

# The Influence of Kinesiology Tape on Postoperative Edema, Pain, and Trismus in Zygomaticomaxillary Fracture

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## Abstract

**Background and Objectives:** Maxillofacial surgery induces alarming facial swelling while treating complex orbital and zygomatic bone fractures for which corticosteroids have been used aggressively causing side effects. This study is aimed to evaluate the efficacy of Kinesiology Tape (KT) in isolated zygomaticomaxillary complex (ZMC) fractures in the reduction of postoperative swelling, pain, and trismus. **Methods:** This was a prospective study involving thirty patients with isolated ZMC fractures divided into two groups: test and control. Surgery was performed in accordance with the standardized protocol customized for the study. KT was used on the test group. The objective assessment of swelling involving six specific reference points making five lines and pre- and postoperative mouth opening was recorded. The subjective assessment of pain and efficacy of KT was checked at the time of discharge. **Results:** There was a significant reduction in swelling in the postoperative period in the study group as compared to the control. The study group showed minimum swelling, and the rate of resolving was faster. Subjectively 86.6% of the patients were very satisfied in the study group and did not find any disturbance to the use of KT or difficulty in the neck movement. No significant difference was recorded in trismus and pain in both the groups. **Conclusions:** The postoperative swelling was significantly lower with application of KT in ZMC fractures. No significant influence was seen on pain and trismus. The subjective assessment of the patients revealed that the mouth opening increased after surgery in the study group which may be due to placebo effect. KT could be a simple, inexpensive, noninvasive approach in management of postoperative morbidity which promises to improve the quality of life.

**Keywords:** Kinesiology tape, pain, rigid internal fixation, swelling, trismus, zygomaticomaxillary fractures

## INTRODUCTION

The management of facial bone fractures has evolved over centuries, and various methods of treatment have been advocated by the pioneers ranging from Barton bandages to present-day principles of rigid fixation using miniplate osteosynthesis.<sup>[1]</sup>

Open reduction and internal fixation (ORIF) in comparison to the conservative management of facial fractures improves the quality of life for the patients by achieving anatomic reduction, early return to function, reducing the intermaxillary fixation period, lesser incidence of postoperative infections, nonunion/malunion of fractured fragments as well as reducing the postoperative hospitalization period, thereby reducing the overall costs as well.

However, a major drawback of the procedure is the postoperative morbidities such as pain, swelling, and trismus, which is attributed to its invasive nature and soft-tissue management during the procedure. This has a negative impact on the patient's quality of life.

Any invasive procedure is followed by an inflammatory response as a direct and immediate consequence of trauma

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to the tissue which leads to pain, swelling, and trismus in the orofacial region. Complications encountered in the postoperative period prolong the period of hospitalization, thereby increasing the probability of the patient succumbing to nosocomial infections.<sup>[1]</sup>

An extensive search of the literature to control the immediate postsurgery inflammatory response revealed modalities such as medications like analgesics, antibiotics, corticosteroids and proteolytic enzymes, laser application, physical therapeutic methods like cryotherapy, manual lymph drainage, and various taping methods.<sup>[2,3]</sup> The literature does not provide consensus that a single method is standard enough to be clinically applied as a protocol for the prevention of postoperative periorbital swelling, pain, and trismus following surgical intervention of zygomaticomaxillary complex fracture. Hence, further research is required to formulate an ideal and cost-effective method in preventing or managing the postoperative morbidities of surgeries in the orofacial region.

Ever since the introduction of kinesiological tape (KT) in the 1970s,<sup>[4]</sup> its popularity in the treatment of sports injuries and a variety of other conditions has exponentially increased. KT supports injured muscles and joints, relieves pain, and increases blood and lymph flow to the site of injury. However, further research is required to establish the authenticity of these claims.<sup>[5]</sup>

The thickness of KT is similar to the epidermis and thereby aids in increasing the distance between the epidermis and dermis which in turn improves the lymph and blood flow, preventing the congestions of lymphatic fluids and hemorrhage. The fluid drainage is directed from areas of higher pressure toward lower pressure by taping along the desired pathway. It is propagated that the kinesiological taping can be beneficial in the management of postoperative swelling in the maxillofacial region by accelerating the drainage exudates and lymph.<sup>[6]</sup>

The primary objective of this study was to evaluate the efficacy of KT on postoperative swelling, pain, and trismus in isolated zygomatic complex (ZMC) fractures which is not done as per the literature search. Although KT is being used extensively in sports injuries and has proven its worth, its efficacy in the maxillofacial region is yet to be established.

## SUBJECTS AND METHODS

### Data gathering

This prospective study was carried out at a craniofacial center between 2017 and 2019. One hundred and eighty-four cases of various facial bone fractures were treated during the study, which included 53 ZMC fractures out of which 30 were isolated ZMC fractures.

The inclusion criteria are as follows. All surgeries were performed by a single oral and maxillofacial surgeon under general anesthesia which included patients aged 18–60 years, where surgical intervention of isolated ZMC fracture was indicated with three-point fixation. Patients excluded were

isolated zygomatic arch fracture, other fractures treated with two-point fixation, and any history of allergic reaction to adhesive tape. The patients were randomly assigned to a study group involving the application of KT and a control group which did not involve KT application.

Surgery was performed in accordance with the standardized protocol customized for the study. Standardized approaches used were lower blepharoplasty and supratarsal and intraoral vestibular incision, and three-point fixation was done with miniplates. This study was standardized with patients in both the groups who received hydrocortisone 100 mg half an hour prior induction, and no corticosteroid or proteolytic enzyme was administered during the postoperative period.

KT taping was performed on the test group patients by a single investigator under the guidance of a physiotherapist trained in kinesiological taping.

### Standard KT application procedure

- Preparation of the recipient area prior to surgery
- Skin was freed from moisture and oils just before the application of the tapes
- KT was placed after ORIF immediately when patient was shifted to recovery room
- Kinesiological tape was cut into strips of 1.5 cm width, and the length was individually measured for each patient from the clavicle to the highest point of the swelling.

Only one of the designated investigators assessed all the measurements at six specific time periods from preoperative measurement to the 7<sup>th</sup> postoperative day.

### Parameters for preoperative and postoperative assessment

#### Swelling

Assessment of swelling was done using a five-line measurement utilizing a standard plastic tape for measurement (accuracy 0.5 mm):

- (Line a) posterior tragal point-lateral canthus of the eye
- (Line b) posterior tragal point-lateral point lip commissure
- (Line c) posterior tragal point-pogonion

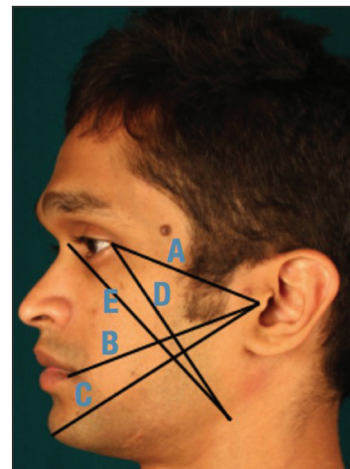


Figure 1: Linear measurements to record the swelling

- (Line d) lateral canthus of the eye–inferior point of the angle of the mandible
- (Line e) inferior point of the angle of the mandible–nasion [Figure 1].

The mean sum of these measurements recorded at 6 periodic various time intervals was subjected to statistical analysis independent and dependent *t*-test.

### Pain

Ten-level Visual Analog Scale (VAS) was used to assess pain, no pain denoted by 0 and moderate pain by 5, with 10 signifying severe pain. Mann–Whitney U-test was used for analysis.

### Trismus

Interincisal distance was measured preoperatively and postoperatively using measuring scale to determine maximal mouth opening. Statistical analysis was done using parametric test (Kolmogorov–Smirnov test).

### Subjective assessment

The satisfaction and convenience of all the patients included in the study (KT and non-KT control group) were evaluated with scores, very satisfied, satisfied, and not satisfied

Patients in the study KT group were asked if they found the tape:

- Not disturbing
- Slightly disturbing
- Very disturbing.

### Effect of tape on the neck movements

- Not affecting them in their movements
- Slightly affecting them in their movements
- Highly affecting them in their movements.

### Data analysis

Preoperative and postoperative measurements were compared, and the data were subjected to Mann–Whitney U and independent statistical analysis.

### Ethical consideration

This study was approved by the Institutional Review Board (IRB), and patients were consented for the same (SDMCDS/IRB/2019/OMFS/6).

## RESULTS

The study comprised of thirty patients with isolated zygomaticomaxillary fractures. Seventeen (56.6%) were right-sided ZMC fractures and 13 (43.3%) left-sided ZMC fractures. The mean age was 33 years in the study group and 35 years in the control group, as shown in Supplemental Table 1.

### Swelling

No significant difference was noted between the preoperative swelling and swelling immediately after tape application in either of the groups. The significant statistical difference was noted between the groups on postoperative days 1, 2, 3, and 7.

The maximum swelling was determined by calculating the difference of mean maximum swelling and mean sum of the measurements immediately after the application of the tapes. The maximum swelling in the control group was higher (13.6 cm) than the study group (13.1 cm) which was statistically significant. It was also noted that the maximum swelling was noted on day 1 in the study group which steadily decreased as opposed to the control group where the maximum swelling was noted on day 3 which was quite significant [Figures 2 and 3], as shown in Supplemental Table 2.

### Mouth opening

The mean mouth opening in the study group preoperatively was 3.3 cm with a standard deviation of 0.75 and postoperatively was 3.9 cm with a standard deviation of 0.40. In the control group, the mean mouth opening preoperatively was 3.5 cm with a standard deviation of 0.45 and postoperatively was 3.9 cm with a standard deviation of 0.36. The mouth opening of the study group and control group was not found to be statistically significant, i.e., the *P* value of the difference of mouth opening preoperatively and postoperatively in the study group and control group was 0.9030 and 0.5560, respectively, as shown in Supplemental Table 3.

### Pain

The pain was analyzed using the VAS on both the groups and was subjected to test, and no significant difference was noted between the two groups, as shown in Supplemental Table 4.

### Subjective assessment

86.6% of the patients found were extremely satisfied while 13.3% of the patients found it satisfied.

86.6% of the patients in the study group did not find any disturbance due to KT or difficulty in the neck movement due to KT while 13.3% of the patients in the study group found KT to be disturbing and slightly affecting the neck movement.

## DISCUSSION

Zygomaticomaxillary complex fractures account for a major share of midface fractures.<sup>[1,7]</sup> Fractures are inadvertently associated with morbidities such as swelling, pain, and



**Figure 2:** Maximum postoperative swelling in control nonkinesiology tape (KT) group



**Figure 3:** Maximum postoperative swelling in the kinesiological tape (KT) group

restricted movement of the affected site depending on the degree of injury, all of which in turn affect the social, economic, and mental well-being of the individual. Various methods are tried to restrict the postoperative morbidity to minimum and aim at restoring the patients as early as possible with minimum disabilities.

A plethora of techniques have been proposed throughout the course of medicine in the management of postoperative swelling, pain, and other morbidities such as trismus.<sup>[8]</sup>

The application of steroids in maxillofacial surgery has been in use since 1950.<sup>[3]</sup> In the present study, both the groups received 100 mg of hydrocortisone, keeping in mind the trauma induced from intubation, and even if the single dose had any effect on swelling, it was for both the groups. Glucose levels are increased with the usage of glucocorticoids significantly. A decrease in the synthesis of collagen and growth factors at the site of injury is also caused by glucocorticoids. A lag is seen in the presentation of signs of inflammation and infection which are critical for the clinical verification of local disturbances is masked by dexamethasone. All the above-discussed unfavorable factors of steroid usage mandate research to provide an alternative for the same.<sup>[9-12]</sup>

Laser is the most recent introduction in reducing postoperative discomfort. It has been speculated that application of laser on affected site induces lymph vessel proliferation and increases their diameter as well as decreasing the permeability of the blood vessels. This method is successfully tested in the third molar surgery. Its effect on various facial fractures is yet to be established.<sup>[13]</sup>

Cryotherapy is yet another simple, cost-effective method. It is believed that the application of lower temperatures to the postoperative site causes reduction in the blood flow, vasoconstriction, and reduced metabolism which in turn limit the bacterial growth. However, the efficacy of effects of cryotherapy remains controversial.

The assessment of effect of various drugs poses great difficulty in view of its varied nature, parameters, and methods utilized for each study.<sup>[13-15]</sup> Postoperative pain and swelling in the head-and-neck region are found to be better managed by the use of nonsteroidal anti-inflammatory drugs (NSAIDs) along with another drug rather than NSAID alone. Ristow *et al.* assessed the efficacy of manual lymph drainage following the extraction of third molars. They demonstrated an improvement in the lymph drainage using reproducible facial measurements and VAS.<sup>[3]</sup>

Kinesiological tape has extensively been used in sports injuries and rehabilitation in various body parts, but little research with regard to its efficacy in the maxillofacial region is done.<sup>[16]</sup> In this study of thirty patients with isolated ZMC fractures, there was a significant influence of KT application on postoperative swelling and tissue reaction in the study group. The maximum swelling is encountered postoperatively on the 2<sup>nd</sup> or 3<sup>rd</sup> postoperative day which was in consensus with the control group. However, in the study group, the peak swelling was reached between 0.5 and 1 days postoperatively. The reduction of the swelling was faster in the study group in comparison with the control group. A 60% reduction in the swelling noted in the first 2 postoperative days has been attributed to the thickness, adhesiveness, and stretch of the tape achieved during application. The kinesiological tape included a cotton elastic tape with a nonallergic adhesive. KT has been intrinsically designed to accommodate 20%–30% stretch longitudinally. The stretch allows the tape to return to its original size following its application which creates convolutions on the skin which is believed to increase the interstitial space, thus promoting the lymphatic and blood flow to the region. A pilot animal study proposed that elevation of skin aided in the microvalve opening in the initial lymphatic vessels which created a periodic compression and decompression of the superficial and deep initial lymphatics and an appropriate dynamic pressure variation.<sup>[17]</sup>

Few investigators suggest that the pain is relieved by KT application by reduction of pressure on nociceptors. No significant pain reduction was noted in either of the groups in this study in conjunction with other reported studies.<sup>[7]</sup> Moderate or less pain was present for all the predetermined time intervals in both the groups, i.e., VAS <5. The standardized analgesic administration in all patients can be attributed to this finding. There was no evidence to show the effect of KT in postoperative pain reduction.

Mouth opening showed no statistically significant difference between the control and study groups in the study. Although subjectively, the patients in the KT group gave a feedback of improved mouth opening as opposed to the non-KT group. This finding can be due to the faster resolution of the swelling which resolves the skin tension and also the role of placebo effect cannot be ruled out.

None of the patients encountered any allergic reaction to the material of the tape or the adhesive. Skin irritation resulting from the constant friction due to the elasticity and movement of the neck was also not encountered in this study.<sup>[18]</sup>

According to a study on albino rats after inducing soft-tissue trauma, KT application increased the epidermis–dermis distance significantly. It was noted that the distance increased 1.5 times after 30 m of application of KT and 3 times following application of KT for 6 h as opposed to non-KT application, suggesting that the effect of the taping is directly proportional to duration of application.<sup>[19]</sup> This finding favors the speculation that the convulsions on the skin seen after KT application increase the distance between the skin and subcutaneous tissue causing reduction in congestion of lymphatic fluid and hemorrhages beneath the skin. In the study, the authors also mentioned that the 3D arrangement of collagen fibers and also preserved the integrity of the dermis.<sup>[2,20,21]</sup>

It is postulated that KT application also reduces the nerve growth factor and B-cell lymphoma-2 immune reactivity, which can be interpreted as a reduction in pain sensation and tissue reconstruction following trauma. These mentioned observations advocate a potential benefit of KT in clinical care.<sup>[17,22,23]</sup>

A major impediment encountered in this study was to establish an objective, reliable, and easily reproducible method for the demonstration of postoperative swelling. Of the innumerable methods suggested in the literature, many were complex, expensive, nonstandardized, or inexplicit.<sup>[24,25]</sup> A linear measurement of the swelling by the utilization of easily reproducible standardized facial landmarks was employed to assess the swelling across various time periods. The human error encountered in this method was kept to a minimum as only one of the investigators was assigned to take measurements for all the patients involved in the study. Only limitation of study was increase in the swelling in the periorbital region in the KT group could not be objectively assessed.

## CONCLUSION

Kinesiologic tape (KT) is a simple, inexpensive, noninvasive approach in management of postoperative swelling in the zygomaticomaxillary complex fractures which promises to improve the quality of life during the immediate postoperative period.

## Patient consent

Patient consent was obtained.

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## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Coskun Benlidayi I, Salimov F, Kurkcu M, Guzel R. Kinesio taping for temporomandibular disorders: Single-blind, randomized, controlled trial of effectiveness. *J Back Musculoskelet Rehabil* 2016;29:373-80.
2. Al-Khateeb TH, Nusair Y. Effect of the proteolytic enzyme serrapeptase on swelling, pain and trismus after surgical extraction of mandibular third molars. *Int J Oral Maxillofac Surg* 2008;37:264-8.
3. Brignardello-Petersen R, Carrasco-Labra A, Araya I, Yanine N, Beyene J, Shah PS. Is adjuvant laser therapy effective for preventing pain, swelling, and trismus after surgical removal of impacted mandibular third molars? A systematic review and meta-analysis. *J Oral Maxillofac Surg* 2012;70:1789-801.
4. Chou YH, Li SH, Liao SF, Tang HW. Case report: Manual lymphatic drainage and Kinesio taping in the secondary malignant breast cancer-related lymphedema in an arm with arteriovenous (A-V) fistula for hemodialysis. *Am J Hosp Palliat Care* 2013;30:503-6.
5. Genc A, Cakarar S, Yalcin BK, Kilic BB, Isler SC, Keskin C. A comparative study of surgical drain placement and the use of Kinesiologic tape to reduce postoperative morbidity after third molar surgery. *Clin Oral Investig* 2019;23:345-50.
6. González-Iglesias J, Fernández-de-Las-Peñas C, Cleland JA, Huijbregts P, Del Rosario Gutiérrez-Vega M. Short-term effects of cervical Kinesio taping on pain and cervical range of motion in patients with acute whiplash injury: A randomized clinical trial. *J Orthop Sports Phys Ther* 2009;39:515-21.
7. Banerjee G, Briggs M, Johnson MI. Kinesiology taping as an adjunct for pain management: A review of literature and evidence. *Indian J Pain* 2016;30:151.
8. Kafa N, Citaker S, Omeroglu S, Peker T, Coskun N, Diker S. Effects of Kinesiologic taping on epidermal-dermal distance, pain, edema and inflammation after experimentally induced soft tissue trauma. *Physiother Theory Pract* 2015;31:556-61.
9. Dutta A, Gopinath A, Reyazulla M, Ramesh K, Srivastava S, Agarwal S. Kinesiologic tape breaking the traditional pharmacologic management of postoperative morbidity. *World J Dent* 2015;6:199-202.
10. Lietz-Kijak D, Kijak E, Krajczyk M, Bogacz K, Luniewski J, Szczegieliński J. The impact of the use of Kinesio taping method on the reduction of swelling in patients after orthognathic surgery: A pilot study. *Med Sci Monit* 2018;24:3736-43.
11. Morris D, Jones D, Ryan H, Ryan CG. The clinical effects of Kinesio® Tex taping: A systematic review. *Physiother Theory Pract* 2013;29:259-70.
12. Ristow O, Hohlweg-Majert B, Stürzenbaum S, Kehl V, Koerdt S, Hahnefeld L, *et al.* Therapeutic elastic tape reduces morbidity after wisdom teeth removal – A clinical trial. *Clin Oral Investig* 2013;18:1205-12.
13. Ristow O, Hohlweg-Majert B, Stürzenbaum SR, Kehl V, Koerdt S, Hahnefeld L, *et al.* Therapeutic elastic tape reduces morbidity after wisdom teeth removal – A clinical trial. *Clin Oral Investig* 2014;18:1205-12.
14. Ristow O, Pautke C, Kehl V, Koerdt S, Schwärzler K, Hahnefeld L, *et al.* Influence of Kinesiologic tape on postoperative swelling, pain and trismus after zygomatico-orbital fractures. *J Craniomaxillofac Surg* 2014;42:469-76.
15. Thorén H, Snäll J, Kormi E, Numminen L, Fåh R, Iizuka T, *et al.* Does perioperative glucocorticosteroid treatment correlate with disturbance in surgical wound healing after treatment of facial fractures? A retrospective study. *J Oral Maxillofac Surg* 2009;67:1884-8.
16. Tozzi U, Santagata M, Sellitto A, Tartaro GP. Influence of Kinesiologic tape on post-operative swelling after orthognathic surgery. *J Maxillofac Oral Surg* 2016;15:52-8.
17. Kase K, Wallis J, Kase T. Clinical Therapeutic Applications of the

- Kinesio Taping Method. Albuquerque: Kinesio Taping Association; 2003.
18. Yaedú RY, Mello MA, Tucunduva RA, da Silveira JS, Takahashi MP, Valente AC. Postoperative orthognathic surgery edema assessment with and without manual lymphatic drainage. *J Craniofac Surg* 2017;28:1816-20.
  19. Andreasen JO, Jensen SS, Schwartz O, Hillerup Y. A systematic review of prophylactic antibiotics in the surgical treatment of maxillofacial fractures. *J Oral Maxillofac Surg* 2006;64:1664-8.
  20. Assimes TL, Lessard ML. The use of perioperative corticosteroids in craniomaxillofacial surgery. *Plast Reconstr Surg* 1999;103:313-21.
  21. Williams S, Whatman C, Hume PA, Sheerin K. Kinesio taping in treatment and prevention of sports injuries. *Sports Med* 2012;42:153-64.
  22. Aznar-Arasa L, Harutunian K, Figueiredo R, Valmaseda-Castellón E, Gay-Escoda C. Effect of preoperative ibuprofen on pain and swelling after lower third molar removal: A randomized controlled trial. *Int J Oral Maxillofac Surg* 2012;41:1005-9.
  23. Tsai HJ, Hung HC, Yang JL, Huang CS, Tsao JY. Could Kinesio tape replace the bandage in decongestive lymphatic therapy for breast-cancer-related lymphedema? A pilot study. *Support Care Cancer* 2009;17:1353-60.
  24. Bjorn H, Lundqvist C, Hjelmstrom P. A photogrammetric method of measuring the volume of facial swellings. *J Dent Res* 1954;33:295-308.
  25. Buyukkurt MC, Gungormus M, Kaya O. The effect of a single dose prednisolone with and without diclofenac on pain, trismus, and swelling after removal of mandibular third molars. *J Oral Maxillofac Surg* 2006;64:1761-6.

**Supplemental Table 1: Distribution of patients in two groups (study and control)**

Gender	Study group	Control group	Total
Male	15	15	30

**Supplemental Table 2: Comparisons of two groups (study and control) with swelling (cm) scores at different time points by independent test**

Time points	Study group		Control group		P
	Mean	SD	Mean	SD	
Preoperative	12.79	0.74	13.19	0.56	0.1061
Immediate postoperative	13.04	0.62	13.33	0.50	0.1583
Day 1	13.10	0.69	13.56	0.57	0.0500*
Day 2	12.97	0.82	13.60	0.51	0.0165*
Day 3	12.80	0.84	13.48	0.50	0.0120*
Day 7	12.73	0.83	13.25	0.54	0.0500*
Preoperative to immediate postoperative	0.25	0.21	0.14	0.17	0.1532
Preoperative to day 1	0.31	0.27	0.37	0.22	0.4832
Preoperative to day 2	0.18	0.34	0.41	0.33	0.0650
Preoperative to day 3	0.01	0.26	0.29	0.27	0.0076*
Preoperative to day 7	-0.06	0.22	0.05	0.17	0.1219

\* $P < 0.05$ . SD: Standard deviation

**Supplemental Table 3: Comparisons of pre- and postoperative mouth opening (cm) scores in two groups (study and control) by dependent test**

Groups	Time points	Mean	SD	Mean different	SD different	Percentage of change	<i>P</i>
Study group	Preoperative	3.39	0.75	-0.55	0.40	-16.14	0.0001*
	Postoperative	3.93	0.40				
Control group	Preoperative	3.57	0.45	-0.36	0.23	-10.07	0.0001*
	Postoperative	3.93	0.36				

\**P*<0.05. SD: Standard deviation

**Supplemental Table 4: Comparisons of two groups (study and control) with pain scores at different time points by Mann-Whitney U-test**

Time points	Study group		Control group		<i>P</i>
	Mean	SD	Mean	SD	
Day 1	4.20	1.42	4.00	1.46	0.6783
Day 2	1.73	0.96	2.47	1.30	0.0779
Day 3	0.33	0.62	1.00	0.85	0.0381*
Day 7	0.00	0.00	0.00	0.00	1.0000
Day 1-2	2.47	0.99	1.53	1.25	0.0538
Day 1-3	3.87	1.13	3.00	1.13	0.0488*
Day 1-7	4.20	1.42	4.00	1.46	0.6783

\**P*<0.05. SD: Standard deviation