDI) and central sensitization (CSI) scores, indicating that the effect may not cover all parameters. Nevertheless, our regression analyses show that depression severity and gender can independently predict pain relief. Our data suggest that the treatment environment may affect both physical and psychological parameters.

The clinical efficacy of suprascapular nerve PRF and intra-articular injections in the treatment of frozen shoulder has been previously evaluated in many studies [2,12]. However, how these applications may affect clinical results when performed in different environmental conditions (outpatient clinic vs. operating room) has not been systematically addressed to date. Our study offers a different perspective in this respect. Studies have shown that suprascapular nerve pulsed radiofrequency (PRF) application provides longer-term and more significant pain control compared to steroid injection alone.[3] Agarwal et al[13]. reported that injections administered together with suprascapular PRF provided significant functional and analgesic benefits up to 6 months. This finding is consistent with the SPADI (functionality) and NRS (pain) improvements observed in both groups in our study. Yan and Zhang[14] emphasized that the effectiveness of these applications is not coincidental in their randomized controlled study, in which they showed significant improvements in SPADI and VAS scores with suprascapular PRF application compared to placebo. Additionally, treatment guidelines support the short-term efficacy of IA injections [15]. Finally, Challoumas et al.[1] reported in their meta-analysis that intra-articular steroid injections were superior to other non-invasive methods in terms of pain and function in the first 12 weeks. In our study, the significant improvement observed in NRS and SPADI scores in the first 1 and 3 months in both the operating room and outpatient clinic groups is consistent with these findings. Higher patient satisfaction in the operating room group may be explained by both technical precision and psychological factors. Patients might have perceived the environment as more comfortable and reassuring. In the study by Park et al.[5], USG and FG methods were compared; although no difference was found in terms of clinical effectiveness of the treatment results, the anatomical accuracy of the injection was found to be higher with FG; this was reported to probably result in faster clinical responses. However, Ahmad et al.[16] reported in their prospective study that early clinical improvement (first 4 weeks) was better after USG-guided hydrodilatation compared to FG. Some methodological factors have been effective in the emergence of this contradiction between the results. Ahmad et al. evaluated only hydrodilatation with intra-articular steroid and saline as a treatment application, sedation was not provided during the procedures, and all procedures were evaluated in the same environment. However, in our study, suprascapular PRF was applied in addition to intra-articular injections, the applications were made in different environments, sedation was provided, and many variables such as psychosocial evaluation parameters were evaluated together. Although USG may offer short-term benefits due to technical ease, our findings indicate that procedures conducted in the operating room have a stronger impact on both clinical outcomes and patient satisfaction.

In our study, in addition to pain and functionality, psychological parameters (anxiety and depression), sleep quality, and central sensitivity levels were also evaluated with comprehensive scales. We observed significant improvements in BAI, BDI, PSQI, and CSI scores in both groups in the post-treatment period. However, when evaluated in terms of time*group interaction, we observed that the improvement in anxiety (BAI) and sleep quality (PSQI) scores was more pronounced in the operating room group. This suggests that environmental factors related to the application environment may also play a role in the treatment response. These findings imply that psychosocial factors such as perceived environmental safety or sedation-induced relaxation may contribute to treatment outcomes, beyond the purely biological effects of PRF and injections. The fact that no difference was observed between the environment groups in CSI and BDI scores in our study suggests that the effect on more profound psychological states such as central sensitization and depression may be limited. Although the systematic review by Brindisino et al.[17] reported that the psychological profile has an effect on prognosis in frozen shoulder, it also stated that an

interventional procedure alone may be limited in improving these factors. The regression analysis results of our study showed that the BDI score can independently predict pain relief. This finding shows that patients with high levels of depression feel pain more intensely and respond less to treatment. In addition, it was predicted that male gender would experience more pain relief. In the review by Meints et al.[18], it was emphasized that depression and anxiety levels are among the factors that directly affect the response to chronic pain treatment. In addition, Fillingim[19] reported that the female gender experiences more chronic pain and shows less response to treatment. Our findings seem to be related to the existing information. With all these results, it can be said that in an entity with a biopsychosocial aspect such as frozen shoulder, it is important to consider the psychological state in treatment planning, not only physical interventions. Therefore, the intervention should be evaluated not only in a biological but also in an environmental and psychological context.

Our study is one of the first studies comparing suprascapular nerve PRF and intra-articular injection methods, which we frequently apply to frozen shoulder patients, in different application environments (outpatient clinic vs. operating room). The main contribution of our study is to highlight how clinical, psychological, and functional outcomes differ depending on the treatment environment. In addition, showing the predictive value of depression and gender on pain response shows that individual and psychosocial factors should be taken into account in treatment. There are some basic limitations of our study. Since the retrospective analysis was conducted, patient groups were not randomized and therefore there may be external factors influencing the treatment environment preference (not wanting sedation, hospital logistic situation, etc.). Although interventional procedures were performed in different environments, it was not possible to evaluate psychological effects in a completely isolated manner. This situation makes it difficult to establish a direct causality between the procedure environment and psychological parameters. Finally, the relatively low number of patients, the single-center study, and the evaluation of only short- and medium-term (1st and 3rd month) results are other limitations, which make it difficult to evaluate the generalizability of the findings and long-term effects. For all these reasons, the results obtained need to be supported by larger sample, prospective, and randomized controlled

5. Conclusion

This study shows that interventional treatment modalities applied in the treatment of frozen shoulder may have different effects on clinical, functional, and psychological outcomes depending on the application environment and technique (FG vs. USG). Applications performed with sedation and FG guidance in the operating room environment provided more significant improvements in pain, functionality, anxiety, and sleep quality, and higher patient satisfaction. It has also been shown that individual factors such as depression level and gender can predict treatment response. These findings emphasize that environmental factors such as application conditions and the patient's psychosocial profile should be taken into consideration as much as the biological effects of interventional treatments.

Statement of ethics

The study received approval from The Kayseri City Hospital Ethics Committee granted approval for this study (date: 29.04.2025 number: 419).

genAI

No artificial intelligence-based tools or generative AI technologies were used in this study. The entire content of the manuscript was originally prepared, reviewed, and approved by both authors.

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Conflict of interest statement

The authors declare that they have no conflict of interest.

Availability of data and materials

This Data and materials are available to the researchers.

Author contributions

Concept – AB; Design – AB; Supervision – AB, ASEZ; Resource – AB, ASEZ; Materials – AB; Data collection and/or processing – AB, ASEZ; Analysis and/or interpretation – AB, ASEZ; Literature review – AB, ASEZ; Writing – AB, ASEZ; Critical review –AB, ASEZ.

Both authors contributed equally to the article. Both authors read and approved the final manuscript.

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