Clinical and Experimental Health Sciences

Original Article / *Özgün Araştırma*

Investigation of Dentoskeletal and Soft Tissue Effects of Forsus Fatigue Resistant Device and Jasper Jumper Appliances in Class II Malocclusions

Sınıf II Maloklüzyonlarda Forsus Fatigue Resistant Device ve Jasper Jumper Apareylerinin Dentoiskeleletsel ve Yumuşak Doku Üzerine Etkilerinin İncelenmesi

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Cite this article as: Buyuk S.K., Genc E., Benkli Y.A., Arslan A. Investigation of Dentoskeletal and Soft Tissue Effects of Forsus Fatigue Resistant Device and Jasper Jumper Appliances in Class II Malocclusions. Clin Exp Health Sci 2018; 8: 291-295.

ABSTRACT

Objective: The aim of this study was to investigate skeletal, dental and soft tissue effects of Forsus Fatigue Resistant Device (FRD) and Jasper Jumper appliances in correction of Class II malocclusion.

Methods: 33 patients were divided into two groups as treated with Forsus FRD appliance (18 subjects: 8 females, 10 males-mean age: 15.79 ± 1.50 years) and treated with Jasper Jumper appliance (15 subjects: 9 females, 6 males-mean age: 16.12 ± 1.58 years), randomly. Initial and final lateral cephalometric radiographies were traced and analyzed digitally. The data were analyzed statistically.

Results: In the assessment of the skeletal parameters, both two groups had similar outcomes and there were no statistically significant differences ($p>0.05$). In both groups ANB, Convexity angles and Wits values decreased and maxillomandibular discrepancy improved on sagittal plan. Maxillary incisors were proclined in Forsus FRD group, and maxillary incisors were retroclined in Jasper Jumper treated group and there was a statistically significant difference between groups ($p<0.05$). In the assessment of mandibular incisor, proclination occurred in both two groups. In the soft tissue evaluation, facial profile was improved through upper lip retrusion and lower lip protrusion and there were no statistically significant differences between groups in these values ($p>0.05$).

Conclusion: The skeletal and soft tissue effects of the Forsus FRD and Jasper Jumper appliances were similar while there were some differences in dental effects. Some factors such as skeletal age, cephalometric values should be taken into consideration when making a choice about the fixed functional appliance.

Keywords: Class II malocclusion, fixed functional appliance, Jasper Jumper, Forsus FRD

ÖZ

Amaç: Bu çalışmanın amacı, Sınıf II maloklüzyonu düzeltmede kullanılan Forsus Fatigue Resistant Device (FRD) ve Jasper Jumper apareylerinin iskeletsel, dişsel ve yumuşak doku üzerine etkilerinin incelenmesidir.

Yöntemler: 33 hasta, Forsus FRD apareyi ile tedavi edilenler (18 birey: 8 kız, 10 erkek-ortalama yaş aralığı 15,79 ± 1,50) ve Jasper Jumper apareyi ile tedavi edilenler (15 birey: 9 kız, 6 erkek-ortalama yaş aralığı 16,12±1,58) olmak üzere randomize bir şekilde iki gruba ayrılmışlardır. Başlangıç ve bitiş lateral sefalometrik radyografiler dijital olarak çizilmiştir ve analiz edilmiştir. Veriler istatistiksel olarak analiz edilmiştir.

Bulgular: İskeletsel parametreler değerlendirildiğinde her iki grupta da benzer sonuçlar görülmektedir ve istatistiksel olarak anlamlı farklılıklar bulunmamıştır ($p>0,05$). Her iki grupta da ANB, Konveksite açıları ve Wits değerleri azalmış ve sagittal yönde maksillomandibular uyumsuzluk düzelmiştir. Forsus FRD apareyi ile tedavi edilen grupta üst keserler prokline olmuşlardır. Jasper Jumper apareyi ile tedavi edilen grupta ise üst keser retroklinasyonu mevcuttur ve gruplar arası karşılaştırmada istatistiksel olarak anlamlı bir farklılık mevcuttur ($p<0,05$). Alt keser dişler değerlendirildiğinde her iki grupta da proklinasyon meydana gelmiştir. Yumuşak doku değerlendirmesinde üst dudakta retrüzyon, alt dudakta ise protrüzyon ile yüz profilinde düzelme sağlanmıştır ve bu değerlerde gruplar arasında istatistiksel olarak anlamlı bir fark bulunmamıştır ($p>0,05$).

Sonuç: Forsus FRD ve Jasper Jumper apareylerinin iskeletsel ve yumuşak doku etkileri benzer olmakla birlikte dental etkilerinde bazı farklılıklar bulunmaktadır. Sabit fonksiyonel apareyin seçiminde hastanın iskeletsel yaşı, sefalometrik değerleri gibi faktörler göz önünde bulundurularak karar verilmesi gerekmektedir.

Anahtar Kelimeler: Sınıf II maloklüzyon, sabit fonksiyonel aygıt, Jasper Jumper, Forsus FRD

INTRODUCTION

Skeletal Class II malocclusions are a very common malocclusion type in orthodontic treatment (1). This type of malocclusion is often associated with mandibular skeletal retrusion. Therefore, the main goal of the skeletal Class II treatment protocol is to modify and direct mandibular growth (2). In this way, skeletal compliance and facial soft tissue profiles can be improved (3).

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There are many studies in the literature about the treatment of Class II malocclusion. In the treatment of Class II malocclusion, many treatment options were developed as many as daily and many orthodontic appliances were used. Approaches such as the use of removable or fixed intraoral functional appliances, the use of extra-oral appliances, premolar extraction orthodontic treatment and orthognathic surgery are examples of these treatment options. The functional treatment approach is guided by mandibular growth and constitutes the actual treatment protocol in adolescent orthodontic subjects. Although the philosophy of removable and fixed functional appliances is basically the same, these appliances have been involved in many researches in recent years, with advantages such as constant functional devices being able to be applied simultaneously with fixed orthodontic treatment, continuous constant force application, independence of patient co-operation and patient comfort (4). It is possible to separate fixed functional devices into semi-rigid (e.g., Eureca Spring, Twin Force Bite Corrector, Jasper Jumper, Forsus FRD) and rigid (e.g., Herbst, MARA). Similar results were observed in dento-skeletal groups in both groups, despite the advantages of allowing semi-rigid appliances lateral jaw movements, patient co-operation and hygiene, easy adaptation, and no need for complex laboratory procedures (5, 6).

Jasper Jumper appliance is a semi-rigid functional device developed by J. J. Jasper in 1987 (7). It is made of soft gray synthetic material with an open spring. One disadvantage is that it has a more flexible structure and permits lateral jaw movements. In the Class II correction, the skeletal effect of Jasper Jumper appliance is rather than dentoalveolar (2, 8-11). Developed by Bill Vogt, the Forsus Fatigue Resistant Device (FRD) is another semi-rigid, fixed functional device. It is basically a telescopic system of stainless steel spring and pin, available in different dimensions. Compared to rigid functional appliance systems, it has advantages similar to Jasper Jumper appliances. Jasper Jumper and Forsus FRD are attached to the maxillary first molar band and mandibular arch wire. In both systems, one can observe improvement of the facial profile in terms of skeletal effect, dental effects, inhibition of maxillary growth, extrusion and retrusion of upper incisor, intrusion and protrusion of lower incisors, distal tipping of upper molars, mesial tipping of lower molars, posterior rotation of occlusal plane and forward movement of the pogonion (8, 9, 12).

The aim of this study was to compare the effects of the Forsus FRD and Jasper Jumper fixed functional appliances on skeletal, dental and soft tissue.

METHODS

This study was performed with 33 adolescent patients (17 female, 16 male), each with a Class II malocclusion. All subjects had applied for orthodontic treatment to the Department of Orthodontics, Faculty of Dentistry, Ordu University. The Ordu University Clinical Research Ethics Committee (2015/12) approved this study. In addition, parents of the individuals involved in the study signed informed consent forms.

All participants in this study were permanent mandibular individuals with normal/mild prognathic maxilla, retrognathic mandible, normal-vertical growth pattern, and Class II molar relationship. Individuals with severe crowding in both arch, cleft lip and palate, and other genetic syndromes were excluded from this clinical study.

Eighteen patients were treated with Forsus FRD fixed functional appliance (8 female, 10 males; mean age range 15.79 ± 1.50 years). Fifteen patients were treated with Jasper Jumper appliance (9 female, 6 male; mean age range 16, 12 ± 1.58 years). The two groups were randomly allocated.

Treatment Process

In both groups, 0.022 x 0.028-inch slot Roth prescription brackets and upper molar bands were bonded. Both maxillary and mandibular dental arches were leveled to allow connection with a 0.017 x 0.025-inch stainless steel arch wire. Both arch wires were cinched-back. At the end of this phase, lateral cephalometric films were taken for the T1 phase.

The Jasper Jumper was performed in accordance with the manufacturer's instructions. Similarly, the Forsus FRD appliance was connected to the mandibular arch wire and auxiliary tubes of the molar bands (Figure 1).

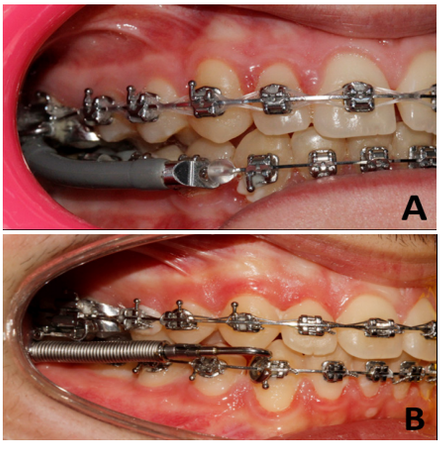

Figure 1. (A) Jasper Jumper appliance, (B) Forsus FRD appliance

Patients were checked at four-week intervals and appliance activations were performed at the required times. After the Class I molar and the canine relationship were obtained, the appliances were removed and Class II intra-oral elastic use for retention was initiated. Immediately after removal of the appliance, cephalometric films were taken to evaluate T2.

Cephalometric Analysis

A total of 66 cephalometric films were digitally traced and analyzed immediately before and after placement of the appliances (T1, T2) were obtained using the same cephalostat with the same instrument (Kodak Cephalostat, Rochester NY, USA) by a single observer (E.G.) in a digital cephalometric software program. Cephalometric films were analyzed and measured according to three different categories: dental, skeletal and soft tissue parameters. Thirty-nine cephalometric parameters were also evaluated (Tables 1 and 2). Also, the method of Pancherz (13) was used to evaluate the linear changes in the sagittal direction. In order to determine intraobserver reliability, the same measurements were repeated on 14 cephalometric films one month later.

Table 1. Comparison of T1 cephalometric values between Forsus FRD and Jasper Jumper.

Cephalometric Measurements	Forsus FRD		Jasper Jumper		*P*
	Mean	SD	Mean	SD	
Skeletal Measurements					
SNA (°)	81.42	4.62	79.49	2.85	0.170[x]
SNB (°)	75.66	3.98	74.91	2.50	0.536[x]
ANB (°)	5.76	1.95	4.57	2.29	0.118[x]
Wits (mm)	4.46	2.20	3.07	2.10	0.074[x]
NPerp-A (mm)	-1.16	4.30	-2.57	4.01	0.341[x]
NPerp-Pog (mm)	-9.90	7.33	-11.38	7.17	0.564[x]
Convexity (°)	9.38	5.21	7.22	6.49	0.296[x]
SN-Pog (°)	77.16	3.63	76.13	2.91	0.383[x]
SN-GoMe (°)	31.79	5.18	35.65	4.92	0.116[x]
OccP/SN (°)	16.30	4.40	17.18	3.75	0.545[x]
Y-axis/SN (°)	69.12	2.90	70.66	3.80	0.195[x]
Gonial angle (°)	120.77	7.38	124.33	6.90	0.165[x]
Saddle angle (°)	122.72	7.15	125.24	5.10	0.502[y]
Articular angle (°)	148.31	9.15	145.10	7.28	0.281[x]
FMA (°)	24.29	6.11	26.83	5.39	0.219[x]
FMIA (°)	58.87	8.04	55.98	6.05	0.260[x]
Posterior facial height (mm)	75.70	6.59	75.39	4.26	0.875[x]
Anterior facial height (mm)	111.87	7.49	114.29	5.87	0.316[x]
NL-OL (mm)	9.04	4.47	8.75	3.88	0.848[x]
OL-ML (mm)	15.48	5.18	17.49	4.49	0.246[x]
A-OLP (mm)	71.86	3.67	70.59	4.17	0.360[x]
Pog-OLP (mm)	70.51	4.87	70.08	4.08	0.708[y]
Dental Measurements					
U1/SN (°)	96.35	13.26	105.24	10.36	0.043[x]
U1/PP (°)	103.63	11.93	113.67	10.18	0.015[x]
IMPA (°)	96.82	5.34	97.19	6.82	0.862[x]
U1-NPog (°)	7.71	4.89	10.07	3.80	0.137[x]
L1-NPog (°)	2.06	3.89	3.64	3.39	0.228[x]
U1/NA (°)	14.94	11.80	25.76	9.54	0.008[x]
U1-NA (mm)	3.63	2.26	5.57	1.80	0.012[x]
L1/NB (°)	24.27	6.81	26.75	5.93	0.278[x]
L1-NB (mm)	4.32	2.22	5.27	1.74	0.188[x]
Overjet (mm)	5.26	2.32	5.76	2.52	0.559[x]
Soft Tissue Measurements					
Labiale Superius-S Line (mm)	-1.79	2.48	-1.75	1.66	0.955[x]
Labiale Inferius-S Line (mm)	-0.99	2.90	-0.31	2.53	0.478[x]
Labiale Superius-E Line (mm)	-3.72	2.99	-3.59	1.97	0.886[x]
Labiale Inferius-E Line (mm)	-2.12	3.23	-1.36	2.81	0.483[x]
Labiale Superius – OLP (mm)	89.04	5.04	88.07	4.12	0.554[x]
Labiale Inferius – OLP (mm)	86.26	5.16	86.31	4.75	0.976[x]
Pog(s)-OLP (mm)	82.56	5.29	82.15	4.22	0.810[x]

[x]: Results of independent t test; [y]: Results of Mann-Whitney *U* test; SD: standard deviation

Table 2. Comparison of treatment changes(T2-T1)Forsus FRD and Jasper Jumper groups

Cephalometric Measurements	Forsus FRD		Jasper Jumper		*P*
	Mean	SD	Mean	SD	
Skeletal Measurements					
SNA (°)	-0.05	1.34	-0.39	0.77	0.386[x]
SNB (°)	0.58	1.56	0.01	0.53	0.146[x]
ANB (°)	-0.63	0.71	-0.43	0.79	0.450[x]
Wits (mm)	-2.31	2.10	-2.12	2.35	0.807[x]
NPerp-A (mm)	0.52	3.47	-0.19	2.63	0.516[x]
NPerp-Pog (mm)	1.77	5.83	0.19	5.66	0.440[x]
Convexity (°)	-1.39	1.74	-0.77	2.01	0.344[x]
SN-Pog (°)	0.58	1.55	0.03	0.59	0.173[x]
SN-GoMe (°)	-0.35	2.64	-0.03	1.13	0.663[x]
OccP/SN (°)	2.16	3.30	3.01	2.99	0.451[x]
Y-axis/SN (°)	0.03	1.97	0.30	1.01	0.311[y]
Gonial angle (°)	-0.19	4.35	-0.05	2.67	0.914[x]
Saddle angle (°)	0.44	1.97	-0.13	2.16	0.656[x]
Articular angle (°)	-0.61	5.76	0.00	3.82	0.728[x]
FMA (°)	-0.90	3.41	-0.21	2.89	0.542[x]
FMIA (°)	-8.11	6.66	-4.23	7.62	0.129[x]
Posterior Facial Height (mm)	3.24	2.54	1.73	1.76	0.061[x]
Anterior Facial Height (mm)	3.74	4.01	2.06	2.34	0.181[x]
NL-OL (mm)	1.91	3.42	2.87	3.24	0.413[x]
OL-ML (mm)	-2.51	3.24	-2.84	3.12	0.901[y]
A-OLP (mm)	-2.80	2.87	-2.07	1.74	0.398[x]
Pog-OLP (mm)	-5.71	5.18	-4.80	4.08	0.585[x]
Dental Measurements					
U1/SN (°)	6.10	10.16	-3.51	9.70	0.010[x]
U1/PP (°)	6.32	9.81	-3.44	9.88	0.008[x]
IMPA (°)	9.02	6.28	4.95	6.58	0.079[x]
U1-NPog (°)	0.26	2.65	-1.93	2.63	0.025[x]
L1-NPog (°)	2.70	1.24	1.11	2.07	0.010[y]
U1/NA (°)	6.15	9.90	-3.27	9.59	0.010[x]
U1-NA (mm)	0.08	1.67	-1.15	1.57	0.038[x]
L1/NB (°)	9.25	6.75	4.19	6.30	0.035[x]
L1-NB (mm)	1.75	0.82	0.61	1.42	0.007[x]
Overjet (mm)	-2.14	2.42	-2.51	2.24	0.651[x]
Soft Tissue Measurements					
Labiale Superius-S Line (mm)	-0.86	1.01	-0.39	1.10	0.211[x]
Labiale Inferius-S Line (mm)	0.75	1.56	0.67	1.99	0.902[x]
Labiale Superius-E Line (mm)	-1.14	1.19	-1.11	1.17	0.928[x]
Labiale Inferius-E Line (mm)	0.64	1.67	0.27	2.01	0.572[x]
Labiale Superius – OLP (mm)	-3.23	3.23	2.25	2.52	0.346[x]
Labiale Inferius – OLP (mm)	-5.43	4.32	4.07	3.29	0.322[x]
Pog(s)-OLP (mm)	-5.69	5.23	4.49	3.97	0.470[x]

[x]: Results of independent t test; [y]: Results of Mann-Whitney *U* test; SD: standard deviation

Statistical Analysis

All measurements were statistically analyzed using the SPSS (SPSS for Windows version 20.0; SPSS Inc, Chicago, IL) program. After applying the normal distribution test, parametric tests were applied

to the normal distribution parameters, whereas non-parametric tests were applied to the non-normal distribution parameters. The independent t-test and Mann-Whitney U test were used in the analysis of the data measured between the groups. For all tests, results with a *p* value less than 0.05 were considered statistically significant.

RESULTS

For all skeletal, dental and soft tissue measurements, intraobserver correlation coefficients were found to be greater than 0.946. This ratio is reliable in repeated measurements. For all 33 patients, statistical evaluations of cephalometric measurements taken before and after Forsus FRD and Jasper Jumper appliance treatment are shown in Tables 1 and 2. Class I molar and canine relation, ideal overbite and overjet were obtained at the end of treatment in all patients. When skeletal parameters were evaluated, similar results were seen in both groups and no statistically significant differences were found ($p> 0.05$). In both groups, maxillary retrusion and mandibular protrusion were observed, and the mandible rotated in the posterior direction ($p> 0.05$). ANB, convexity angles and Wits measurement values decreased in both groups and maxillomandibular incompatibility was corrected. Posterior and anterior facial height increased in both groups ($p> 0.05$).

Statistically significant differences were found between groups in dental parameters. In the group treated with a Forsus FRD appliance, upper incisors proclined. In the group treated with Jasper Jumper appliances, the upper incisors retroclined and there was a statistically significant difference between the groups ($p< 0.05$). Upper lip protrusion developed in the group treated with Forsus FRD appliances, whereas retrusion was observed in the group treated with Jasper Jumper appliances ($p< 0.05$). Mandibular incisors proclined in both groups. There was no statistically significant difference between the groups treated ($p> 0.05$). Overjet values also decreased in both groups; there was no statisrically difference between the groups ($p> 0.05$). In addition, the occlusal plane performed a rotation in the posterior direction in both groups, but there was no statistically significant difference between the two groups ($p> 0.05$).

Soft tissue evaluation showed retrusion in the upper lip and protrusion in the lower lip. There was no statistically significant difference between the groups ($p> 0.05$).

DISCUSSION

Recently, fixed functional appliances have an important place in the treatment of Class II malocclusions. The efficacy of these devices, which are frequently used in orthodontic clinical practice, are also very important. The purpose of this study was to evaluate the skeletal, dental and soft tissue effects of Forsus FRD and Jasper Jumper fixed functional appliances. Both appliances are commonly used in orthodontics as fixed functional appliances.

In our study, the SNA angle decreased in both groups. Looking at these findings, it can be said that both appliances restrict the sagittal growth of maxilla. However, considering that point A is affected by tooth movement and that there was incisal tooth proclining in the Forsus FRD group and the retroclining in the Jasper Jumper group, this effect on maxilla of the Jasper Jumper appliance was significantly higher. The distance of A-OLP increased and the A point moved as if it moved forward. This was probably related to the posterior positioning of the OLP plane due to the posterior rotation of the occlusal plane. Cacciatore et al. (12) and Jones et al. (14) found a similar reduction in the SNA angle in their study by using Forsus FRD fixed functional appliance. Once more, our findings support the findings of Bassarelli et al. (15) that Jasper Jumper appliances, combined with an anterior bite plane, had a slight retraction effect on maxilla in growing subjects. Küçükkeleş et al. (2) and Nalbantgil et al. (9) also referred to the limiting effect of the Jasper Jumper appliances growth in maxillary in late adolescent patients.

Considering the increase in SNB, SN-Pog and Pog-OLP values, it can be said that the mandible moved forward in both groups. When the decrease in ANB, Wits and convexity values was assessed, it can be concluded that the Class II correction showed a skeletal improvement. There was also a rotation in the posterior direction of the mandible in both groups, which caused an increase in the anterior face height. Many studies in the literature have achieved similar results; however, Günay et al. (4), Cope et al. (8) and Covell et al. (16) reported that Jasper Jumper and Forsus FRD appliances had no skeletal effect on the mandible.

Although skeletal changes in the two groups in our study were similar, dental changes showed significant differences. In the group treated with Forsus FRD appliances, the upper incisor teeth proclined and protruded, while the Jasper Jumper appliance had a retroclination and retrusion effect. Similarly, Jones et al. (14) also found that the Forsus FRD appliance was the cause of proclining in the upper incisors (4, 12). Jasper Jumper appliances generally resulted in retrusion of maxillary incisors (2, 9). Mandibular anterior tooth movement was similar to protrusion and proclination in both groups. However, this undesirable proclining can be minimized with an orthodontic mini-screw inserted between the mandibular canine and the premolars (17). The use of a negative torque mandibular incisor bracket or lower incisor lingual crown torque is also considered an option.

When the soft tissue values of the facial profile were assessed, retrusion on the upper lip and protrusion on the lower lip improved the soft tissue profile. The increase in the upper lip OLP values is also thought to be related to the posterior positioning of the OLP, possibly due to the posterior rotation of the occlusal plane.

Use of the Forsus FRD and the Jasper Jumper appliances has dental and skeletal effects, but dental effects are more prominent in the late adolescent period. Numerous studies have achieved the same results (4, 9). Similar to growing individuals, the dentoalveolar effects of the appliances were found to be higher than the skeletal effects. Cacciatore et al. (12) reported that the main contribution to the correction of malocclusion was the dentoalveolar effect in their studies of the active treatment effects of Forsus FRD appliances on growing individuals. Morever, Küçükkeleş et al. (2) found the effect of Jasper Jumper appliances to be 80% dentoalveolar in growing individuals. In addition, Bassarelli et al. (15) reported that Jasper Jumper appliances used in conjunction with the anterior bite plane provided 75% skeletal and 25% dentoalveolar correction in growing individuals.

CONCLUSION

Both Forsus FRD and Jasper Jumper fixed functional appliances were found to be very successful in the treatment of Class II malocclusions. Some differences in dental effects were found, but skeletal effects and dentoalveolar effects were similar in the late adolescence period. Dentoalveolar effects were greater than skeletal effects. Determination of which fixed functional appliance should be used, should be based on factors such as the skeletal age and the cephalometric values of the patient.

Ethics Committee Approval: The Ordu University Clinical Research Ethics Committee (2015/12) approved this study.

Informed Consent: Yes

Peer-review: Externally peer-reviewed.

Author contributions: Concept – S.K.B., E.G., Y.A.B., A.A.; Design – S.K.B., E.G., Y.A.B., A.A.; Supervision – S.K.B., E.G., Y.A.B., A.A.; Resource – S.K.B., E.G.; Materials –Y.A.B., A.A.; Data Collection and/or Processing – S.K.B., E.G.; Analysis and/or Interpretation – S.K.B., E.G.; Literature Search S.K.B., E.G.; Writing – S.K.B., E.G.; Critical Reviews – S.K.B.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: This research study was funded by Ordu University Scientific Research Project Committee (Ar-1522).

Etik Komite Onayı: Bu çalışma için etik komite onayı Ordu Üniversitesi Klinik Araştırma Etik Kurulu tarafından (2015/12) alınmıştır.

Hasta Onamı: Evet.

Hakem Değerlendirmesi: Dış Bağımsız.

Yazar Katkıları: Fikir – S.K.B., E.G., Y.A.B., A.A.; Tasarım – S.K.B., E.G., Y.A.B., A.A.; Denetleme – S.K.B., E.G., Y.A.B., A.A.; Kaynaklar– S.K.B., E.G; Malzemeler – Y.A.B., A.A.; Veri Toplanması ve/veya işlemesi – S.K.B., E.G; Analiz ve/veya Yorum – S.K.B., E.G; Literatür taraması – S.K.B., E.G; Yazıyı Yazan – S.K.B., E.G; Eleştirel İnceleme – S.K.B.

Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemişlerdir.

Finansal Destek: Bu çalışma Ordu Üniversitesi Bilimsel Araştırma Projeleri tarafından desteklenmiştir (AR-1522).

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