BULLETIN OF STOMATOLOGY AND MAXILLOFACIAL SURGERY
Volume 21, Issue 6

DOI: 10.58240/1829006X-2025.21.6-356

CASE REPORT

VIRTUAL PLANNING OF MANDIBLE DEFECTS SECONDARY RECONSTRUCTION IN KROKODIL DRUG-ADDICTED PATIENTS

Yuri Poghosyan [1,2], Koryun Hakobyan[2]

[1] Professor, Department of Oral surgery and maxilla-facial surgery, Yerevan State Medical University, Armenia
[2] Department of Maxillofacial Surgery, "Yerevan" m/c, Yerevan, Armenia
* Corresponding author Yuri Poghosyan Professor, Department of Oral surgery and maxilla-facial surgery, Yerevan State Medical University, Department of Maxillofacial Surgery, "Yerevan" m/c, Yerevan, Armenia
E-mail: poghosyan.yuri@mail.ru

Received: *Jun 5, 2025;* ***Accepted:*** *Jul 25, 2025;* ***Published:*** *Jul.31,2025*

ABSTRACT

Background: Treatment for stage 3 cases of mandible ONJ involves segmental resection, with or without TMJ exarticulation. These cases result in large continuity defects of the mandible. Primary reconstruction of such defects carries a high risk of disease recurrence. In 21,4% of stage 3 mandible ONJ cases, disease recurrence is observed after segmental resection without primary reconstruction. For this reason, secondary reconstruction is employed in ONJ patients. Delayed reconstruction of the mandible reduces the recurrence rate but complicates the proper alignment of the mandible fragments in their initial anatomical position.
Aim: The aim of this study is to share our approach to using virtual surgical planning for secondary reconstruction of the mandible, utilizing only stereolithographic models.
Materials and methods: This is a retrospective study of four patients with secondary mandibular defects due to the resection of stage-3 Krokodil drug-related osteonecrosis. All cases were analyzed concerning complaints, age, period of Krokodil use, Krokodil withdrawal period, and surgery outcomes. Before surgery, CBCT, orthopantomography were performed in all cases. Then, using the CT scans, the mandible defect was reconstructed by mirroring the healthy side. The reconstructed mandible model was printed on a 3D printer. The reconstructive plate was prebended on the model. In all patients, the existing defects were reconstructed using only prebended reconstructive plates
Results: The postoperative follow-up period ranged from 6 to 18 months. No recurrence occurred during the postoperative period for any patient. All patients noted good aesthetic and functional outcomes.
Conclusion: Within the limitations of the study, the use of 3D virtual planning and prebent reconstructive plates can be an effective and predictable method for the secondary reconstruction of mandible defects using only a reconstruction plate in Krokodil drug-addicted patients.

Keywords: *Medication-related osteonecrosis of mandible; Krokodil drug-related osteonecrosis of mandible; mandible segmental resection; MRONJ surgical treatment; Krokodil drug; 3D surgery planning; mandible defect reconstruction*

INTRODUCTION

"Crocodile" is a low-cost, home-made heroin substitute whose main ingredient is desomorphine (dihydrodeoxymorphine-D or 4,5a-epoxy-17-methylmorphinan-3-ol), which has strong opioid psychoactive properties. It can be administered orally, intravenously, or by mouth. Krokodil is the street name for a new synthetic drug mixture because the drug causes necrotic or greenish-black skin lesions that resemble crocodile skin .[1,2].

The primary component of Krokodil is desomorphine, a synthetic opioid. Drug abusers synthesize Krokodil themselves using cheap and readily available substances that can be easily obtained from drug stores[2]. Among the substances used in the process are codeine-containing analgesics (Sedalgin, Pentalgin, etc.), iodine, soda, red phosphorus (from matchboxes), hydrochloric acid, and gasoline; thus, during intravenous use, various byproducts

enter the bloodstream[2]. Low serum C-terminal telopeptide (CTX) levels found in these patients indicate decreased bone turnover, resulting from the effects of some components of Krokodil[3].

A common serious complication of Krokodil is facial bone necrosis, the most common precipitating factor of which is tooth extraction. The onset of osteonecrosis usually occurs within the first 1-1.5 years after extraction; other predisposing factors include poorly fitting dentures and inaccurately fixed restorations, which cause trauma and plaque retention and contribute to the development of periodontal disease.

The exact pathogenesis of Krokodil drug-related osteonecrosis is unclear, but it has been compared to drug-related osteonecrosis of the jaw (MRONJ) and the long-described "phosphorus jaw" (phosphorus osteomyelitis) in factory workers. It has been noted that Krokodil-related osteonecrosis of the jaw, like MRONJ, affects the lower jaw more often than the upper jaw.

Thus, Krokodil exhibits an anti-resorptive effect on bone tissue, meaning that ONJ in Krokodil abusers represents a new type of medication-related osteonecrosis of the jaws (MRONJ).

Surgery is the primary method for treating Krokodil drug-related ONJ[2]. Patients who undergo drug withdrawal for at least one month before surgery demonstrate low rates of recurrence following jaw resection that extends at least 0.5 cm into healthy tissue[2]. Treatment for stage 3 cases of mandible ONJ involves segmental resection, with or without TMJ exarticulation[2]. These cases result in large continuity defects of the mandible. Primary reconstruction of such defects carries a high risk of disease recurrence. In 21,4% of stage 3 mandible ONJ cases, disease recurrence is observed after segmental resection without primary reconstruction[2]. For this reason, secondary reconstruction is employed in ONJ patients.

Delayed reconstruction of the mandible reduces the recurrence rate but complicates the proper alignment of the mandible fragments in their initial anatomical position. These challenges also extend the operational time.

The aim of this study is to share our approach to using virtual surgical planning for secondary reconstruction of the mandible, utilizing only stereolithographic models.

MATERIALS AND METHODS

2.1. Patients

This is a retrospective study of four patients with secondary mandibular defects due to the resection of stage-3 Krokodil drug-related osteonecrosis, treated in the Department of Maxillofacial Surgery at the “Yerevan” Medical Center, Yerevan, Armenia. All cases were analyzed concerning complaints, age, period of Krokodil use, Krokodil withdrawal period, and surgery outcomes.

2.2. Reconstructive plate prebending

Before surgery, CBCT, orthopantomography were performed in all cases (Fig. 1a).

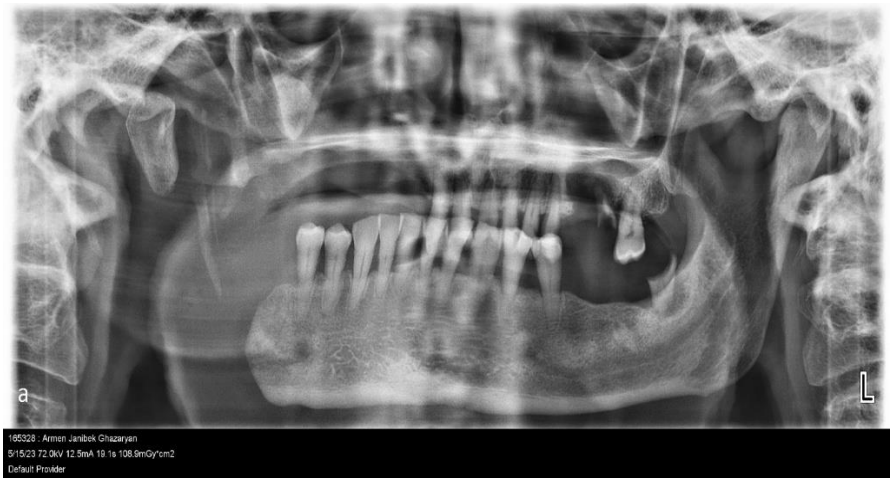

Figure 1. Krokodil drug addicted patient, with mandibular defect, due to mandible ONJ resection. a)preoperative OPG. There is a large continuity defect of the right mandible

Then, using the CT scans, the mandible defect was reconstructed by mirroring the healthy side. The reconstructed mandible model was printed on a 3D printer. The reconstructive plate was prebended on the model (Fig. 2).

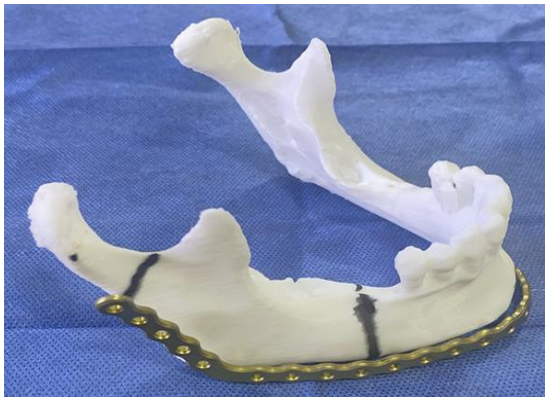

Figura 2. prebended reconstructive plate, on the reconstructed and 3D printed mandible model. Black lines show the mandible defect area c)Intraoperative view of the mandible reconstruction d) Postoperative OPG

2.3.Suregery

In all patients, the existing defects were reconstructed using only prebended reconstructive plates (Fig.3).

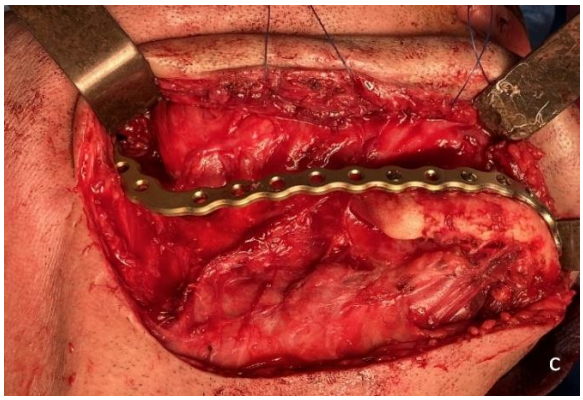

Figure 3. Intraoperative view of the mandible reconstruction

2.4. Statistical analysis

Data were expressed as means ± SEM. IBM SPSS Statistics 20 was used for statistical analysis.

3. Results

All patients tested positive for HCV. The mean age of the patients was 52 ± 1.9 years (range 48–57). The mean durations of Krokodil use and withdrawal were 13.5 ± 3.6 months (range 8–24) and 25.5 ± 3.8 months (range 18–36), respectively. Primary mandible resection due to stage 3 Krokodil drug-related osteonecrosis was performed 37.5 ± 9.9 months (range 18–60) months prior. All patients reported complaints related to facial deformity, issues with chewing, and breathing difficulties. The postoperative follow-up period ranged from 6 to 18 months (Fig. 1d). No recurrence occurred during the postoperative period for any patient. All patients noted good aesthetic and functional outcomes.

Figure 4. Postoperative OPG

DISCUSSION

There is little data in the literature on the replacement of Krokodil drug–related ONJ defects of the mandible. The treatment of Krokodil drug–related ONJ is challenging[2]. The phosphorus present in crocodile leads to changes in bone metabolism at the cellular level through apoptosis induced by osteoclasts.

Delayed treatment and continued drug abuse can lead to life-threatening conditions such as endocarditis, meningitis, pneumonia, multi-organ failure, etc. The social aspect of this addiction must be considered. These patients usually avoid hospitalization until symptoms become unbearable.

Distribution of Krokodil -induced necrosis according to the jaw, the mandible, the krokodil-induced osteonecrosis usually affects the jaw body and angles. Sometimes the mandibular canal and the inferior alveolar nerve can be involved.

Patients with desomorphine-related osteonecrosis usually require multi-stage surgery, which they often refuse[2]. Mandibular segmental resection is the primary treatment method for stage 3 cases. Large defects in the mandible develop following treatment[2]. Due to the high rates of disease recurrence in most cases, secondary reconstruction of such defects is necessary. The Krokodil drug affects all bones, resulting in a high risk of complications at the donor site. Because of the intravenous use of synthetic drugs without prior purification, all Krokodil-addicted patients exhibit vascular issues. Typically, the size of the defects is about half the jaw, which is too large for non-vascularized grafts. All of the aforementioned conditions create complexity in reconstructing mandibular continuity defects in Krokodil-addicted patients with autogenous bone grafts. To mitigate such risks, defect reconstruction is performed only with reconstructive plates.

Secondary mandibular reconstruction is a complex procedure. One of the main challenges is accurately positioning the remaining mandibular fragments in their exact original anatomical position[4,5,6].

Computer-assisted surgery is becoming more popular in maxillofacial surgery. Before adopting 3D technologies, correctly positioning mandibular fragments during secondary reconstructions was challenging because the procedure depended solely on the surgeon's experience[4,7]. Consequently, these procedures often resulted in improper occlusion and unsatisfactory aesthetics. After introducing virtual technologies, mandibular reconstructions are becoming more precise. Virtual planning and 3D modeling help solve this issue [4,7]. The best results are obtained when initial CT scans taken before mandibular resection are available, allowing for the restoration of the mandible's original anatomy. When these initial scans are not available, virtual reconstruction of the mandibular defect by mirroring the healthy side can achieve a satisfactory anatomy. Pre-bending the reconstruction plate further reduces operative time and improves accuracy[4,7]. This technique yields better results when the defect is lateral until the midline, but may be less precise if the defect crosses the midline. Nonetheless, symmetrical positioning of both TMJs can still produce good outcomes. In this study, four patients were treated using the mirroring technique, resulting in favorable aesthetic and functional outcomes.

The main treatment for Krokodil-associated osteonecrosis of the jaw is surgery. Surgery involves removal of necrotic bone and closure of the defect. An extraoral approach is usually used to open the necrotic bone[8-16]. Discontinuation of medication, radical necrotectomy, and proper closure of the formed defects are the main factors that lead to successful treatment of patients with Krokodil-associated osteonecrosis of the jaw.

Therefore, the publication of well-documented cases of treatment of drug-related osteonecrosis of the mandible with a long observation period and their comparison with previously published data is of great interest.

CONCLUSION

Within the limitations of the study, the use of 3D virtual planning and prebent reconstructive plates can be an effective and predictable method for the secondary reconstruction of mandible defects using only a reconstruction plate in Krokodil drug-addicted patients.

DECLARATIONS

Informed consent

Informed consent was obtained from the patient in this study.

Conflict of interest

The authors declare that they have no conflict of interest.

Funding

This study was not funded by any fund.

Acknowledgements

None

REFERENCES

1.Hakobyan KA: Clinical picture, diagnosis and treatment of facial bones osteonecrosis at patients who use the drug 'Krokodil'. Yerevan State Medical University, 2013 Dissertation

2.Poghosyan YM, Hakobyan KA, Poghosyan AY, Avetisyan EK. Surgical treatment of jaw osteonecrosis in 'krokodil' drug addicted patients. J. CranioMaxillofacial Surg. 2014;42: 1639–1643.

3. Hakobyan KA, Poghosyan YM, Poghosyan AY. C-terminal telopeptide level in 'Krokodil' drug-related jaw osteonecrosis patients.NewArmen Med J.2017;11:57-61.

4.Yu Y, Zhang WB, Liu XJ, Guo CB, Yu GY, Peng X. A New Procedure Assisted by Digital Techniques for Secondary Mandibular Reconstruction With Free Fibula

Flap. J Craniofac Surg. 2016 Nov;27(8):2009-2014.
5.Andrade WN, Lipa JE, Novak CB, Grover H, Bang C,Gilbert RW, Neligan PC. Comparison of reconstructive procedures in primary versus secondary mandibular reconstruction. Head Neck. 2008 Mar;30(3):341-5.
6.Yamakawa S, Hayashida K. Safety and efficacy of secondary mandibular reconstruction using a free osteo-cutaneous fibula flap after segmental mandibular resection: a retrospective case-control study. BMC Surg. 2021 Apr 9;21(1):189.
7.Krishnadas A, Iyer S, Balasubramaniam D, Subash P, Subramaniam N, Kapahtia R, Pullan S, Ramu J. Simplified Virtual Surgical Planning Method for Reconstruction of Secondary Maxilla and Mandibular Defects Using Free Bone Flap. J Maxillofac Oral Surg. 2023 Mar;22
8.Sabeva E, Dochev D. Necrotic Lesions Associated with Desomorphine ("Krokodil") Drug Abuse: a Systematic Review. J Oral Maxillofac Res. 2025 Mar 31;16(1):e1. doi: 10.5037/jomr.2025.16101.
9.van Kempen EEJ, Brand HS. Effects of krokodil (desomorphine) use on oral health - a systematic review. Br Dent J. 2019 Nov;227(9):806-812
10.Hakobyan K, Poghosyan Y. Spontaneous bone formation after mandible segmental resection in "krokodil" drug-related jaw osteonecrosis patient: case report. Oral Maxillofac Surg. 2017 Jun;21(2):267-270.
11.Neves JF, Alves EA, Soares JX, Cravo SM, Silva AM, Pereira Netto AD, Carvalho F, Dinis-Oliveira RJ, Afonso CM. Data analysis of "krokodil" samples obtained by street-like synthesis. Data Brief. 2015 Nov 28;6:83-8.
12.Hakobyan K, Poghosyan Y. "Krokodil" drug - Related osteonecrosis of midface: A case series. J Craniomaxillofac Surg. 2019 Dec;47(12):19181921. [
13.Hakobyan KA, Poghosyan YM, Poghosyan AY. C-terminal telopeptide level in "Krokodil" drug-related jaw osteonecrosis patients. New Armen Med J. 2017 Jul 1;11(3):57-61.
14.Hakobyan K, Poghosyan Y. The efficacy of mylohyoid muscle flap use in surgical treatment of 'krokodil' drug-related osteonecrosis of the mandible. J Craniomaxillofac Surg. 2022 Feb;50(2):188-192
15.Poghosyan Y, Hakobyan K. Krokodil drug-related osteonecrosis of skull base: A case report. Neurochirurgie. 2022 Jul;68(4):466-468.
16.Hussain H, Angly S, Michel G, Garcia E, Fadel A. Krokodil-Associated Cutaneous Ulceration, Cardiac Arrhythmia and Thrombi. Eur J Case Rep Intern Med. 2023 Nov 17;10(12):004181.