SURGICALLY ASSISTED RAPID MAXILLARY EXPANSION: RETROSPECTIVE ANALYSIS OF COMPLICATIONS 2012-2017

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Transverse maxillary deficiency (TMD) is one of the most common types of skeletal dysplasia in clinical practice [23]. TMD can be treated surgically or orthodontically, depending on the patient's age and clinical parameters [3]. Surgically assisted rapid maxillary expansion (SARME) has become the most common therapy in treating patients with TMD when orthodontic expansion is not sufficient due to the severity of TMD or not acceptable due to patient's skeletal maturity [1,18]. According to Mommaerts it is recomended to perform SARPE

if patient's age is >14 years, so SARME is used in patients with completely or almost finished craniofacial growth and mid-palatal suture ossification [14].

Some authors [2,5,23] describe surgically assisted rapid maxillary expansion as a relatively safe procedure, especially comparing to orthognathic surgery, though all of them mention the fact that SARME is not completely free of complications. With a constantly growing number of patients seeking orthognathic help, it is important to evaluate common complications of SARME in order to provide patients precise information about risks associated with surgery and to minimize possible risk factors as well. The aim of this study was to reveal the most typical postoperative SARME complications in a group of patients treated at a single clinical center.

Surgically assisted rapid maxillary expansion is a part of a complex treatment of patients with transverse maxillary deficiency more than 4 mm [1,6,9]. SARME minimizes the risks associated with orthodontic correction of severe TMD, such as root resorption, periodontal disease, lateral tooth extrusion and relapse [1,19]. Nevertheless, SARME itself is associated with several complications to be considered.

According to recent articles the most common SARME complications are neurosensory deficits, postoperative pain, asymmetric and/or inadequate expansion, epistaxis, dental complications [3,18,23,24]. Also there are complications associated with different SARME techniques: 1) performing or not performing pterygomaxillary osteotomy; 2) using bone-borne [14] or tooth-borne or combined (mini-implant- and tooth-borne) [25] distraction device.

Currently there is no consensus on either to perform pterygomaxillary disjunction (PMD) during SARME or not [8]. Not performing PMD is stated by some authors as a reason of an insufficient widening of the maxilla in the molars region (V-shaped widening) [2,10]. On the contrary Han et al. and Kilic et al. reported greater posterior maxilla widening in the group of patients who underwent SARME without PMD comparing to PMD SARME group [7,8]. Laudemann at al., recommend to perform PMD in patients older than 20 years and not to perform it in patients < 20 years in order to avoid the decline in transverse maxillary widening from anterior to posterior and lateral pterygoid bending [13]. Some authors consider performing pterygomaxillary osteotomy as a part of SARME risky due to the possibility of such complications as maxillary artery branches injury and the plates fracture [16,19,20]. So Zandi et al., due to the favorable outcomes of both techniques recommend to perform SARME without PMD so to decrease the risk of complications [27].

The choice of the distraction device is another factor to be considered while analyzing SARME complications. Currently there are two commonly used distraction device types: the transpalatal distractor (TPD) (bone-borne) and tooth-borne appliances such as Hyrax and Hass [14,18]. After TPD was introduced by Mommaerts in 1999 it was supposed it would help to avoid complications associated with tooth-born distraction device such as buccal tipping of the teeth, root resorption and periodontal problems [12] . Nevertheless, in the systematic review by Verstraaten et al. only weak evidence was found that there is less buccal tipping of the teeth in bone-borne expansion [22]. According to Koudstaal et al. no differences in stability, tipping and relapse was found between SARME with bone-borne and tooth-borne distraction device [12]. Currently there is no strong evidence regarding which SARME technique is associated with less complications thus and so the choice should be maid according to patient's individual requirements in each clinical case [26].

Materials and methods. Clinical cases of the patients who underwent SARME in period between 2012 and 2017 at the Clinical Center of Maxillofacial, Plastic Surgery and Dentistry, Moscow were evaluated during the study. All the patients had maxillary deficiency more than 4 mm and completed mid-palatal suture ossification. 679 clinical cases were originally selected for the study. 14 cases were excluded because patients had cleft in anamnesis or were treated using tooth-borne distraction device instead of the bone-borne. 665 patients remained in the study (247 males and 418 females, mean age 25,3 years).

Operation technique.

All the operations were performed by five surgeons of the Clinical Center of Maxillofacial, Plastic Surgery and Dentistry, Moscow, using bone-borne distraction device (either monolithic or sectional construction). No pterygomaxillary suture separation was made.

To perform the operation general anesthesia with nasotracheal intubation was combined with local anesthesia (Naropine 0,75% - 20ml with vasoconstrictor).

Two cruciform incisions were made on the right and the left parts of the palatine mucosa between the second premolar and the first molar to position distractor properly (in case sectional construction was presented, at first, distractor modules were put subperiosteally and then distraction device was placed into modules). After that the device was activated.

One incision (horizontal or vertical) was made in the frenulum area between two central incisors. In period between 2012 and 2015 years V-shaped incision between upper canines was performed.

Mucoperiosteum was separated tunnelly from the piriform aperture towards the maxillary tuber both at the right and the left sides symmetrically. Nasal mucosa was separated from the nasal cavity bottom. The Le Fort I osteotomy was performed from the piriform aperture towards the maxillary tubers bilaterally using reciprocating saw. Mid-palatal suture osteotomy was performed by the reciprocating saw as well. Chisels were used for Le Fort I and nasal septum osteotomies. The distraction device was activated so that the gap between central incisors would reach at least 2 mm.

Hemostasis during the operation. Sutures. Distraction device activation starts on postoperative day 7 and reaches from 0.3 to 1 mm daily. 3 weeks after activation is finished patient should visit orthodontist for the further treatment. It is recommended not to remove the device for 4 months since operation. 3 weeks after activation is finished and before the distraction device is re-moved patient should visit surgeon every 2 weeks for a check-up.

Radiological evaluations.

CBCT scans were made for each patient 3 times: before the surgery (within 2 months) -T1, after the surgery before the activation started - T2 and a year after SARME - T3, using the "I-CAT" device (USA).

The following measurements were made to evaluate the amount of distraction and possible complications such as relapse, insufficient or asymmetric expansion: U6-U6 – maxillary denture width is measured as the distance between the most convex parts of the buccal surfaces of two upper first molars.

P1-P1 – palatal vault width between the upper canines.

P2-P2 – palatal vault width between the second upper premolars.

P3-P3 – palatal vault width between the first upper molars.

Results and discussion. All the operations were performed according to the described technique. After activation was complete the expansion between 1.1 and 2.1 achieved from 4 to 15 mm.

As the result of retrospective analysis 450 cases of SARME postoperative complications were identified in 665 patients between 2012 and 2017. One patient could have 1 or more complications.

The following postoperative complications were revealed: 1) Paresthesia of the infraorbital nerve branches and nasopalatine nerve was observed in 198 cases out of 665. Patients reported unilateral and bilateral paresthesia of the front teeth. All the cases resolved completely during 6 months postoperative.

It is needed to be mentioned that the lowest percent of paresthesia was noted in 2016 year (11,3% - 20/177) and 2017 (10,5% - 18/173) (Diagram 1).

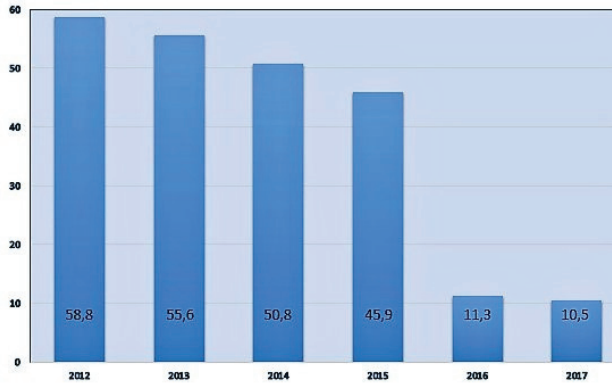

Diagram 1. The frequency of occurrence of the paresthesia of the infraorbital nerve branches and nasopalatine nerve in the Clinical Center of Maxillofacial, Plastic Surgery and Dentistry, Moscow 2012-2017 (%)

2) Distraction device displacement. 61 patients presented with this complication. All of them had devices with sectional construction. In most cases there were no screw fixation of the device's modules so as to not perforate palatine roots of the teeth (Photo 1).

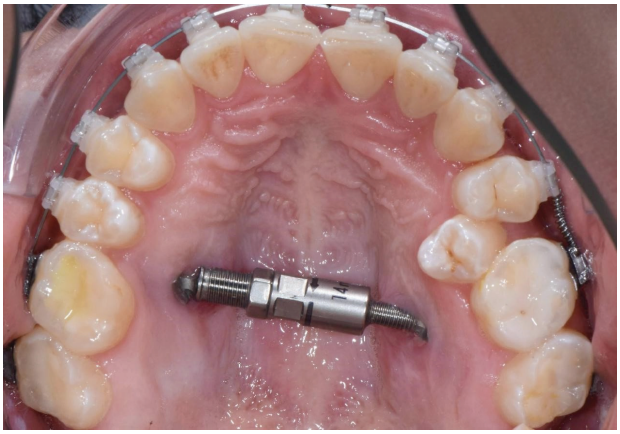

Photo 1. Distraction device displacement

3) Inflammation in distractor modules area was presented in a total of 57 cases: in patients whose level of oral hygiene was insufficient (Patient Hygiene Performance >1,7), and also in patients who had distraction device mobility (Photo 2).

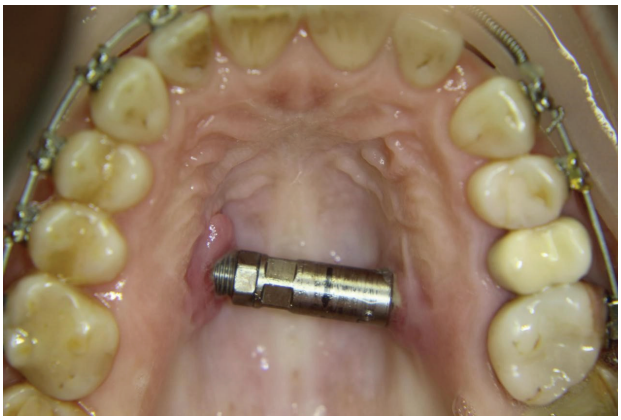

Photo 2. Inflammation in distractor modules area

4) Asymmetric expansion was observed in 27 patients. In 24 cases the complication was compensated by the following orthodontic treatment and in 3 cases additional surgery was required.

5) Relapse frequency of occurrence – 18/665. This complication was taken into account in case of the relapse more than 2 mm in interdental width between right and left first upper molar.

6) Distractor's loss was presented in 20 cases. 1 distraction device was swallowed by the patient. The complication was observed in patients with sectional construction of the device and was associated with the loosening of the device and mechanic pressure during eating.

7) Insufficient expansion of the maxilla 10 patients didn't come for the activation of the distractor that's why it wasn't done completely.

32 out of 665 had an inadequate expansion in molars zone. That can be explained by the features of the operation technique (no pterygomaxillary osteotomy). To correct an inadequate expansion of the maxilla orthognathic surgery with segmental osteotomy was performed as a second step of surgical treatment.

8) Postoperative bleeding was observed in 7 patients. In 6 cases epistaxis took place (4 happened on the same day operation was performed, 1 - on the third day and 1 - on the 7th day).

In 1 case the bleeding was palatine (on the 5th day). In 4 cases of nasal bleeding anterior nasal pack was required and in 2 cases - posterior.

9) Soft tissue complications 5 patients had medial recession in the central incisors area and 1 had necrosis of the palatine mucosa caused by trauma during distraction device positioning (Photo 3).

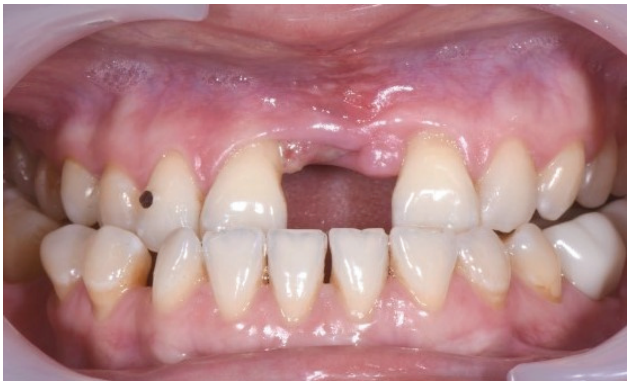

Photo 3. After the removal of the distraction device. Medial recession of 1.1 is presented

10) Maxillary sinus perforation by the distractor's module was observed in 6 patients in postoperative period during the activation.

11) Dental complications in 3 cases there was a 1.1 tooth discoloration. Electro-odonto-diagnosis of this teeth was >200 mkA.

12) Formation of defective bone regenerate was observed in 2 patients. After activation period was complete there was a defective bone regenerate presented by fibrous tissue in the anterior part of mid-palatal suture (Table 1).

Of the 665 patients presented in this article, 52,93% (352/665) had one or more postoperative complication. This corresponds with the results presented by Smeets et al., - 52.25% (58/111) [18] and is significantly higher than Carvalho et al. presented in the recent systematic review - 21.97% [4].

2016 and 2017 years had the lowest level of complications, that can be associated with using minimally invasive access. In 2016-2017 we performed a linear horizontal or vertical incision in frenulum zone instead of V-shaped one from tooth 1.3 to 2.3, that we used to do between 2012 and 2015. The amount of such complications as paresthesia of the infraorbital nerve branches and nasopalatine nerve, postoperative bleeding and dental complications were decreased noticeably possibly due to minimally invasive technique.

Paresthesia of the infraorbital nerve branches and nasopalatine nerve is the most frequent complication in this study (198/665). Patients experienced postoperative numbness of the teeth 1.5-2.5. One week after the operation EOD of this teeth resulted significantly higher numbers comparing to the normal marks before the operation. Paresthesia resolved during first 6 month after the operation. A number of authors in their studies noted not only numbness of the teeth but of the upper lip as well: Dergin [5] (11/60 cases of paresthesia, 4 of which included the numbness of the upper lip), Verquin [23] (16/55, 3 - paresthesia of the upper lip). In our study there was no lip paresthesia. We associate it with minimally invasive technique.

A number of complications presented in the study is associated with distraction device dislocation. Displacement 9,2% (61/665) and loss 3% (20/665) of the device was observed in following cases:

a) when there was no screw fixation of the distractor modules in order to avoid tooth roots perforation.

b) when patients missed activation procedures/checkups, that led to weakening of the device and its further loss/displacement.

The distractor's loss rate reported by Verlinden et. al. (4 cases out of 73 - 5,5%) [21], Ramieri et.al. (5/29 - 17,2%) [17] and Neyt et.al. (14/57 - 24,6%) [15] is higher than in this study (3%). Displacement of the distractor was observed by Koudstaal et.al. (1/10 - 10%) [11], Neyt et. al. (6/57 - 10,5%) [15], whose results are similar to the ones presented in this article. This group of complications was successfully corrected by the device change or repositioning. 35 patients out of 665 needed segmental osteotomy of the maxilla to be done during the following surgical treatment. The indications for segmental osteotomy were the following: 1) 3/35 patients had asymmetric expansion of the maxilla that couldn't be corrected by orthodontic treatment.

2) In 32/35 cases the expansion in the molars zone was inadequate while in incisors area the necessary level of distraction was achieved. In all the cases asymmetric/inadequate expansion was successfully corrected after segmental osteotomy of the maxilla was performed.

During the activation process 6 cases of palatine perforation were registered with the device modules dislocated in the maxilla sinus. In all 6 cases the protocol of activation wasn't followed properly. This complication was corrected by performing sinusotomy and module's removal out of sinus. 7 patients suffered postoperative bleeding. This complication was mentioned by Dergin [5] -12/60 nasal bleeding, 9 of which occurred at the following day after the operation. In the group of 120 patients Williams [24] observed 4 epistaxis within 7 days after SARME was performed. In our study 6 out of 7 bleeding were nasal, 4/7 happened on the first postoperative day, 1 - on the 3rd day, 1 – in the 7th . All 6 cases were stopped by nasal packing (4 by the-anterior and 2 by the posterior). 1/7 bleeding was palatine and it occurred on the postoperative day 5 in the zone of the left distractors module as the result of devices weakened pressure on the palate. The complication was resolved by soft tissue stitching.

As far as the operation technique doesn't include pterygomaxillary suture separation, the risk of bleeding because of pterygoid venous plexus trauma is minimized. Thus the main reasons of bleeding performing this technique are trauma of nasal mucosa while performing mid-palatal suture osteotomy or lateral nasal wall osteotomy and trauma of greater palatine artery [5].

Inflammation in distractor modules area was observed in 57 patients whose level of oral hygiene was insufficient (PHP>1.7), and also in patients whose distraction device wasn't stable. This complication can be prevented by the correction of patients' oral hygiene level and by the control of the devices fixation (checkups every 2 weeks).

In 18 cases the relapse was observed in interdental width between first right and left molar, despite distraction device activation has been made with hypercorrection (2 mm).

In 5 cases patients had dental recession occurred due to trauma while performing midpalatal osteotomy and due to forced activation >1 mm a day). All 5 recessions were on the medial surfaces of the teeth (in 4 cases tooth 1.1 had recession and in 1 case - 2.1).

All the recessions were self-corrected during the orthodontic treatment. In 1 case necrosis of the palatine mucosa was presented. It was caused by trauma during distraction device positioning. Dental complications were observed in 3 patients and were characterized by 1.1 teeth vitality loss (>200 mkA) and discoloration. In all the cases the teeth were depulped and internal tooth bleaching was made. The complication was caused by

trauma during the osteotomy. In 2 cases formation of the defective bone regenerate in the anterior part of mid-palatal suture was noted. That could be caused by the forced activation of the distraction device.

Conclusion. SARME is an operation associated with the risks of postoperative complications. Treatment planning, following the operation protocol and using the minimally invasive access help to avoid the majority of complications.

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SUMMARY

SURGICALLY ASSISTED RAPID MAXILLARY EXPANSION: RETROSPECTIVE ANALYSIS OF COMPLICATIONS 2012-2017

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Surgically assisted rapid maxillary expansion (SARME) is a common technique developed to treat skeletally mature patients with transverse maxillary deficiency. Although SARME is supposed to be a relatively safe procedure, it is not completely free of complications. The purpose of this study was to reveal the most typical postoperative SARME complications.

Retrospective evaluation of the clinical cases of 665 patients (247 males and 418 females, mean age 25,3 years) with the diagnosis of maxillary transverse deficiency, who underwent SARME in period between 2012 and 2017 at the Clinical Center of Maxillofacial, Plastic Surgery and Dentistry, Moscow.

According to the results of the research, the most typical complications of SARME are paresthesia of the infraorbital nerve branches and nasopalatine nerve (198/665), distraction device dislocation (61/665), inflammation in the distraction device area (57/665), insufficient expansion of the maxilla (42/665), asymmetric expansion (27/665).

The number of complications revealed indicates that SARME is an operation associated with the risks of postoperative complications. Careful treatment planning, following the operation protocol and performing the minimally invasive access can help to avoid the majority of complications.

Keywords: maxillary transverse deficiency, surgically assisted rapid maxillary expansion, SARME, SARPE, RME, TMD, complications.

РЕЗЮМЕ

ХИРУРГИЧЕСКОЕ РАСШИРЕНИЕ ВЕРХНЕЙ ЧЕЛЮСТИ: РЕТРОСПЕКТИВНЫЙ АНАЛИЗ ОСЛОЖНЕНИЙ ЗА 2012-2017 ГГ.

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Хирургическое расширение верхней челюсти является общепринятым методом лечения пациентов с завершенным кранио-фасциальным ростом при недоразвитии верхней челюсти по трансверсальной плоскости. Несмотря на то, что хирургическое расширение верхней челюсти является относительно безопасной манипуляцией и сопряжено с риском возникновения осложнений.

Целью исследования явился анализ наиболее встречаемых послеоперационных осложнений хирургического расширения верхней челюсти.

Проведен ретроспективный анализ 665 клинических случаев пациентов (247 мужчин, 418 женщин, средний возраст 25.3 лет) с недоразвитиой верхней челюстью по трансверсальной плоскости, которым проведено хирургическое расширение верхней челюсти с 2012 по 2017 гг. в Клиническом центре челюстно-лицевой, пластической хирургии и стоматологии, (Москва).

Согласно результатам анализа, наиболее частыми послеоперационными осложнениями хирургического расширения верхней челюсти являются парестезия ветвей подглазничного и носо-небного нерва (198/665), смещение дистракционного аппарата (61/665), воспаление слизистой в области дистракционного аппарата (57/665), недостаточное расширение верхней челюсти (42/665), асимметричное расширение верхней челюсти (27/665).

Выявленное число осложнений указывает, что хирургическое расширение верхней челюсти является вмешательством, сопряженным с риском возникновения послеоперационных осложнений. Тщательное планирование лечения, следование операционному протоколу и проведение операции через наименее инвазивный доступ позволяют избежать осложнения.

რეზიუმე

ზედა ყბის ქირურგიული გაფართოება: გართულებების რეტროსპექტული ანალიზი, 2012-2017 წწ.

ა.დრობიშევი, ი.კლიპა, ნ.დრობიშევა, ნ.ილინა, ი.ჟმირკო

მოსკოვის ა.ევდოკიმოვის სახ. სახელმწიფო სამედიცინო-სტომატოლოგიური უნივერსიტეტი, რუსეთის ფედერაცია

კვლევის მიზანს წარმოადგენდა ზედა ყბის ქირურგიული გაფართოების ოპერაციის შემდგომი ყველაზე ხშირი გართულებების ანალიზი.

ჩატარებულია 665 კლინიკური შემთხვევის (247 - მამაკაცი, 418 - ქალი, საშუალო ასაკი – 25.3 წელი) რეტროსპექტული ანალიზი პაციენტებისა განუვითარებელი ზედა ყბით ტრანსვერსულ სიბრტყეში, რომელთაც მოსკოვის ყბა-სახის, პლასტიკური ქირურგიისა და სტომატოლოგიის კლინიკურ ცენტრში 2012-2017 წწ. ჩაუტარდათ ზედა ყბის ქირურგიული გაფართოების ოპერაცია.

ჩატარებული ანალიზის შედეგების მიხედვით, ზედა ყბის ქირურგიული გაფართოების ოპერაციის შემდგომ ყველაზე ხშირ გართულებას წარმოადგენს თვალის და ცხვირ-სასის ნერვების ტოტების პარესთეზია (198/665), დისტრაქციული აპარატის ცდომა (61/665), ლორწოვანის ანთება დისტრაქციული აპარატის მიდამოში (57/665), ზედა ყბის არასაკმარისი გაფართოება (42/665), ზედა ყბის ასიმეტრიული გაფართოება (27/665).

გართულებების გამოვლენილი რაოდენობა მიუთითებს, რომ ზედა ყბის ქირურგიული გაფართოება წარმოადგენს ოპერაციისშემდგომ გართულებათა განვითარების რისკთან შეუღლებულ ოპერაციას. მკურნალობის გულდასმით დაგეგმვა, ოპერაციის პროტოკოლის დაცვა და ოპერაციის ჩატარება მინიმალურად ინვაზიური მიდგომით ხელს უწყობს გართულებათა მაღალი სიხშირის თავიდან აცილებას.