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The Impact of the Use of Kinesio Taping Method on the Reduction of Swelling in Patients After Orthognathic Surgery: A Pilot Study

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Background: Orthognathic surgery (OGS) is associated with extensive surgical intervention within the soft and hard tissues of the facial region of the skull leading to inflammatory reactions. The presence of postoperative swelling indicates the accumulation of exudate or transudate; both these fluids occur in surgery. Massive swelling is a significant problem, because the tension of tissues intensifies pain sensations. The aim of the study was to evaluate the effectiveness of the kinesio taping method (KT) in patients after orthognathic surgery in the area of the facial skull in terms of eliminating postoperative swelling.

Material/methods: The study of the impact of kinesiology tape applied after orthognathic surgery to the craniofacial area on the elimination of swelling was performed in sixteen patients who suffered from this complication after bilateral sagittal split osteotomy.





Results: The swelling was shown to be reduced after KT; within the same study the differences were statistically significant between the left and right sides and for the same side ($p < 0.05$). The application of the lymphatic kinesio taping method led to the reduction of tension in the affected area and restoration of proper lymphatic circulation in the region covered by swelling. This allows for the improvement of the blood and lymph microcirculation and activation of self-healing processes.

Conclusions: The analysis of the impact of the practical use of the lymphatic KT on complications after orthognathic surgery revealed that it had a beneficial effect on the reduction of swelling. The use of the KT method seems promising because it is simple to carry out, not traumatic, economical and rarely causes undesirable allergies.

MeSH Keywords: **Edema • Kinesiology, Applied • Orthognathic Surgery**

Abbreviations: **OGS** – orthognathic surgery; **BSSO** – bilateral sagittal split osteotomy; **KT** – kinesio taping

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Background

Complications may occur both during and after clinical dental procedures. The most common problems can be encountered after dental and maxillofacial surgery [1,2]. Orthognathic surgery (OGS) is an inseparable component of the combined orthodontic-surgical treatment of patients with heterogeneous occlusion-facial disorders [3,4].

Orthognathic operations

Surgical techniques that have evolved over recent decades now allow for almost any displacement within the bony facial structures [5–7]. In the jaw, LeFort I osteotomy has become popular, whereas in the mandible, bilateral sagittal split osteotomy (BSSO) is popular, while 2-jaw osteotomy is a combination of both these techniques in 1 operation [8,9]. Depending on individual needs, it is possible to extend the procedure to include genioplasty or segmental osteotomy of the jaw [10–12]. OGS is associated with extensive surgical intervention within soft and hard tissues of the facial region of the skull leading to inflammatory reactions [13,14]. Correction of defects of a gnathological character requires a combined orthodontic-surgical-physiotherapeutic treatment [15]. Pre-operative orthodontic preparatory procedure aims at aligning the dental arches and, depending on the type and severity of the defect, lasts from 6 to 24 months [16]. It involves the reposition of teeth, regardless of their mutual occlusion relation to the opposite arch, which leads to decompensation and deepening the existing defect [17]. During the operation, there is an attempt to restore the correct occlusion conditions and to obtain a symmetrical and harmonious facial appearance for the patient [18]. To stabilize the results, postoperative orthodontic treatment is required, often lasting up to 12 months, and sometimes up to 4 years. In the case of BSSO, extensive surgery involves the risk of a series of complications that can be divided into early and late [19]. The first ones, developing up to 24 hours after the surgery, include: bleeding, ventilation disorders, postoperative wound pain, soft tissue swelling, inflammatory reactions, infections, nausea, and vomiting [20]. Late complications that may occur in differently long periods of time after the surgery include: recurrence of the defect, unfavorable nasolabial aesthetics, nasal septum curvature, temporomandibular joint dysfunction, idiopathic appendages knuckles atrophy, bone necrosis, swelling, and neurological disorders [20].

Swelling as a postoperative complication

Changes in the tissues are caused by endogenous biological mediators that are released from blood cells and damaged tissues during inflammation. These include histamine, serotonin, cytokinin, and prostaglandin [21]. Although the inflammatory reaction is one of the defense mechanisms of the body against

harmful factors, it is associated with unpleasant feelings and often considerable a discomfort, which does not always lead to recovery but quite the contrary, they may result in severe, life-threatening homeostasis disorders [22]. Pain, swelling, congestion, fever, and impaired function sometimes not only do not disappear in the course of the treatment process, but cover new areas of the body, leading to the intensification of symptoms [23]. Due to the increased osmotic pressure in the capillaries (Starling's law) surgical trauma in the craniofacial region always causes tissue damage characterized by congestion, dilation of blood vessels, increased capillary permeability with liquid accumulation in the interstitial space, and migration of granulocytes and monocytes [24,25]. The presence of postoperative swelling indicates the accumulation of exudate or transudate; both these fluids occur in surgery [26–29]. The extension of the incision, manipulation within the tissues, and long duration of the treatment may affect the extent of swelling. According to the published data, postoperative swelling and pain are significantly less intense after smaller tissue incisions [30–32]. Like pain, swelling is evidence of inflammation and occurs in the immediate postoperative period, usually increasing up to 4 days after surgery, to gradually disappear within a few weeks. Massive swelling is a significant problem, because the tension of tissues intensifies pain sensations [33]. A desire to reduce postoperative swelling is important for several reasons, including the potential danger of respiratory failure and the possibility of inferior alveolar nerve dysfunction through mechanical pressure. Not without significance is the fact that long-lasting swelling is difficult to accept by patients for aesthetic reasons [34].

Treatment of swelling

There are several methods for reducing significant swelling after dental and maxillofacial surgery, with the most common being cooling (halotherapy) [35]. Steroid medications are also used to reduce swelling. The literature provides data on the high efficacy of reducing the inflammatory reaction and the associated swelling by the administration of dexamethasone in the preoperative period [36]. Glucocorticosteroids are also recommended to reduce postoperative swelling [37]. They diminish the permeability of capillaries, and consequently fewer inflammatory mediators penetrate into tissues [38–40]. Therefore, the use of glucocorticoids was evaluated in dental and maxillo-facial surgery to decrease unwanted postoperative complications [41–46]. Several methods of controlling the immediate inflammatory response relating to head and neck surgery have been described and used, including drugs, such as analgesics [47–50], corticosteroids [51], antibiotics [52], proteolytic enzymes [53], laser treatments [54], and physical therapeutic methods like cryotherapy or manual lymphatic drainage (MLD) [55]. No single treatment method significantly prevents and/or reduces swelling without potential undesirable

side effects. Therefore, other techniques should be developed for better control of postoperative swelling in dental surgery.

Kinesio taping (KT) method

KT is increasingly applied in combating lymphoedema. It was developed by the Japanese therapist and academic lecturer Kenzo Kase. More than 30 years ago, he created a special tape, which by the correct application, i.e. sticking with a small stretch (about 15%) to the skin, raises the surface of the skin, thereby increasing the space between the dermis and fascia [56,57]. The expansion of this space, in the opinion of the author, should reduce lymph retention. The patch used for this method has a thickness and weight similar to skin. Its stretchability is 130% to 140%. The waterproof tape is made of 100% cotton, while the adhesive on the inside is applied in the shape of a sinusoid, which allows the air to flow. The main advantages of using the KT method propagated by individual authors include: the influence on skeletal muscle functions (normalization of tension), improvement of microcirculation, activation of lymph outflow, stimulation of the endogenous system of anesthesia (the analgesic effect), and correctional benefits in eliminating postural defects. The result of the lymphatic application is to reduce the tension of the affected area and restore proper lymphatic circulation in the region covered by swelling. This allows for improving the blood and lymph microcirculation and activating self-healing processes [58–60]. The method causes primarily sensory, but also proprioceptive effects. KT as a method supporting soft tissue therapy and normalization of the tension of the myofascial system is an excellent tool in the hands of physicians and physiotherapists for clinical rehabilitation.

Study objective

The aim of the study was to evaluate the effectiveness of the KT method in orthognathic patients in the area of the facial skull in terms of the elimination of postoperative swelling.

Material and Methods

Patients

The study of the impact of KT after OGS in the craniofacial area on the elimination of swelling was carried out in 16 patients, aged 19–24 years, in whom this complication occurred. The patients, selected from the group of patients, were operated on from October 2015 to June 2017 and BSSO was performed on all of them.

The inclusion criteria were as follows: all patients were generally healthy and did not take medications permanently. The

selected patients did not have pre-existing medical conditions and did not take drugs that could affect their ability to undergo surgery or wound healing after the operation. In order to minimize discrepancies in the handling of oral tissues, each patient was operated on by the same maxillofacial surgeon using the same surgical technique on both sides. The exclusion criteria were as follows: regular drug therapy, mental illness, coagulopathy, diabetes, or chronic infections. The patients were not addicted to nicotine, alcohol, or drugs.

The study was approved by the Bioethics Committee of the Pomeranian Medical University in Szczecin (KB – 0012/36/15). It is in accordance with ethical standards, all participants signed written informed consent and were acquainted with the technique and the course of the research. The protocol was developed in accordance with the latest version of the World Medical Declaration of the Helsinki Association [61]. There was no financial incentive to participate in the study, and the subjects had the option to withdraw at any time.

Numeric determination of the examination of the extent of swelling

A flexible ruler was used to determine the measurable parameters. In order to assess the extent of swelling, 5 distances (in mm) were measured at 6 points on the face, from the angle of the mandible to: 1) the tragus skin point, 2) the outer angle of the eye, 3) the nasal border – wing of the nostril 4) the lip angle, and 5) the soft pogonion (Figure 1), and then the mean value was calculated [62]. Two dentists measured swelling before using the first KT, after 5 days and on the tenth day. The swelling was measured for the first time 24 hours after the operation.

Description of the physiotherapeutic KT method

The lymphatic KT method was applied to the area covered by swelling, i.e., the cheeks, pre-auricular – masseter area of the face and the neck. The lymphatic KT technique is based on the application of a tape cut into 4 parts, called tails, which cover the swollen treatment sites with a tape tension of stretch. 10% (Figure 2). Each patient was instructed to perform all daily activities for 5 days without unnecessary care for the patches. The application was made twice with a 1-weekend break. All the procedures of sticking KT tapes were performed by the same researcher, holding the K-Taping certificate. Before applying the tape, the skin was cleaned, freed from moisture and fat, and shaved if necessary. All tape applications were made using K-Active Tape Classic tape, 50 mm × 17 m (Nitto Denko Corporation, Japan). The length of the tape was measured individually for each patient, starting from the collarbone and ending at the point of the largest swelling. The tape was cut into 4 equal strips (approximately 1.25 cm wide). The

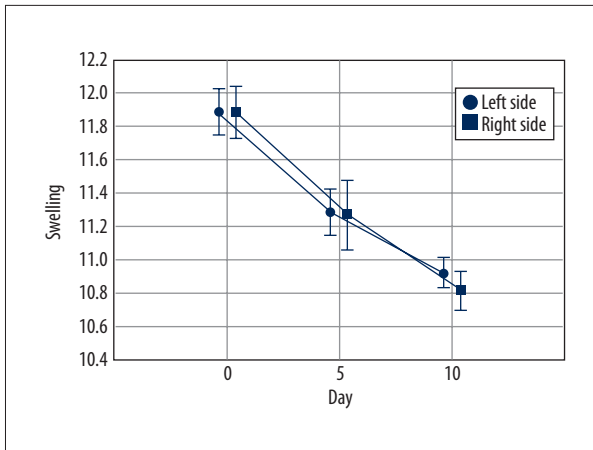


Figure 1. The method of measuring the extent of swelling before the KT application.

tape was carefully released from the paper backing, with great care taken not to touch the glue. The base was placed slightly above the supraclavicular lymph node region towards which drainage was directed. The tails were put on the skin of the cheek with a the stretch. The lymphatic strips were directed towards the appropriate lymphatic duct crossing the cervical, subglottic, mandibular, submandibular, pre-auricular, and parotid lymph nodes, reaching the zygomatic arch.

Results

Statistical analysis

The analysis of variance for repeated measurements with double classification for swelling variable was used (repetition factors: study 0, 5, and 10, and for the left and right sides). The studies showed a statistically significant decrease in the extent of facial swelling, and insignificant differences between the sides (Table 1).

Table 1. Analysis of variance for repeated measurements with double classification.

Analysis of variance for repeated measurements					
	SS	Degrees of freedom	MS	F	p
Constant term	110554.8	1	110554.8	77954.614	0
Error	21.27291	15	1.41819		
Study	41.34520	2	20.6726	140.58347	0.00000
Error	4.41146	30	0.14705		
Side	0.08167	1	0.08166	0.89307	0.35962
Error	1.37167	15	0.09144		
Study * side	0.02646	2	0.01323	0.21451	0.80817
Error	1.85020	30	0.06167		

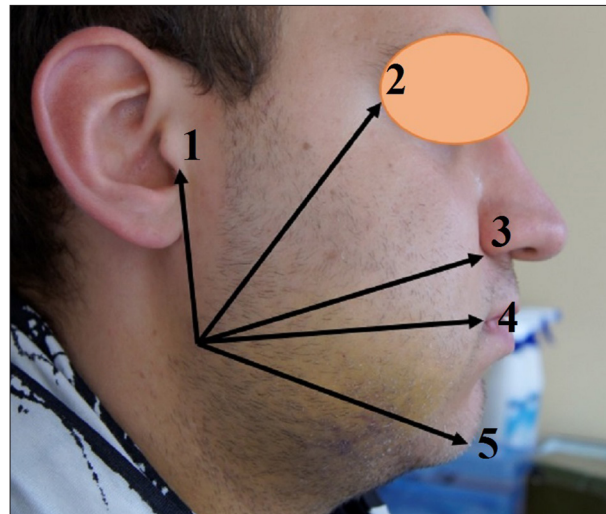


Figure 2. Kinesiologic tape stuck in order to reduce swelling.

Despite the incompatibility of distributions of some variables with normal distribution (the Shapiro-Wilk test) the analysis of variance was applied due to the low absolute values of skewness and kurtosis, and the high resistance of variance analysis to the lack of distribution normality (Table 2).

The assumption of sphericity was verified by the Mauchley test. Due to the asphericity of the interactions between the sides ($P < 0.01$ for Mauchley test) multivariate analysis of variance (MANOVA) was used.

The studies showed a statistically significant difference in the extent of swelling after the therapy, both on the right and left sides. However, there was an insignificant difference between the sides, and a negligible effect of interactions between the sides (Table 3).

Table 2. Analysis of variance due to low absolute values of Skewness and Kurtosis.

	N important	\bar{x}	Median	Min.	Max.	SD	Factor change	Skewness	Kurtosis
Swelling R_0	16	11.88	12.0	11.5	12.3	0.256	2.156	-0.224	-1.087
Swelling L_0	16	11.88	12.0	11.4	12.3	0.299	2.520	-0.441	-1.161
Swelling R_5	16	11.28	11.2	11.0	11.6	0.264	2.339	0.107	-1.945
Swelling L_5	16	11.27	11.4	10.5	11.8	0.384	3.410	-0.831	0.331
Swelling R_10	16	10.92	11.0	10.5	11.1	0.180	1.646	-1.817	2.354
Swelling L_10	16	10.81	10.9	10.5	11.0	0.219	2.023	-0.575	-1.528

Table 3. Multidimensional analysis of variance.

Multidimensional tests for repeated measurements: DV_1						
	Test	Value	F	Effect df	Error df	P
Study	Wilksa	0.0502895	132.19404	2	14	0.00000
Side	Wilksa	0.9689649	0.4804365	1	15	0.49882
Study*Side	Wilksa	0.9211825	0.5989287	2	14	0.56289



Figure 3. Swelling reduction after KT applications.

The research also showed a statistically significant reduction of the extent of swelling between the left and right sides, and for the same side (Figure 3).

Swelling evacuation was observed within 10 days after the use of KT treatments based on lymphatic applications (Figure 4).

Discussion

Swelling usually increases up to 4 days after surgery, to slowly regress within a few weeks. The gradual and spectacular evacuation of swelling, which is an expression of inflammation and

occurs in the immediate postoperative period, is observed after using 2 lymphatic KT applications, and this was demonstrated in our research. The effect of this application is based on draining the lymph into the submandibular lymph nodes, and in some cases also into the cervical lymph nodes. Unfortunately, the comparison of these considerations with the published research on the role of drugs in the evacuation of postoperative swelling is difficult due to the variability of parameters and methods used. The administration of glucocorticoids is common in oral and maxillo-facial surgery [63]. Although they are commonly applied after the extraction of third molars, there are few published materials proving their potential benefits after OGS [64,65]. The impact of non-steroidal anti-inflammatory

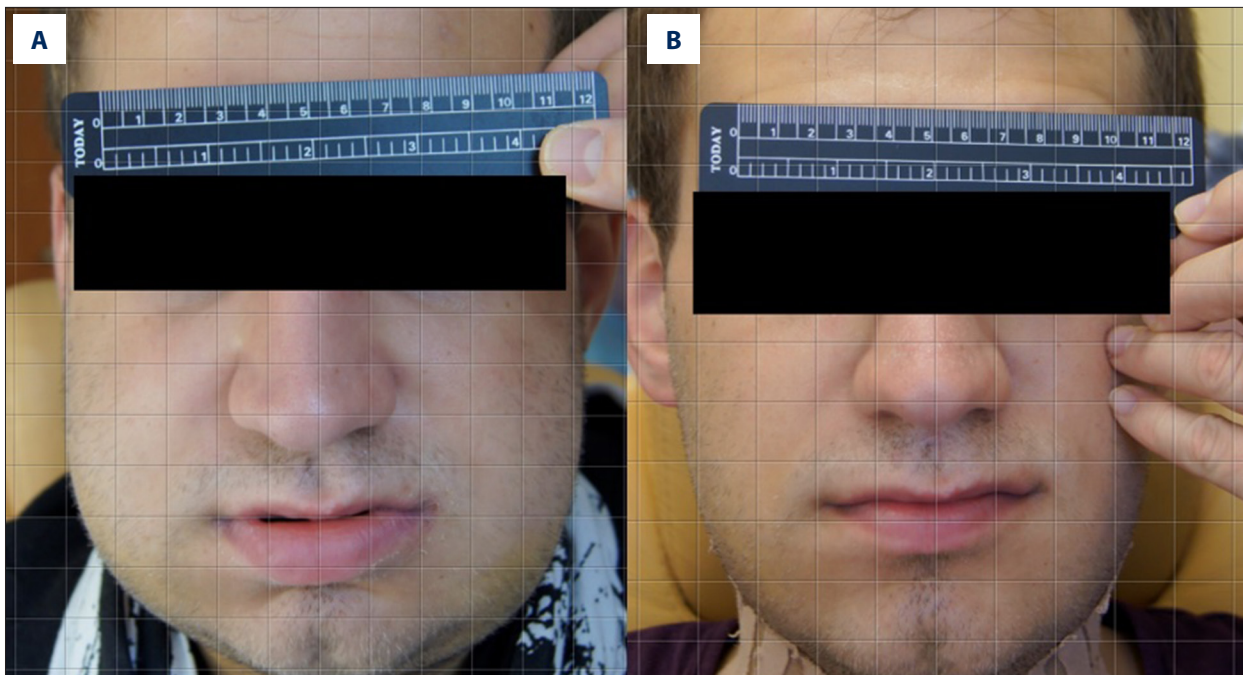


Figure 4. A spectacular limitation of the extent of swelling following the application of the KT method; (A) patient before the physiotherapeutic KT therapy; (B) reduction of the extent of swelling after 10 days of therapy.

drugs (NSAIDs) has been studied on the reduction of pain and inflammation. The literature indicates that the combination of an NSAID and another drug is often more effective in controlling postoperative pain and swelling after head and neck surgery [66]. However, we must remember that the use of any drug carries the risk of side effects and serious complications. The KT method is more and more frequently described in rehabilitation protocols and the prevention of sports injuries [67]. Breitenbach presented innovative research on the use of KT in pregnant women. The important fact is that each research was carried out separately and was in no way dependent on each other. In both studies the authors observed that proper KT application reduced pain in the lumbosacral spine and lymphoedema of the lower limbs [68]. The reduction of lymphoedema using KT in patients after mastectomy was obtained by many authors who applied this method with the lymphatic application [69]. Jung-Hyun demonstrated a statistically significant decrease in the intensity of pre-menstrual pain and tension in women [70]. The effectiveness of analgesic kinesiologic tapes used in sacral pain was investigated by Chen et al. and Added et al. [71,72]. The aim of the study was to assess the effectiveness of the application in traditional rehabilitation plans prepared for physiotherapists to be used in patients with the aforementioned disease. A similar topic of research was presented by Paoloni, who studied the impact of KT on pain in the lumbar spine [73]. The studies on the efficacy of KT in the physiotherapy of patients after laparoscopic cholecystectomy showed that it led to a reduction in the perception of pain and a significant decrease in the use of analgesics. The

method also provides effective support for physiotherapy and reduces functional disorders resulting from laparoscopic cholecystectomy by stabilizing the post-operative wound, which shortens the duration of hospitalization [74].

Despite the existence of promising research on KT's efficacy, there is no methodology available to apply this technique in surgical complications in dentistry. There are many studies on the control of postoperative swelling in maxillofacial surgery. Semper-Hogg et al. investigated the effectiveness of dexamethasone and proved that its use significantly reduced postoperative swelling. However, the authors concluded that further research was necessary to assess the ideal dose and duration of glucocorticoid therapy required to achieve maximum benefits [75]. The cases of drug-related allergies and side effects tend to focus on alternative methods. Osunde et al. described the use of laser as a relatively new method of reducing postoperative discomfort, especially swelling [76]. It is believed that laser irradiation increases the number and diameter of lymph vessels, with a concomitant reduction of blood vessel permeability. However, its use in maxillofacial surgery has not yet been studied. The application of ice is simple, cheap, and repeatable. Its therapeutic effect results from changes in the blood flow as a consequence of vasoconstriction and reduced metabolism, thus minimizing bacterial growth. However, data confirming the impact of cryotherapy on swelling are controversial, as reported by Rana et al. [35]. Szolonoky et al. investigated the effectiveness of manual lymphatic drainage (MLD) in the evacuation of swelling after the extraction of third

molars. Using repeated face measurements and the VAS pain scale they showed that MLD improved lymph circulation and helped to reduce swelling and postoperative pain [55]. Our research has shown that KT, as a cheap method of treatment, has a potential impact on the reduction of swelling and beneficial clinical effects. KT allows for the immediate reduction of swelling compared to baseline values, which was also confirmed by Tozzi et al. [77].

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Conclusions

The analysis of the impact of the practical use of the lymphatic kinesiio taping method on complications after orthognathic surgery revealed that it had a beneficial effect on the reduction of swelling. It should also be noted that the method has a very wide spectrum of applications in physiotherapy, including not only the elimination of swelling, but also the improvement of function. Further research is needed to determine whether KT can reduce or eliminate the need for additional drugs, such as steroids.

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