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Artículo original

Análisis de patrones de cierre velofaríngeo en pacientes con paladar hendido al realizar las técnicas quirúrgicas de esfinteroplastia lineal y doble z-plastia de Furlow. Estudio piloto

Analysis of velopharyngeal closure patterns in patients with cleft palate when performing the linear sphincteroplasty and Furlow double z-plasty surgical techniques. Pilot study

María José Hernández Álvarez,* Hernán Castilla Canseco,‡ Guadalupe Góngora Cadena,§ Fabiola Salgado Chavarría¶

RESUMEN

Objetivo: Correlacionar el tipo de patrón de cierre velofaríngeo en los pacientes con paladar hendido utilizando dos tipos diferentes de cierre quirúrgico con las técnicas de esfinteroplastia lineal de Bardach y doble z-plastia de Furlow. **Material y métodos:** Se realizó un estudio piloto transversal, retrospectivo, en el Hospital Pediátrico de Peralvillo, en el periodo de enero de 2017 a febrero de 2020. **Resultados:** Se registraron 118 pacientes con paladar hendido que fueron tratados quirúrgicamente, sólo 16 cumplieron con los criterios de inclusión, 11 fueron hombres (68.75%) y cinco mujeres (31.25%). La técni-

ABSTRACT

Objective: *Correlate type of velopharyngeal closure pattern in patients with cleft palate using two different types of surgical closure with the Bardach linear sphincteroplasty and Furlow double z-plasty techniques.* ***Material and methods:*** *A retrospective, cross-sectional pilot study was realized at Peralvillo Pediatric Hospital, in the period from January 2017 to February 2020.* ***Results:*** *118 patients with cleft palate who were treated surgically were registered, only 16 fulfilled the inclusion criteria, 11 were male (68.75%), five female (31.25%). The main surgical technique used was Bardach 62.5 and the double*

* Residente de Cirugía Oral y Maxilofacial, Universidad Nacional Autónoma de México (UNAM), México.
‡ Jefe del Servicio de Cirugía Maxilofacial del Hospital Pediátrico de Peralvillo.
§ Otorrinolaringología y Cirugía de Cabeza y Cuello del Hospital Pediátrico de Peralvillo.
¶ Responsable de Investigación de la Clínica de Cirugía Oral y Maxilofacial, UNAM.

Correspondencia:
Dr. Hernán Castilla Canseco
Hospital Pediátrico de Peralvillo.
Calzada San Simón Núm. 14, Col. San Simón Tolnahuac, 06920, Alcaldía Cuauhtémoc, CDMX.
Tel: 55 3398-2851/72 2267-0189
E-mail:cmfhcc@gmaill.com

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ca quirúrgica principalmente utilizada fue Bardach 62.5 y la doble Z Furlow se utilizó en seis ocasiones (37.5%). El patrón de cierre circular fue el más prevalente (media 10.1 años) realizada en ocho hombres y tres mujeres, seguido del coronal (media 5.2 años) ejecutada en cuatro niños, dos femeninos y dos masculinos y rodete de Passavant (media 14 años) efectuada en un masculino. **Conclusiones:** Pocos estudios describen los patrones de cierre velofaríngeo en pacientes con paladar hendido, pero concuerdan que fisiológicamente el patrón circular es el más común en el ámbito mundial. Este estudio puede ser utilizado para seguir realizando otras investigaciones en las cuales se tenga una mayor muestra para el análisis de patrones de cierre velofaríngeo, y comparen técnicas quirúrgicas para saber con cuál de ellas se obtiene el patrón de cierre velofaríngeo más adecuado para la fonación en pacientes de habla hispana.

Palabras clave: Paladar hendido, esfínter velofaríngeo, fonación, insuficiencia velofaríngea.

Z Furlow was used on six occasions (37.5%). The circular closure pattern was the most prevalent [mean 10.1 years] performed in eight males and three females, followed by the coronal [mean 5.2 years] performed in four children, two females and two males, and Passavant's ridge [mean 14 years] performed in a masculine. ***Conclusions:*** *Few studies describe velopharyngeal closure patterns in patients with cleft palate, but they agree that physiologically the circular pattern is the most common worldwide. This study can be used to continue carrying out other investigations in which there is a larger sample for analysis of velopharyngeal closure patterns and comparing surgical techniques to find out which of them is the most appropriate velopharyngeal closure pattern obtained for phonation in Spanish speaking patients.*

Keywords: *Cleft palate, velopharyngeal sphincter, phonation, velopharyngeal insufficiency.*

INTRODUCCIÓN

El paladar hendido es un desorden congénito común dentro de las hendiduras orofaciales de etiología multifactorial,[1] ocurre embriológicamente en la sexta semana de vida intrauterina cuando los procesos maxilares sufren una falta de fusión, lo que provoca una comunicación de las cavidades nasal y bucal, alterando procesos fisiológicos como la respiración, fonación y masticación.[2]

El lenguaje humano es soportado por estructuras anatómicas complejas y procesos fisiológicos matizados. El mecanismo velofaríngeo funciona como esfínter que interviene en la fonación, deglución, respiración y la audición, el cual consta de una válvula muscular que se extiende de la parte ulterior del paladar duro a la pared faríngea posterior e incluye al velo (paladar blando), las paredes faríngeas laterales y la pared faríngea posterior.[3,4,17]

La función del mecanismo velofaríngeo es crear un sello hermético entre el velo y las paredes faríngeas para separar las cavidades oral y nasal para varios propósitos, incluyendo el lenguaje.[3,4,17]

En pacientes con paladar hendido, la disfunción velofaríngea es una condición clínica compleja que se divide en dos grandes entidades: insuficiencia velofaríngea, que es definida como la inhabilidad para el completo cierre del esfínter velofaríngeo, es decir un defecto estructural (un velo del paladar corto); mientras que la incompetencia velofaríngea consiste en un movimiento insuficiente del velo del paladar, esto es, un defecto fisiológico (movimiento del velo del paladar insuficiente), siendo las principales consecuencias escape de aire nasal o hipernasalidad, soplido nasal audible, ronquido nasal, falta de nitidez en las consonantes y errores en la articulación de palabras, teniendo como resultado un lenguaje casi incomprensible.[5,6,23]

Los patrones de cierre velofaríngeo se clasifican según el grado en el que los componentes del esfínter velofaríngeo son activados durante la fonación, descritos inicialmente por Skolnick y Crofort (1973): coronal, sagital, circular y circular con rodete de Passavant; estos patrones de cierre se establecen dependiendo de los movimientos relativos del velo y de las paredes posterior y laterales de la faringe al cierre del esfínter *(Figura 1)*.[3,5,7-9,18]

Los métodos más comunes para evaluar la función faríngea son subjetivos y objetivos: 1) evaluación perceptual del habla por un terapista de lenguaje con un criterio estandarizado; 2) examinación clínica por el cirujano maxilofacial; y 3) evaluación sistemática transoral y nasal con nasoendoscopia por un otorrinolaringólogo estandarizado.[10]

Diversas técnicas quirúrgicas son usadas para el tratamiento de la insuficiencia velofaríngea, las cuales tienen como objetivo común crear una obstrucción parcial permanente del espacio velofaríngeo. Las veloplastias son técnicas quirúrgicas que se realizan sobre el velo del paladar con el objetivo de alargarlo mediante el desplazamiento de los colgajos hacia atrás, o utilizando el principio de desplazamiento posterior *(push-back)*; dentro de las cuales, la más utilizada es la doble z- plastia de Furlow.[11,12,19] Por otro

lado, las esfinteroplastias o faringoplastias dinámicas son técnicas quirúrgicas que actúan sólo a nivel de las paredes faríngeas (laterales y posteriores) con el objetivo de disminuir los diámetros de la orofaringe, a nivel de los surcos laterales rinofaríngeos, reconstruyendo un verdadero esfínter orofaríngeo de dimensiones reducidas, un ejemplo de éstas es la técnica de Bardach.[3,4,16,20]

En la literatura mundial, existen muy pocos estudios que hablen acerca de los patrones velofaríngeos en pacientes con paladar hendido y menos técnicas quirúrgicas eficaces para la obtención de un adecuado patrón de cierre. El objetivo del presente artículo es correlacionar el tipo de patrón de cierre velofaríngeo en los pacientes con paladar hendido utilizando dos tipos diferentes de cierre quirúrgico con las técnicas de esfinteroplastia lineal de Bardach y doble z-plastia de Furlow.

MATERIAL Y MÉTODOS

Se trata de un estudio piloto transversal, retrospectivo. Se observaron 118 pacientes con paladar hendido que fueron tratados quirúrgicamente en el Hospital Pediátrico de Peralvillo, en el periodo de enero de 2017 a febrero de 2020, los criterios de inclusión fueron los siguientes: pacientes de ambos sexos, de tres a 20 años de edad, que presentan paladar hendido primario unilateral derecho o izquierdo, paladar submucoso, paladar bilateral que no presentaran enfermedad sistémica concomitante, que se sometieron a cirugía con las técnicas de esfinteroplastia lineal de Bardach y doble z-plastia de Furlow y contaran con consentimiento informado y asentimiento. Los criterios de exclusión: pacientes con paladar hendido secundario, o con veloplastias/esfinteroplastia previas de paladar, pacientes sindrómicos o con enfermedades sistémicas. Los criterios de eliminación: pacientes a los cuales no se les realizaron las técnicas quirúrgicas de esfinteroplastia lineal de Bardach y doble z-plastia de Furlow y aquéllos que no contaron con la edad necesaria para realizar la nasofibroendoscopia.

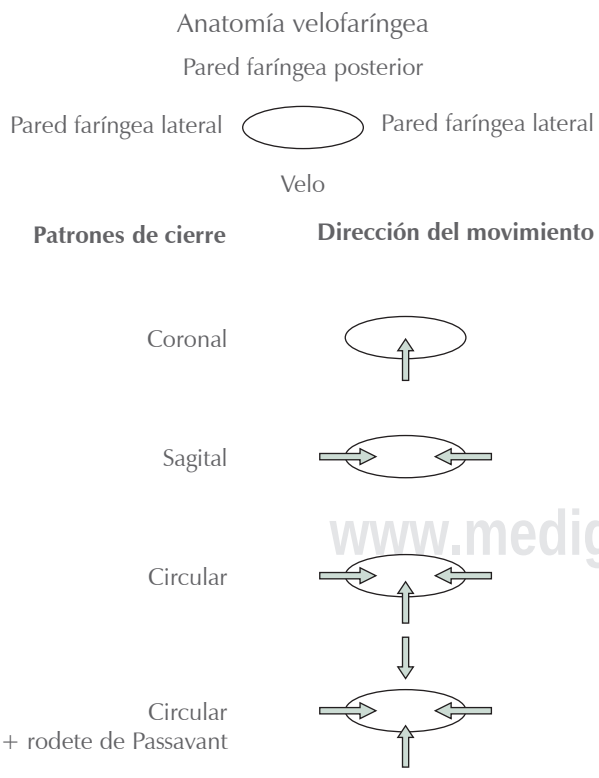

Figura 1: Patrones de cierre velofaríngeo.
Tomado y modificado de: Skolnick M et al.[5]

Protocolo de tratamiento: las intervenciones quirúrgicas ocurrieron en el periodo de tiempo de enero de 2017 a febrero de 2020. Las dos técnicas que se utilizaron fueron la esfinteroplastia lineal de Bardach y la doble z-plastia de Furlow, las cuales fueron realizadas por el mismo cirujano maxilofacial. Los pacientes iniciaron su terapia de lenguaje al mes de postoperados.

La nasofibroendoscopia (NFE) se llevó acabo seis meses posteriores al acto quirúrgico. Este procedimiento fue realizado por la otorrinolaringóloga de dicho hospital usando un nasofibroendoscopio de fibra flexible Richard Wolf® de 3.5 mm de diámetro de longitud nL', 300 mcm de flexión en la punta de trabajo (serie 7223.001), con canal de trabajo 1.1, ángulo de imagen 90º, una dirección de visión 0º y un ángulo de curvatura de 130º hacia proximal y distal, con una cabeza de cámara de 50 Hertz (serie5514961). La NFE se realizó de acuerdo a las recomendaciones de estandarización: el paciente se coloca sentado en un ángulo de 90° con respecto al piso, se coloca una solución de lidocaína® simple a 1% y oximetazolina® a 0.025% en dilución 50/50 con dispersor en las fosas nasales, tres disparos en cada fosa nasal dirigidos hacia la cabeza, cuerpo y cola del cornete inferior y se da una latencia de cinco minutos, realizando una rinoscopia antero-posterior, introduciendo el NFE a través de una fosa nasal, pasando a través del meato inferior y piso nasal, lo que permite realizar una inspección del paladar duro y blando, además de la visualización directa del esfínter velofaríngeo, de sus estructuras y movimientos realizados durante el habla y la deglución en forma dinámica; después se

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le realizó a cada paciente una evaluación fonológica pidiéndole que formulará fonemas velares k/c/q tales como: «Kuki quiere coco», «Kike come queso» y «Cuca» con base en los criterios de Henningsson,[13] obteniendo una imagen del patrón velofaríngeo que se produjo en el momento de la fonación.

RESULTADOS

Análisis de datos: fueron colectados, tabulados y analizados en un ordenador, con paquete estadístico STATA® MP versión 14, se utilizó análisis estadístico de χ^2 con una $p < 0.05$.

Se registraron 118 pacientes con paladar hendido que fueron tratados quirúrgicamente en el Hospital Pediátrico de Peralvillo, en el periodo de enero de 2017 a febrero de 2020, sólo 16 cumplieron con los criterios de inclusión,[11] correspondieron al género masculino (68.75%), cinco al femenino (31.25% SE 1.2, DE 5.08, IC 95% 6.47-11.89). El promedio de edad del sexo masculino fue de 9.8 (DE 5.7) y del sexo femenino de 7.8 (DE 3.1).

De forma ascendente a descendente los diagnósticos fueron: labio y paladar hendido unilateral izquierdo-LPHUI (43.75% DE 6.9), seguido del paladar hendido submucoso-PHS (37.5% DE 3.7), labio y paladar hendido bilateral-BI (12.5% DE 2.1) y labio y paladar hendido unilateral derecho (6.25%).

La esfinteroplastia fue el principal procedimiento en el velo del paladar en comparación con la veloplastia doble zeta *(Figura 2)*; el promedio de edad de los pacientes sometidos a esta técnica quirúrgica fue de 7.8 (DE 5.1) y 11.5 (DE 4.3) años, respectivamente.

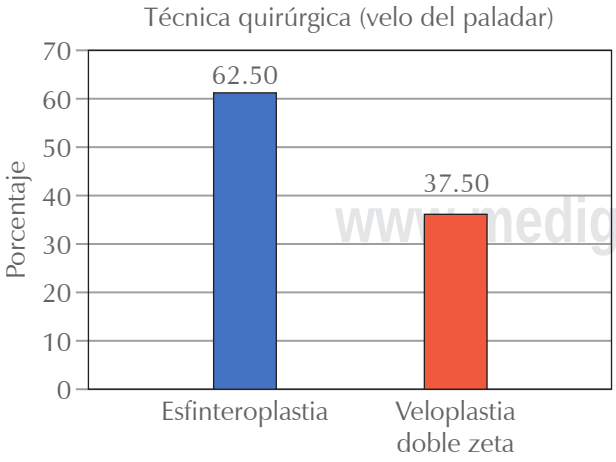

Figura 2: Muestra la técnica quirúrgica empleada para cierre de velo de paladar.

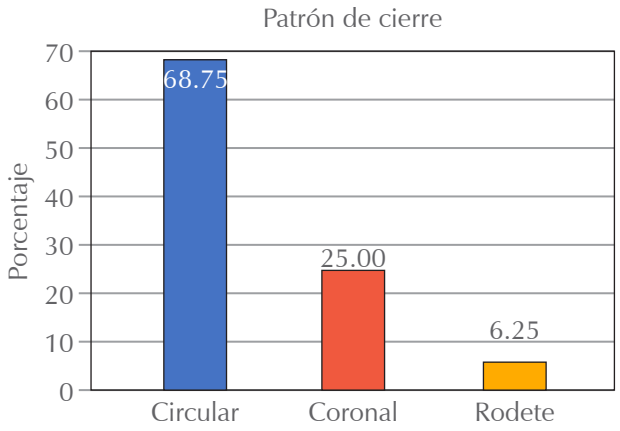

Figura 3: Patrones de cierre velofaríngeo que se presentaron en este estudio.

La técnica quirúrgica principalmente utilizada fue la esfinteroplastia lineal de Bardach 62.5% (SE 1.6, DE 5.18, IC 95% 4.09-11.50) y la doble z Furlow se utilizó en seis ocasiones (37.5% SE 1.7, DE 4.37, IC 95% 6.47-11.50); se requirió de cirugías agregadas, 43.75% Bardach, veau Wardill Kilner 25%, von Lagenback 6.25% y ninguna 25%.

El patrón de cierre circular fue el más prevalente (media 10.1 años, DE 5.3) realizada en ocho masculinos y tres femeninos, seguido del coronal (media 5.2 años, DE 1.7) ejecutada en cuatro niños, dos femeninos y dos masculinos y rodete de Passavant (media 14 años) efectuada en un masculino *(Figura 3)* $p < 0.05$.

DISCUSIÓN

En la presente investigación se determinaron los patrones más comunes de cierre velofaríngeo descritos en la literatura, en pacientes con paladar hendido, posterior al cierre quirúrgico mediante las técnicas doble z-plastia de Furlow y la esfinteroplastia lineal de Bardach.

La esfinteroplastia lineal de Bardach es una variante a la técnica de Wardill, en la cual se realiza una incisión en el margen de la fisura, prolongando las incisiones por detrás del plano de la úvula hacia posterior, siguiendo los pilares faríngeos posteriores de la amígdala en sus dos tercios superiores, se realiza una disección roma con la finalidad de movilizar el músculo palatofaríngeo, proporcionando con esto un doble objetivo de dinámica velar, estrechando la proximidad de las paredes faríngeas laterales, realizándolo de la misma manera de ambos lados,

suturando después los colgajos en tres planos: nasal, muscular y oral respectivamente, a nivel de los pilares posteriores y obteniendo una elongación lineal velar de 15 a 20 milímetros por detrás de la posición de la úvula, lo que se ve reflejado en una mayor longitud y dinámica del movimiento del velo al involucrar el pilar posterior, limitando la invasión a la pared faríngea posterior y eliminando morbilidades asociadas a la técnica original *(Figura 4)*.[11,12,19,21]

Las técnicas quirúrgicas realizadas en este estudio, como la esfinteroplastia lineal y la doble z-plastia son efectivas para lograr un patrón de cierre fisiológicamente adecuado, siendo la z-plastia de Furlow más efectiva para acercarse a éste, con una taza de éxito de 96.6%, según Wong y colaboradores,[14] quienes refieren que sus pacientes no requirieron de un segundo acto quirúrgico por presencia de insuficiencia velofaríngea.

El cierre velofaríngeo es acompañado de la contracción de diferentes músculos incluyendo al elevador del velo palatino, músculo de la úvula,

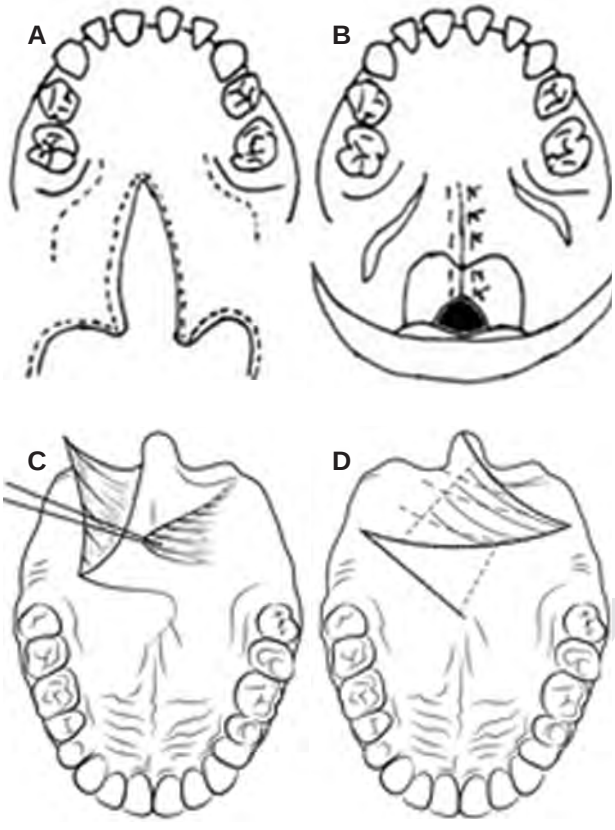

Figura 4: A-B) Técnica de Bardach. **C-D)** Técnica doble z-plastia de Furlow.
Tomado y modificado de: Michael S et al,[20] Monserat E et al.[21]

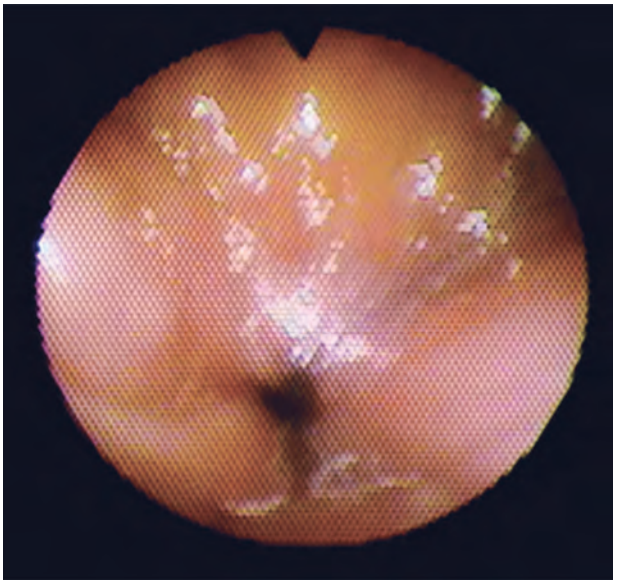

Figura 5: Patrón de cierre velofaríngeo circular.

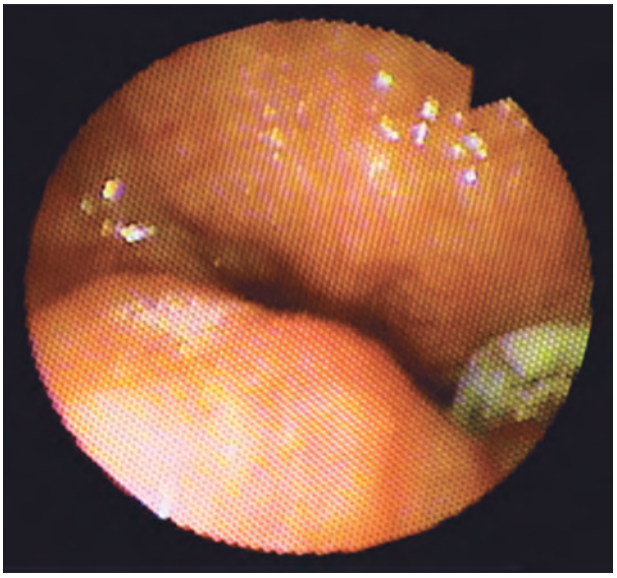

Figura 6: Patrón de cierre velofaríngeo coronal.

constrictor superior de la faringe, palatofaríngeo, palatogloso, salpingofaríngeo y el tensor del velo del paladar que es responsable de la función de la trompa de Eustaquio.

Los patrones de cierre velofaríngeo representan una descripción de una condición estática del esfínter en la fase terminal del cierre, por lo que el uso de nasofibroendoscopia es aceptado como el mejor método de análisis clínico para observar el esfínter

velofaríngeo. Golding-Kushner y colaboradores,[8] describieron a la nasofibroendoscopia como sistema de cuantificación y descripción de los movimientos de las estructuras del esfínter velofaríngeo, tal como se realizó en nuestro estudio obteniendo los ángulos e imágenes clínicas adecuadas para observar dicho esfínter *(Figuras 5 y 6)*.

El patrón de cierre velofaríngeo dominante en la población mundial sin fisura palatina es el circular, los patrones de cierre velofaríngeo son categorizados de acuerdo a la pared que contribuye principalmente al cierre del esfínter velofaríngeo durante el habla. El cierre de la válvula velofaríngea es un mecanismo tridimensional que envuelve la función del velo y las paredes faríngeas, por lo que el patrón coronal ocurre cuando hay un movimiento excesivo del velo del paladar, que se desplaza a la pared faríngea posterior con menor movimiento de otras estructuras. El patrón sagital corresponde al movimiento de las paredes faríngeas laterales hacia la línea media con menor movimiento de la pared faríngea posterior y el velo del paladar. El patrón circular cuando todas las estructuras se desplazan juntas hacia la línea media y finalmente el patrón circular con rodete de Passavant, en el cual esta estructura que está formada por fibras del músculo constrictor superior de la faringe contribuye al cierre en la línea media *(Figura 1)*.[3,5,7,8,17,20]

En nuestro estudio, los resultados coinciden con los hallazgos descritos por MacKenzie y su grupo,[15] en los cuales reportaron que el patrón de cierre velofaríngeo que se presentó con más frecuencia fue el Circular en un 58%, igualmente en la investigación de Madrid y colaboradores[6] reportaron la prevalencia del patrón circular en un 39.02%.

En este estudio se confirmó la presencia de tres de los cuatro patrones descritos por Skolnick y Croft,[5] tal como lo observaron Prada Madrid y su equipo,[6] quienes concluyen que el único patrón no registrado fue el sagital, asociándolo a que en este patrón se encuentra prácticamente inactivo el músculo elevador del paladar, no requirieron de un segundo acto quirúrgico por presencia de insuficiencia velofaríngea.

CONCLUSIONES

El adecuado lenguaje depende de la integridad y funcionalidad de las estructuras velofaríngeas, el objetivo de una intervención quirúrgica en pacientes con paladar hendido es restaurar dicha anatomía para obtener una adecuada función velofaríngea.

Pocos estudios describen los patrones de cierre velofaríngeo, así como la frecuencia de presentación de los patrones de cierre en pacientes con paladar hendido, pero concuerdan en que fisiológicamente el patrón circular es el más común en el mundo.

Es importante mencionar que en este estudio las técnicas que se utilizaron ayudan más al desarrollo fisiológico de un patrón circular adecuado, ya que proveen un alargamiento adecuado del paladar sin la necesidad de agregar otros procedimientos quirúrgicos, además de que previenen la contractura longitudinal de la cicatriz, ayudando así a mejorar el lenguaje, la deglución y la ventilación del oído medio.

Esta investigación puede ser utilizada para seguir realizando otras en las cuales se tenga una mayor muestra para el análisis de patrones de cierre velofaríngeo y se comparen técnicas quirúrgicas para saber con cuál de ellas se obtiene el patrón más adecuado para la fonación en casos de habla hispana, así como otros estudios en los cuales se valore la funcionalidad de técnicas quirúrgicas de cierre de hendiduras palatinas mediante la observación de la función del músculo tensor del velo del paladar que ayuda al cierre de la trompa de Eustaquio.

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Review

Basic principles of microvascular surgery applied in maxillofacial surgery. Bibliographic review

Principios básicos de la cirugía microvascular aplicados a la cirugía maxilofacial. Revisión bibliográfica

Erick Geovanny Reyes Castañeda,* José Edgar Garduño Mejía*

ABSTRACT

Treatment of head and neck defects after facial trauma, infection, or tumor resection is a major challenge for maxillofacial surgery; for this reason, it is essential that the correct way to perform this reconstruction is chosen, one of the options is microvascular flaps, so this article makes a bibliographic compilation in order to introduce the maxillofacial surgeon to the basic concepts of microvascular surgery being the cornerstone of microvascular flaps, and thus have one more tool to be able to apply it in cases that require it, as well as the advantages and disadvantages of the available magnification options, the instruments necessary for the correct practice of microvascular surgery, inanimate and living materials. Specimens where the necessary ability to perform microvascular surgery can be developed, the blood vessels most used in anastomosis of the maxillofacial area and finally the physical conditions and technical considerations to perform an anastomosis will be mentioned.

Keywords: Microsurgery, microvascular, anastomosis, microsurgical reconstruction, maxillofacial surgery.

RESUMEN

El tratamiento de los defectos de la cabeza y el cuello tras un traumatismo facial, una infección o la resección de un tumor es un reto importante para la cirugía maxilofacial; por este motivo, es fundamental elegir la forma correcta de realizar esta reconstrucción; una de las opciones son los colgajos microvasculares, por lo que este artículo hace una recopilación bibliográfica con el fin de introducir al cirujano maxilofacial en los conceptos básicos de dicho procedimiento, siendo la piedra angular de los colgajos microvasculares, y así tener una herramienta más para poder aplicarlo en los casos que lo requieran, así como las ventajas e inconvenientes de las opciones de aumento disponibles, los instrumentos necesarios para la correcta práctica de la cirugía microvascular y los materiales inanimados y vivos. Se mencionarán los especímenes en los que se puede desarrollar la capacidad necesaria para realizar la cirugía microvascular, los vasos sanguíneos más utilizados en las anastomosis del área maxilofacial y, finalmente, las condiciones físicas y las consideraciones técnicas para realizar una anastomosis.

Palabras clave: *Microcirugía, microvascular, anastomosis, reconstrucción microquirúrgica, cirugía maxilofacial.*

* Department of Oral and Maxillofacial Surgery Medical Center «Lic. Adolfo López Mateos». Toluca, Estado de México.

Correspondence:
Erick Geovanny Reyes Castañeda
E-mail: drerickreyesmaxilofacial@gmail.com

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INTRODUCTION

During the last decade, oral and maxillofacial surgery has witnessed a significant trend in the inclusion of facial reconstruction from microvascular free tissue transfer. The inception dates back to the introduction of multiple surgical fellowship programs around the world that recruit oral and maxillofacial surgery graduates for training in head and neck surgery and microvascular reconstruction.

In Mexico, the Mexican Association of Oral and Maxillofacial Surgery (AMCBM) in conjunction with the International Association of Oral and Maxillofacial Surgery (IAOMS) as well as the teaching coordination of the Regional Hospital 1º de Octubre, ISSSTE and the postgraduate department of the Faculty of Medicine of the UNAM in 2018 created a training course in microvascular surgery and gave 12 scholarships to maxillofacial surgeons assigned to hospitals with maxillofacial surgery residencies in order to perform facial reconstruction treatments using microvascularized flaps and train new generations. This trend is likely to continue since head and neck defects caused by trauma, infections, osteoradionecrosis of the jaws, bone necrosis of the jaws due to drugs, tumor resections, or simply the physiological wear of the post-extraction maxillary processes represent a challenge. Unique for its reconstruction since the anatomical structures that make up the face and neck are closely related to the aesthetics and function of the patient. So also these patients have to struggle with an emotional and psychological aspect.

It is vitally important to properly choose the method by which the reconstruction is going to be done to return the basic development needs (feeding, breathing, talking) and raising the quality of life. The purpose of this article is to familiarize the maxillofacial surgeon on this subject, and it is very likely that in the following years there will be more publications similar to this one.

Microsurgery is not a specialty or subspecialty, it is any surgical technique designed to be performed with magnification through the use of a microscope or lenses to increase the size of anatomical structures. Microsurgical techniques are used by multiple medical and dental specialties, each of them will have specific procedures in their area, likewise in maxillofacial surgery microsurgical techniques can be used in different situations.

In this publication we will focus on microvascular surgery for microvascular grafts applied in facial reconstruction. Microvascular surgery refers to microsurgery that includes the repair and anastomosis of small blood vessels generally less than 3 mm in diameter.[1]

70 years ago clinical microsurgery was not yet a reality. However, today, we can plan the surgical removal of a tumor with immediate microvascular reconstruction of hard and soft tissues, full dental implantation and prosthetic rehabilitation, in the same surgical time on the same day. Situation that returns self-esteem, and basic functions very quickly.[2]

It is important to mention that in 2020 the Maxillofacial Surgery service of the «Lic. Adolfo López Mateos» Medical Center of Toluca ISEM began to handle cases of microvascular surgery as a single service in the taking of microvascularized graft and its application for mandibular reconstruction, being those in charge are Dr. Erick G. Reyes Castañeda and Dr. Edgar Garduño Mejía, being the first maxillofacial surgery service in Mexico to take the complete case, in future publications a description of the cases as well as their planning will be made.

HISTORY

Traditional microvascular surgery techniques have their beginnings in vascular surgery. In 1800, the only vascular operations performed were vessel ligation. In 1877, Eck (Leningrad) reported the first porto-cava anastomosis in dogs. The first successful end-to-end anastomosis of the carotid arteries was done in sheep and was reported in 1889 by Jassinowski, who used fine curved needles and silk sutures.[1] In 1896, Jaboulay and Briau reported the end-to-end anastomosis of a carotid artery injured on a donkey.[2]

In Chicago, Illinois, in 1896, John Benjamin Murphy performed the first successful human arterial repair after a femoral artery injury, also described the «intussusception technique», in which he used four double needle silk sutures to introduce the proximal artery into the distal artery at a distance of 8 mm, this technique led to narrowing of the anastomosis and thrombosis in animal experiments, but was successful in humans.[1-3]

This technique is still used today when the diameters of the blood vessels are not similar.

In 1899, Dorfler (Rostock, Germany), described his principles for successful vessel repair; and in 1900, Payr (Leipzig, Germany), described the use of extraluminal magnesium tubes to invaginate the cut proximal end of the blood vessel into the distal end. This was similar to the coupling devices used today.[2,4]

Carrel developed a triangulation technique that consisted of placing three simple triangular stitches distributed around the circumference of the vessel and then performing a continuous suture between the three stitches, performing the anastomosis with needles and fine sutures, thus developing the microvascular technique of Carrel, which led him to win the Nobel Prize in Medicine and Physiology in 1912.[2,5]

Before the standardization of vascular repair techniques, there was a controversy over whether to include the tunica intima in vascular sutures.[1,2] There were those such as Jaboulay and Briau, Dorfler, Tomaselli, Jensen and Hopfner who favored the inclusion of the intima, while Burci, Jassinowsky and Carrel and Morel were in favor of the exclusion of the intimate.[1,2] Guthrie and Carrel examined various techniques for anastomoses and found that the inclusion of the intima promoted «uniformly successful results», laying the groundwork for standardization of anastomotic techniques.[1] Watts subsequently used the Carrel technique, and both advocated careful removal of the adventitia that led to long-term success in 13 of 13 carotid artery repairs.[2,6]

Despite advances in large vessel surgery from wartime experiences, there was no similar success rate for smaller vessel anastomosis. Schumacher and Lowenberg reported one of the first large animal studies for smaller vessels and found 12% thrombosis of 70 small arteries that were greater than 3.2 mm in diameter, compared to arteries less than 3.2 mm in diameter that had a rate 30% thrombosis of 26 arteries. Interestingly, it was a common belief in the 1950s that anastomosis of vessels smaller than 5 to 6 mm inevitably led to thrombosis.[7]

Advances in magnification technology paralleled those in surgical technique, being essential for the evolution of modern microsurgical techniques. The first compound microscope was invented by Zacharias and Hans Janseen in 1950.[6] Microsurgical techniques were used for the first time by the Swedish otolaryngologist Carl Olof Siggesson Nylen (1892-1978), who coined the term microvascular surgery and is considered the father of microsurgery, is credited with the design of the first surgical microscope, and demonstrated a 100% patency rate in vessels 1.6 to 3.2 mm in diameter.[2,6] On July 30, 1957, he perform an immediate reconstruction of the cervical esophagus using free jejunum in a man of 63 years, considered the first report of «free tissue transfer». In his report, they performed an end-to-end anastomosis of a branch of the superior mesenteric artery to the superior thyroid artery (2.3 to 3.0 mm in diameter). The mesenteric vein was anastomosed to the anterior facial vein using a silicone titanium ring prosthesis; although the patient died of a stroke on postoperative day seven, the anastomosis was considered viable before the time of death. In 1960 Jacobson and Suárez (pioneers of microvascular surgery) observed that the problem was not in manual dexterity but in visualization, they designed a surgery with a microvascular free flap and are credited with being the first surgeons to use an operating microscope to small blood vessel anastomosis.[2,7,8] This was done in combination with Litmann from the Carl Zeiss Company. In 1961, Jacobson developed the first double binocular microscope, called a diploscope.[7] Vascular microsurgery had a before and after the introduction of the use of microscope, considering this tool an important piece for microvascular surgery. Shortly after reports of small vessel reanastomosis techniques, there were reports of upper extremity revascularization and subsequent finger reimplantation, leading to the increase in the field of clinical microvascular surgery. At Montefiore Hospital in New York, Seidenberg studied anastomosis of arteries varying between 1.5 and 4.0 mm in diameter in mongrel dogs and showed that successful anastomosis was actually the rule, rather than the exception.[9] Two years after the reports de Jacobson and Suarez, Chase and Schwartz reported 100% patency in 34 anastomoses performed in the brachial arteries of dogs (diameter range, 1.2 to 1.7 mm).[9] In this study, the authors used binocular loupes with 4× magnification. Contemporary reconstructive microsurgery was introduced by an American plastic surgeon, Dr. Harry J. Buncke, in 1964.[10,11]

They also reported implantation of a thumb, as well as an index finger in a rhesus monkey, and the first successful transfer from toe to thumb in rhesus monkey. Chen and colleagues reported the first successful reimplantation of the hand. The operating microscope was found to improve results, and this was demonstrated by Chen and his colleagues in Shanghai, China.[2] On July 27, 1965, Komatsu and Tamai report the first successful fully amputated single digit reimplantation performed in Nara, Japan, they reported the repair of two arteries and two veins performing end-to-end anastomosis using interrupted 7-0 and 8-0 sutures in a 28-year-old man whose thumb was amputated at the metacarpophalangeal joint on a steel cutting machine.[12] In 1966, Buncke reported reimplantation of rabbit ears with anastomosis of vessels approximately 1 mm in diameter. This microsurgical procedure was possible thanks to the

use of fine instruments adapted from those used by watchmakers and jewelers, as well as the development of fine sutures attached to fine needles.[13,14]

Between the years 1965 to 1980 in the medical literature there were many reports of tissue transplants from finger to hand, transplantation of feet to hand, also before an audience the reimplantation of an avulsed finger was performed. In the 1980s, microvascular surgery techniques made their way into the fields of hand surgery, plastic surgery, orthopedic surgery, ophthalmology, pediatric surgery, head and neck surgery, urology, and gynecology.

Facial reconstruction is an important part of oral and maxillofacial surgery, however in the United States the transfer of free tissue was integrated late in the procedures performed in this specialty, in contrast to European oral and maxillofacial surgery, where microvascularized free flaps they were practiced for many years earlier than in the United States. This was because free tissue transfer for facial reconstruction in the United States is closely related to the growth of head and neck cancer surgery.[2]

The Second World War was an important trigger for the development of facial reconstruction techniques, since during and after the war numerous traumatic injuries had to be treated, opening up many possibilities to treat defects and laying the foundations for facial reconstruction.

Currently the defects after surgery for resection of benign or malignant tumors of the face are one of the main reasons in the world that need reconstruction. However, there are other factors that can create facial defects and require reconstruction, for example, nowadays first-line or adjuvant radiation plays an important role in the interdisciplinary treatment of malignant neoplasms of the head and neck region, taking as complication osteoradionecrosis of the jaws, the treatment being resection which creates a defect that will need to be treated, likewise the osteonecrosis associated with drugs can create extensive defects or pathological fractures where reconstruction of the jaws is required, also rare forms of congenital hypoplasia of the jaw, as occurs in Goldenhar syndrome, may indicate reconstruction or patients who have suffered infections of dental origin affecting the supporting bone or sequelae of osteomyelitis, and finally the loss of bone in a physiological way when losing dental organs at an early age they are scenarios that require rebuilding. The common characteristic of the different etiological factors mentioned is the loss of mandibular and maxillary integrity, which leads to deficits with respect to aesthetics, lip competence, malocclusion, phonetics, masticatory function and swallowing. Patients with untreated defects in this region generally suffer from loss of facial projection. This phenomenon causes psychosocial stress, among other situations.[15] Therefore, recovery of the continuity of the maxilla and mandible in three dimensions is essential. Further rehabilitation of the dental subunit is the key to achieving optimal long-term aesthetic and functional success. The complexity of the face with respect to form and function necessitates detailed diagnoses and a variety of reconstructive approaches to determine the ideal strategy, which is why different types of microvascular flaps were designed to be able to do head and neck reconstructions. The radial fasciocutaneous free flap was first reported in 1981 by Yang, the subfascial dissection technique became popular in the Western world for oral and mandibular reconstruction in the early 1980s by Muhlbauer, Song, and Soutar, and shortly thereafter in maxillofacial surgical practice by Vaughan.[16-20]

The vascularized fibula flap was first described in 1975 by Taylor.[21] In 1989, Hidalgo reported on its use for the reconstruction of mandibular defects.[22,23] It is currently the gold standard for maxillary and mandibular reconstruction. In 1977, Drever described the clinical application of an island of skin taken with the rectus abdominis muscle as a composite unit, and used it to repair a chest wall defect by rotating a pedunculated myocutaneous flap of superior base, said flap is nourished by the deep superior epigastric vessels, one of the most common uses of the rectus abdominis muscle flap in head and neck reconstruction is the reconstruction of the tongue and floor of the mouth after total or partial glossectomy.[24-27] The scapula flap was developed and popularized in the 1980s by Gilbert, Teot, dos Santos, Swartz, Cormack, and Lamberty. Since then it has been used for a wide range of reconstructive purposes in the head and neck area, the versatility of combining various amounts of skin, muscle and bone makes this flap a very attractive tool.[28-31] The latissimus dorsi flap was the first musculocutaneous flap reported in the medical literature. Tansini described this flap for chest wall reconstruction after radical mastectomy in 1896. In 1978, Quillen first reported the use of the pedunculated latissimus dorsi musculocutaneous flap for reconstruction of the head and neck area.[32]

Follow-up reports by Quillen and Barton confirmed this flap as a useful and versatile technique for repairing craniofacial defects.[33,34] The use of the latissimus dorsi musculocutaneous flap as a free microsurgical flap was reported by Maxwell and

colleagues in 1978.[35] The length and caliber of the neurovascular pedicle, the ease of dissection, the large surface area and the minimal morbidity of the donor site are the main factors that explain the popularity of this donor site for the transfer of tissue as a free flap to the region of the head and neck. Its role in the reconstruction of the head and neck lies in the coverage of extensive defects of the scalp and skull. It is particularly suitable for the reconstruction of defects in the orbit and cheek area, as well as a substitute for the tongue after total glossectomy.[36,37] In 1979 Taylor, Watson, Sanders, and Mayou independently described transfer of the iliac crest bone based on the vascular pedicle for bone reconstruction of the lower leg.[38,39] In 1982, Taylor was the first to report the use of the anterior iliac crest flap for mandibular reconstruction, and later this flap was used for functional reconstruction of the mandible and maxilla.[40] The vascularized iliac crest flap is one of the main flaps for bone reconstruction of head and neck defects after resection of benign or malignant conditions of the mandible and maxilla. Undoubtedly, this flap provides adequate bone stock for orofacial reconstruction and is ideal where prosthetic rehabilitation with dental implants is desired. The flap is based on the deep circumflex iliac artery, which originates from the external iliac artery and branches into muscle, bone, and skin.[41] The most recent development or refinement in facial flap reconstruction has been the advent of perforator vessel-based flaps. In 1988 Kroll and Rosenfield described the clinical application of «a new type of flap» based on unnamed perforator vessels located near the midline of the lumbar region to reconstruct lower posterior midline defects.[42] These perforator vessels are now known as lumbar perforators. Koshima and Soeda in 1989 reported the first true perforator vessel-free flap, in which an «inferior epigastric artery skin flap without rectus abdominis muscle» was used for the reconstruction of the floor of the mouth and groin.[43-47] With recent advances in reconstructive surgery, more emphasis is being placed on matching the quality and quantity of tissue with the necessary requirements at the defect site. To meet these requirements, new potential donor sites for free tissue transfer have been studied and introduced. More than 150 microvascular flaps with different variations and combinations have been described. At present, technology has made a great advance in microvascular and reconstructive surgery, since it reduces surgical time and reduces possible complications. During the growth of microvascular surgery, microneurosurgery developed along with it; however, this topic will not be discussed in this article.

HOW TO START TRAINING IN MICROVASCULAR SURGERY FOR APPLICATION IN ORAL AND MAXILLOFACIAL SURGERY?

Kleinert was known for his tireless practice efforts, he and Jacobson were told that the operating microscope was a «waste of time» and that it would «never be practical to bring a microscope to an operating room».[2,47] However the application of magnification in surgical procedures revolutionized surgery. For the implementation of microsurgery in a clinical way, microsurgical training in inanimate objects and in animal models is an essential stage, as well as knowledge of the instruments, the use of the microscope, knowledge of anatomy and specific techniques of anastomosis, taking grafts and application of the same. Acquiring the skills necessary to perform microsurgery can be beneficial to both the laboratory scientist and the clinical practice of the oral and maxillofacial surgeon. The learning curve of microsurgical techniques demands basic skills and continuous training, which is an important pillar for the success of microvascular surgery, however, resources for continuous training are scarce and patient safety limits teaching opportunities, the operating room has been recognized as a poor classroom for training novice surgeons as it is expensive, stress levels cannot be controlled, and cases may not be sufficient and adequate.[48] In recognition of this, institutions require students to attend a microsurgery course before entering the operating room, which is why laboratory training is basic.

At the Medical Center «Lic. Adolfo López Mateos» of the ISEM we developed a program for training in reconstruction of the face with microvascularized flaps, this program is divided into 3 training stages:

1. Laboratory training (development of the anastomosis).
2. Training in the classroom, amphitheater and computer center (virtual surgical planning and dental implant placement, development of taking microvascular grafts in cadaver and review of theoretical cases) (not reviewed in this article).
3. Application in patient (evaluation of head and neck defects, application of anastomosis and microvascular grafts for reconstruction of the maxillofacial area) (not reviewed in this article).

INTRODUCTION TO THE MICROSURGICAL LABORATORY

1. Laboratory training (development of the anastomosis)

The purpose of a microsurgery course is to develop the ability to perform the anastomosis and make it functional with flow, the basic point of reconstructive surgery in maxillofacial surgery. There are different hospital institutions and universities in the Mexican Republic that offer these courses which vary in duration, levels, and training methods. This training course is taught at the Medical Center «Lic. Adolfo López Mateos» of the ISEM. In the initial microsurgical practice, having a place with the conditions and the necessary devices to learn these techniques is essential. The first steps in this field confront the microsurgeon with a series of elements that are alien to him, despite the fact that he has previous experience in conventional surgery.[49]

The appropriate material, the experimental animals, the means of magnification, the instruments and the microsurgical sutures are some of the elements that we must review *(Figure 1)*.

Optical magnification

The vessels that are normally used in the anastomosis for mandible reconstruction are the facial artery, the facial vein and for maxillary reconstruction the superior labial artery and the angular vein are prepared, which have a variable caliber from 0.7 to 1.5 mm which makes it difficult to view directly.[50] Other blood vessels commonly used as receptors for the anastomosis are the superior thyroid artery and branches of the internal jugular vein whose diameters range from 1.5 to 5 mm.[51]

When the blood vessels to be reconstructed have a diameter of less than 5 mm, the use of optical magnification gives us certain advantages such as:

1. Increased illumination of the operative field.
2. Exact placement of the suture.
3. Allows the use of suture gauges 8-0, 9-0, 10-0.
4. Allows the use of microsurgical instruments.
5. In turn, the use of suture and proper instruments for microsurgery allows an atraumatic technique to be performed on the tissues of the blood vessel.
6. It allows the surgeon to critically evaluate the result of his work.
7. It allows correcting the deficiencies previously evaluated.

There are two types of optical magnification available to surgeons: surgical loupes *(Table 1)* and the surgical microscope *(Table 2)*, each of which has advantages and disadvantages.

When we are about to choose a type of optical magnification we have to take into account the following characteristics:

Magnification capacity: the magnification of an optic is the relationship between the size of the image and the size of the object, it is given by two lenses, one that is the eyepiece (lens closest to the operator's eye and usually have between 5 or 20 magnification) and by the objective (lens closest to the object and usually have between 2 and 4 magnification), together the lenses can give between 10 and 80 increases and is expressed with an X, for example 10X indicates that the object is magnified 10 times its size real.

Size of the operative or vision field: the field of view is the area of operation that you see through the magnifying glasses. The field width is related to the diameter of the loupe, the optical design and the magnification power.

Depth of focus: depth of focus is the range of focus delivered by the magnifying glass. This determines how much the loupe can be tilted or moved while still keeping the entire field of view attentive. Depth of focus depends on lighting, optical design, magnification power, visual power, and the eye's ability to focus with less effort.

Illumination: the lighting is reflected, that is, a light source illuminates the surgical site and the light reflected from the surgical site is observed through the objectives and eyepieces, the light is provided by an external light that is usually LEDs.

However, we should not make the mistake of thinking that higher magnification is always better, since with higher magnification the size of the operative field and the depth of focus decrease, increasing the magnification also requires a gradual increase in illumination.[52]

Surgical loupes

Surgical loupes used in the medical or dental area have a variable magnification range (ranging from 1.5× to 10×). Loupes that have a magnification of

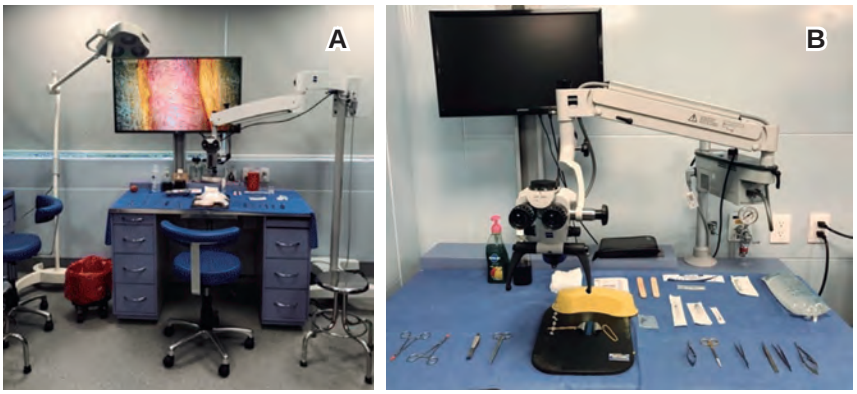


Figure 1:
A) Microsurgery laboratory.
B) Microsurgery surgical table.

Table 1: Advantages and disadvantages of surgical loupes.

Advantages of surgical loupes	Disadvantages of surgical loupes
It is cheap compared to the cost of a microscope Easy to use Less discomfort in the operative field Less possibility of contamination of the operative field	Lack of variable focus Requires independent light The focus is achieved or lost with the movements of the surgeon's head, which can become uncomfortable and make it difficult to adapt to work Loupes of higher magnification at 2.5× a greater size and weight, a limited field of view and a limited depth of field

Table 2: Advantages and disadvantages of the surgical microscope.

Advantages of the surgical microscope:	Disadvantages of the surgical microscope:
The magnification and lighting are modifiable manually or by means of a pedal The light is automatically directed to the workplace, it can be led or xenon The focus is independent and is not altered by the movements of the surgeon's head Binoculars with angle and tilt adjustment Possible camera adaptation for teaching other surgeons Some have two pairs of eyepieces, one for the surgeon and one for the assistant	Cost Initial handling

Figure 2: Surgical loupes.

less than 2× are unsuitable as well as those that are greater than 4.5× since they are difficult to use because they have a narrow operative field and a shallow depth of focus. Loupes between 2.5× to 3.5× provide an adequate combination of magnification, size of the operative field and depth of focus. Some surgical loupes are added with a lamp which also adds adequate lighting.[52]

In general, the working distance that magnifying glasses give us is 42 to 50 cm. We consider that the loupes are a good option for taking the flap, specifically during the dissection of the pedicle and in the preliminary preparation of the recipient blood vessels, the magnification with the loupes adequate for this stage of the procedure is 2.5× *(Figure 2)*.

Surgical microscope

The microscope used is called stereoscopic, this type of microscope is a type of optical microscope that allows observing the surgical site in three dimensions, therefore it does not have a condenser or diaphragm. Initially its use is more difficult unlike surgical loupes, as one adapts to it becomes flexible and comfortable.

Surgical microscopes have a higher magnification than loupes and their use is recommended in the final stage of dissection of the blood vessels or nerves of the pedicle and in the anastomosis. It is recommended that the microscope for use in the operating room or laboratory practice has at least the following characteristics:

Head: 360 degree rotatable trinocular with minimum 45 degree tilt, eyepiece: 30 mm-WF10X/20, Barlow lens: 2.0X, objective: 0.35-9.0X, zoom range: 1:6, diopter adjustment: +/- 5dp, working distance: 200-400 mm.

The eyepiece magnification and lens focal length are chosen based on the amount of magnification and the desired working distance.

Instruments used in microsurgery

Properly designed, constructed, and well-maintained instruments are needed to be successful in microsurgery. Inappropriate instruments will not only frustrate the surgeon but will also indirectly affect the anastomosis by causing unnecessary trauma to the tissue. Usually in microsurgery the instruments used are: forceps, needle holders, scissors, vascular clamps, bipolar electrocoagulation unit.

Forceps

The jeweler's forceps are an important and versatile instrument, as this can be used as needle holders, scissors, dissector and forceps as such, there are many commercial brands that design and manufacture these clamps, using forceps 3c which is a measure is recommended the active parts, their active parts must be sharp, without irregularities, they are used to hold tissue, manipulate and tie the suture, open the lumen of the vessel to give the suture point, proper maintenance must be carried out avoiding bending the tips or any distortion, only small needles and special suture material for microsurgery should be used *(Figure 3)*.

Microsurgical needle holder

A Schreiber TC Barraquerso needle holder without clasp is recommended for easy handling when taking and leaving the needle, since those holders that have a lock can produce vibration when removed and cause damage to the structures of the blood vessel, its length must be 10-12 cm so that it does not weigh on the fingers, round and rough handle of 9 mm in diameter to facilitate the rotation of the needle and allow a completely digital handling, the bites must be small 7 mm in length to avoid that they can obstruct the visibility, flat, smooth and straight bits which allows a needle to be firmly held without bending it and prevents it from slipping, those bits that are toothed can unintentionally cut the suture, which is why smooth is recommended *(Figure 4)*.

Microsurgery scissors

The scissors used are the Schreiber Vannas type scissors of 12 cm in length, with a wide and flat handle, without clasp or zipper, the active part must be 10 mm straight and with an edge, the scissors not only help a sharp dissection of tissue also serves for suture cutting *(Figure 5)*.

Microvascular clamps

These small forceps are used to automatically and atraumatic occlude the blood flow in the arteries or veins to be treated during the anastomosis, it also helps to immobilize since the blood vessel is not retracted, there are single (Biemer-Muller) or double (Acland), the doubles are added with a bar which can help to face the blood vessels, however sometimes they make it difficult to rotate the blood vessel to be able to position the stitches in the posterior area of the diameter of the vessel, their bites must be smooth so as not to damage the endothelium and the pressure must be 40-30 g/mm^2, the end of the blade must be round to avoid damaging the blood vessels, matt black is preferred to avoid light reflection, the measurements of the parts of a cmap are variable according to the diameter of the blood vessels in which it is going to work *(Table 3 and Figure 6)*.

Bipolar electrocoagulation

The electrocoagulation unit is important for haemostasis during dissection, there are two types of electrocoagulation: monopolar and bipolar, with

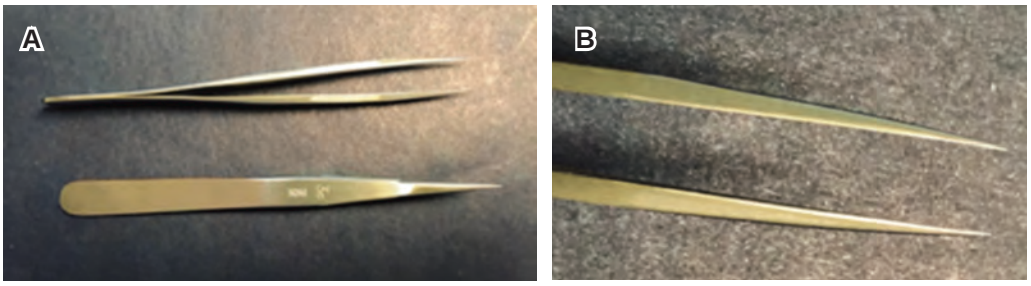


Figure 3:
A) Watchmaker's forceps 3c. **B)** Active part of the watchmaker's forceps.

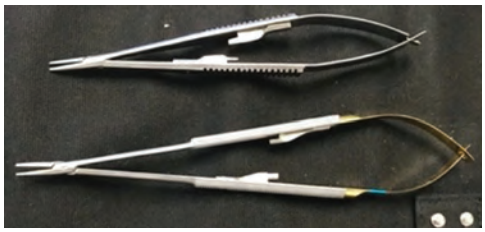


Figure 4: Schreiber TC Barraquerso needle holder.

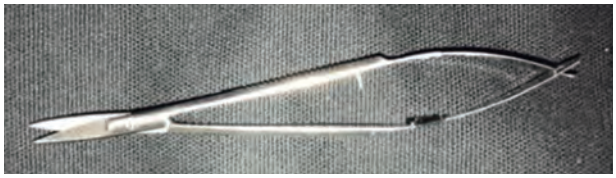
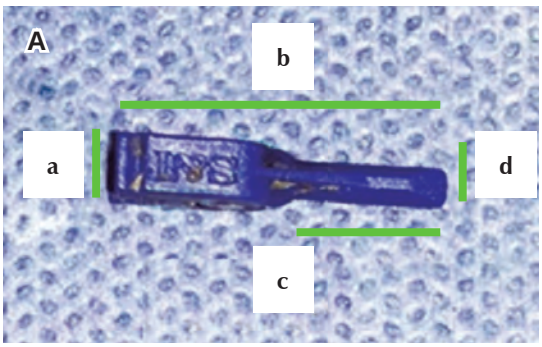


Figure 5: Schreiber Vannas 12 cm scissors.

Table 3: The different measurements that microvascular clamps can have, the pressure they can exert and their relationship with the diameter of the blood vessels are shown.

Clamp Serie	a (mm)	b (mm)	e (mm)	d (mm)	Pressure in grams	Pressure in grams	Blood vessel diameter (mm)
RD	6.0	36.0	16.0	3.0	120-140	–	2.0-5.0
HD	4.0	24.0	10.0	2.0	60-75	30-40	1.5-3.5
B-3	3.5	16.6	7.5	1.7	30-40	–	1.0-2.2
B-2	3.0	11.3	5.5	1.5	17-23	–	0.6-1.5
B-1	2.2	8.0	3.8	1.1	10-14	–	0.4-1.0

one important difference: with a monopolar unit, the current is distributed from the tips and coagulates a relatively large amount of tissue. The electrical current in a bipolar unit is restricted to the shortest distance between the two points and coagulates much less tissue. As current flows only between the tips, it is not necessary to isolate the handles, so it is recommended for dissection.



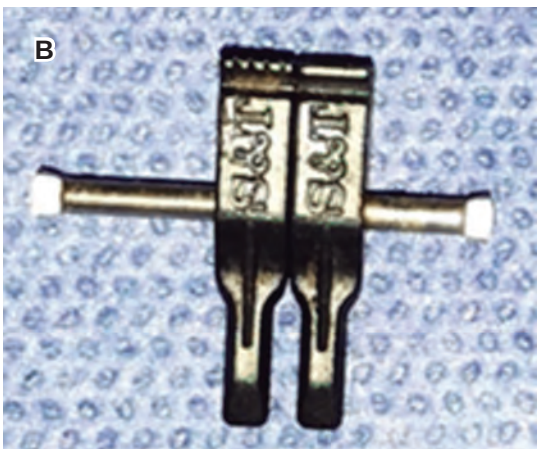


Figure 6: A) Biemer-Muller type simple clamp, the parts of the clam are shown, in relation to table one we can see the possible measurements and their relationship with the calibers of the blood vessels. **B)** Acland type double clamp.

Figure 7: 10-0 nylon suture.

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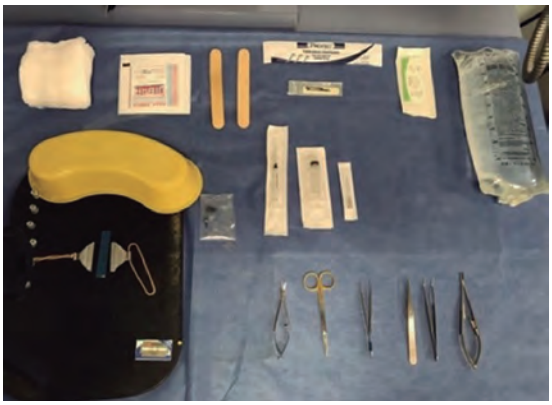

Figure 8: Gauze consumables, swabs, No. 15 scalpel blade, 3-0 silk, sol. Physiological, insulin syringe, 5 cc syringe, 22 G needle.

Microvascular suture

Nylon is the most popular suture for microvascular surgery measuring 8-0 to 10-0. The size of the needle should be 75 to 100 microns in diameter, 1/2 to 3/8 of a circle, with a sharp, conical or combined tip. The needle with a cutting tip is used to penetrate rigid tissue or used in suturing of nerves, the needle with a conical tip is used to penetrate soft tissue and is mainly used in the microvascular anastomosis *(Figure 7)*.

Other instruments used during macroscopic dissection are curved Halsted forceps, Adson forceps with and without teeth, Mayo scissors, and 15 cm

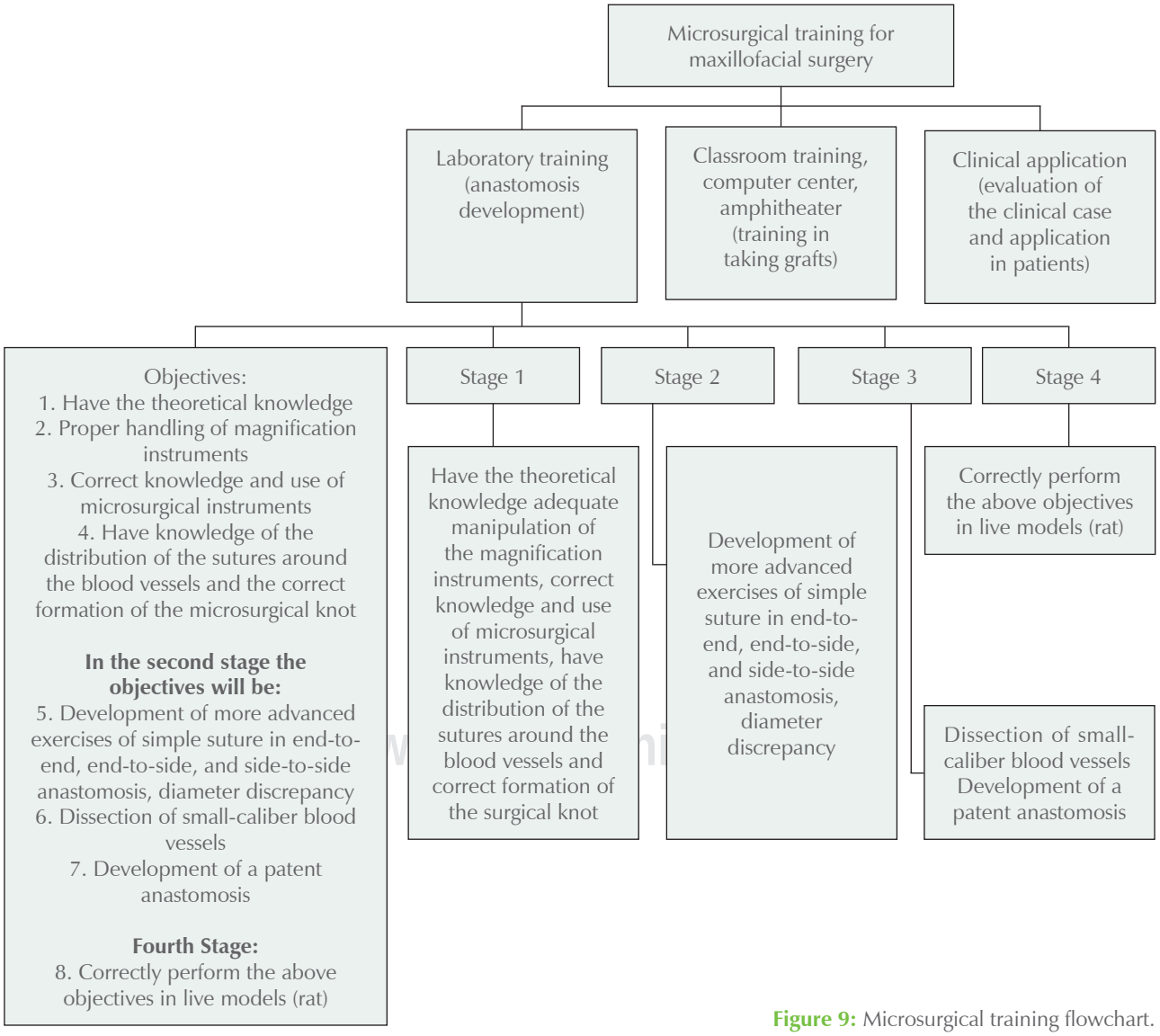

Figure 9: Microsurgical training flowchart.

Table 4: Evaluation of models for microsurgical practice.

Model	n	Availability	Ease of dissection	Dissection time (min)	Number of vessels	Vessel diameter (mm)	Vessel length (cm)	Number of anastomoses	Human similarity	Cost in Mexican pesos/USD
Latex	3	+++	–	–	–	–	–	0	0	10/2.5
Feeding probe	3	++	–	–	–	1.5	30	n	0	500/25
Chicken thigh	15	+++	+++	25	2	2.2	5	3	++	20/1
Chicken wing	3	++	++	25	3	1.1	8	5	++	10/0.5
Turkey wing	5	+++	+	40	2	3.0	6	5	+	30/1.5
Pork leg	3	+	+	60	3	1.8	4	3	+	20/1
Cow heart	2	+	+	60	5	1.7	2	10	+	40/2
Human placenta	1	+	0	120	n	n	15	n	+	0
Abdominoplasty piece	1	0	++	30	4	2.4	15	8	+++	0

Figure 10: Live model of the Wistar rat.

Mayo needle holders. These instruments will not be described in detail as they are instruments that we normally use.

Consumables for practice in live animal model

0.9% physiological solution to irrigate, gauze, for the practice in live animal model separators made with clips and traction with garters, swabs or cottonoids, 10 mL syringe with needle, insulin syringe of 100 UI, scalpel blade No. 15 *(Figure 8)*.

Microsurgical training

Microsurgical training for vascular anastomosis requires acquiring and developing certain skills and abilities, which requires learning to operate with magnification, which requires a lot of practice and patience.

Table 5: Bioethical principles for practices in live animal models.

1. Animal experiments should only be carried out when:
   a. Are essential for the treatment, prevention, diagnosis or study of the etiology of any disease
   b. The experimental results cannot be obtained by means of other procedures
   c. The results are not known in advance, nor is it possible to predict them
2. The animals selected for an investigation must be of the species, age and characteristics suitable for the type of study to be carried out, as well as the minimum number of animals necessary to obtain result
3. All animals destined for research must be legally acquired and come from accredited animal facilities
4. The animals must be housed in clean, dry facilities, adequately designed so that they are comfortable, with free access to water and food
5. The conditions that are offered to the animals should promote their health
6. Researchers must treat animals as beings that are capable of feeling pain and anguish
7. Any procedure that causes pain or anguish must be performed under analgesia or anesthesia
8. The administration of anesthetics and tranquilizers to the animals during the experiments must be supervised by a veterinarian
9. No painful or invasive procedure should begin until it is certain that the animal is under anesthesia
10. Researchers who work with animals must be aware that when they take the life of an animal into their hands, they also have the responsibility of ensuring a good death, providing euthanasia when necessary
11. At the end of the experiment, the animal must receive a dignified death, fast and with a minimum of pain
12. The corpses of animals should never be deposited in garbage containers or sent to the incinerator, until the animal presents cardiac and respiratory arrest and a doctor or the investigator has verified the death

Unfortunately, the skills developed in macrosurgery cannot be transpolated to microsurgery immediately, since hand-eye coordination is different, at the beginning the experience can be frustrating, due to the difficult digital manipulation of the instruments, for example, if pressing too hard on the instrument can cut the suture or the suture may fly off and be lost, causing the needle to break or bend. However, these frustrations or errors can be minimized through a structured and progressive learning system, which is why training should be started in the microsurgery laboratory and practicing from the simplest to the most complicated, taking into account It counts the size of the suture, the type of practice model used, the practices that will be performed on the models and finally the anastomosis on the patient. To be successful in microsurgery, you must have adequate training that allows you to develop dexterity and coordination, it has been shown in clinical and experimental studies that adequate and constant training improves skills and the final functional result of the anastomosis (patency).

As has been proposed in this article, we establish a progression for the development of skills and establish certain objectives that microsurgical training must meet; laboratory training (anastomosis development) will be divided into four stages *(Figure 9)* and in each of these, certain objectives must be met, in the first stage the following objectives must be met:

1. Have the theoretical knowledge.
2. Proper handling of magnification instruments.
3. Correct knowledge and use of microsurgical instruments.
4. Have knowledge of the distribution of the sutures around the blood vessels and correct formation of the microsurgical knot.

In the second stage the objectives will be:

5. Development of more advanced simple suture exercises (end to end (T-T), end to side (T-L), side to side (L-L) and handling of diameter discrepancies.

Third stage:

6. Dissection of small-caliber blood vessels.
7. Development of a patent anastomosis.

Fourth stage:

8. Correctly carry out the previous objectives in live models (rat).

Practical models

Regarding the models in which practices can be done, they are divided into:

1. Inanimate which is subdivided: synthetic and biological.
   a. Synthetic models (latex, silicone, polyurethane) (used in the first and second stages of laboratory training). In the literature there is a wide range of models, many of which demonstrate the ingenuity of their creators, we will present later a synthetic model of practice, similar to a Japanese model.
   b. Biological models (thigh or wing of chicken, turkey, pork, placenta, split skin) (used in the second and third stages).
   Dr. Patricio Andrades C and cols carried out a study in which they evaluate the different practice models, where it is mentioned that latex is ideal for the initial practice of knots despite not being biological tissue, the feeding tube (tube of silicone) is expensive, but it is a very useful model for practices, it is the most used and easily acquired, the chicken thigh is useful for dissecting blood vessels, the chicken wing has the same advantages as the chicken leg with the difference that the blood vessels are smaller, the turkey wing has large-caliber blood vessels which have fibrofatty adventitious tissue that makes dissection difficult, knotting and increases the degree of difficulty allowing the practice of dissection, the legs of pigs present difficult dissection and are not useful for practice, the cow heart is difficult to acquire but has special blood vessels and easy dissection, the human placenta had the di more difficult section but gives access to blood vessels of different lengths, diameters for which different sutures can be practiced, the abdominoplasty piece is of variable availability, but being human tissue certain precautions must be taken, it gives access to large epigastric vessels length and gauge suitable for initial practice *(Table 4)*.[49]
   Based on this study, we designed a training program, since we consider that each model allows us to acquire different skills, therefore, we do not discard any material, rather we use them to develop specific skills.
2. Live models (most used Wistar rat) *(Figure 10)* (last stage). Biomedical experimentation in animals has allowed us to know in a more detailed and precise way, the physiology of the different devices and systems that make up humans and animals, as well as the pathogenesis of infectious and degenerative diseases, favoring

the advancement of knowledge about diseases, its treatment and prevention. The live animal model is a very good option for the practice of anastomosis, however, it is a resource of low availability, expensive, complicated maintenance, and at present the bioethical use of laboratory animals is under great debate. The use of animals in research has allowed great advances in the knowledge and development of biomedical sciences. However, the fact of carrying out experiments with beings capable of feeling pain implies a responsibility towards them on the part of the scientific community,[53] which is why we chose to carry out practices first in inanimate models before reaching the living model. Among the main vertebrate species that continue to be used as research subjects are mice, rats, guinea pigs, rabbits, hamsters, dogs, cats, pigs, goats, sheep, chickens and amphibians. Before thinking about going into the practice with live animals, we must take into account that they are living beings that feel, and thus put into practice the concept of the triple «R» (RRR) introduced in 1990 by Russell and Burch, which refers to a: reduce, refine, replace.[49,53-55] The reduction of animals used and the refinement of the methods and techniques in research will only be achieved if the work is planned in detail and with authentic responsibility, which implies having the minimum necessary number of animals to achieve statistical significance, the refinement of the techniques should reduce pain and discomfort in experimental subjects, and replacement or substitution of animals using alternative methods or other types of practice models. When planning to practice on animals, certain bioethical principles that are found in ethical codes or guides must be followed where the conditions in which live animal models must be treated are contemplated *(Table 5)*.[53-56]

General considerations of the anastomosis technique

Proper setup for anastomoses is one of the most critical steps in a microsurgical procedure as free tissue transfer must have a high blood flow rate to ensure survival. Therefore, the selection of recipient and donor vessels is a very important point to have an adequate evolution, however, in this publication we will not describe these characteristics as they will be addressed in subsequent publications.

Preparation of the surgical environment to perform an anastomosis

When a surgery is properly prepared, whatever it may be, that preparation will be reflected in the anastomosis being easier to perform, a better surgical development, a reduction in surgical time, a reduction in errors and a decrease in stress on the surgeon.

A common mistake made by less experienced surgeons is not spending enough time on this step. We recommend following four preparation times that will serve us in practice in the microsurgery laboratory and in the operating room during the care of a patient:

Position of the surgeon. Surgeons must achieve an optimal position to achieve a comfortable position of the elbow and wrists to facilitate suturing, it is recommended to use a chair that has armrests and place a pad under the wrists, remember that the movements of microsurgical instruments They are digital, the more support the hand has, the shaking of these will decrease.

The surgeon's head and neck should be positioned comfortably when viewing the microscope eyepieces to minimize neck strain, this is accomplished with a chair that has lumbar support and is easy to raise and lower if necessary during surgery.

Instrument area and instrument distribution. The instrument area must be clean, free of unnecessary instruments or consumables. Everything essential during microvascular anastomoses, including a wet pad for cleaning instruments, heparinized irrigation solution, microsurgical instruments, and sutures must be installed before the anastomoses are performed, and they must be accommodated by the surgeon so that the surgeon remember where I put them and don't have to take your eyes off the eyepieces.

Microscope adjustments. Before starting the surgery, the pertinent adjustments must be made to the microscope, and they must be made by the surgeon who will perform the anastomosis, the distance of the eyepieces, the focus, the magnification and the light must be adjusted. At the beginning of the anastomosis the microscope should ideally be positioned so that the vessels are oriented horizontally in relation to the surgeon.

Operative field. Optimal vessel exposure should be achieved. Good lighting is critical, as it increases visual acuity and depth of field. If a vessel is deep within a gap, at an unfavorable inclination, or orientation, it is particularly important to dissect an additional length so that the vessel can be brought

into a position that will adequately expose it for anastomosis. The plane of each blood vessel must also be level. When the plane is uneven, this can cause focusing problems due to the limited depth of field that exists under high power magnification. It is helpful to place a moist sponge or cotton wool under the vessel to elevate the anastomosis site over the surrounding wound area.

This avoids problems of contamination from wound fluids seeping into the anastomosis site and helps to place the vessel on a level plane. A solid colored background can be placed under the vessels to visually simplify the surrounding area and provide a smooth surface against which to suture (green or blue rubber dam). Unfavorable vessel exposure is responsible for many of the technical errors made during surgery. Therefore, it is important to obtain adequate exposure and take the time to properly configure vessels prior to performing anastomoses.

Steps for the construction of an adequate anastomosis

Final preparation of both the recipient and donor blood vessels must be done under the operating microscope. The operative field should be approximately level with the surgeon's elbows.[10]

1. Select in advance the blood vessels to be anastomosed by means of a previous evaluation with an angio-CT.
2. The receptor site must be positioned for optimal exposure.
3. Properly dissect the blood vessels in circumference and a minimum length of 4 cm so that they have an acceptable mobility to avoid tension at the site of the anastomosis.
4. The orientation of the flap pedicle is verified to ensure that the anastomosis is not under excessive tension.
5. The vessels to be anastomosed are positioned to allow adequate surface-to-surface adaptation without tension.
6. Place a contrast medium such as a blue or green rubber dam which will help us to clearly identify the blood vessels to be anastomosed.
7. Placement of microvascular clamps, in our experience it is recommended to use free clamps without a coping bar as it will allow better manipulation of the vessels *(Figure 11)*.
8. Section of the vessel to be anastomosed.
9. Trim the excess adventitia from the end of each vessel so that it is not trapped in the lumen during the anastomosis, since poor removal of the adventitia may cause it to enter the lumen of the vessel and cause an obstruction or a turbulent flow, functioning as a catalyst for platelet aggregation predisposing to thrombus formation and anastomotic failure. Nor should the adventitia be dissected beyond the distance that ensures a clean anastomosis, since an excessive adventitial dissection can damage the vasorum and lead to the formation of pseudoaneurysms *(Figure 12)*.
10. It is verified that the cut edges of the vessels have a clean and uniform edge and they are trimmed again if necessary to avoid that the loose tissue ends invade the lumen because these can be sources for the formation of thrombosis.
11. Inspect the lumen of each vessel by turning the end and looking directly under the microscope to see that there is no obstruction *(Figure 13)*.
12. Gentle irrigation with warm physiological solution to eliminate any loose clot in the light, also the warm water will slightly dilate the walls of the blood vessel.
13. The end of the vessel can also be gently dilated with vessel dilation forceps. However, the excessive stretching of a vessel can cause intimate damage, for which we recommend using the watchmaker's forceps, they are introduced open in physiological solution and closed inside the solution, which will make the forceps retain a little solution, When they are brought into the light of the vessel, they open and this will release a drop, this effect of the drop inside the light of the vessel will allow the walls not to collapse and the light can be seen properly *(Figure 14)*.
14. Level the vessels to be anastomosed, if the surgical field does not allow a similar level to be maintained between the recipient vessel and the donor vessel, a sponge or cottonoid can be used that provides adequate leveling and has the lumen edges parallel. of the vessels *(Figure 15)*.
15. Start suturing with 10-0 nylon, most anastomoses are performed by hand with a simple or continuous suture technique. The selection of a simple or continuous suture technique is determined by the size of the vessel, by the experience and preference of the surgeon, as well as by the suitability of one technique or another in a particular situation. For small vessels, the single dot technique is more accurate. The continuous

stitch technique is faster, but requires careful attention to the spacing and amount of tension on the sutures. Excessive tension tends to have a bag effect in an anastomosis, while insufficient tension tends to produce leaks between the sutures, the following suture technique is suggested for its simplicity and good results, this includes simple stitches, these sutures must be placed at the same distance to distribute the stress evenly around the circumference of the vessels to be anastomosed. During the manipulation of the blood vessel it is suggested to take them from the adventitia or the points previously placed. Many times inserting and withdrawing the needle causes trauma and can rupture the vessel causing bleeding at the suture site, this can be avoided by minimizing hand shaking, keeping the needle perpendicular to the vessel wall and having a mental image of as the anastomosis is going to be completed, the intima of the vessel should not be clamped, and all sutures should be in direct vision since most of the problems or errors occur when it is done blind *(Figure 16)*.

16. Eight stitches must be positioned *(Figure 17)* on the circumference of the blood vessels, starting with the upper one or at 12 o'clock.
17. The second stitch must be made at six o'clock or in the lower part of the circumference of the blood vessels.
18. The third stitch is placed at three o'clock or at the back of the circumference of the blood vessels.
19. A 1 mm diameter medical grade silicone tube can be placed which will function as a guide inside the blood vessels, and which will be removed before placing stitch number 8.
20. The fourth stitch is placed at nine o'clock or in the anterior part of the blood vessels, these four stitches must be left with a long and a short end, a long one is left to be able to manipulate the blood vessel without the need to pull it directly.
21. The fifth stitch is placed between stitch two and three, in a position at approximately 4:30 o'clock.
22. The sixth stitch is placed between points two and four, in a position at approximately 7:30 o'clock.
23. The seventh stitch is placed between point 1 and 3 at 1:30 o'clock.
24. The silicone tube previously placed in the lumen of the vessel is removed.
25. The eighth stitch is placed between stitches 1 and 4, at 10:30 o'clock.
26. The anastomosis is covered with the contrast plastic (rubber dam) and a wet gauze is placed over it, the vascular clamps are removed and we wait a minute *(Figure 18)*.
27. The functionality of the anastomosis is verified, with a «milking» test by clamping the blood vessel with two watchmaker's forceps, occluding the flow beyond the anastomosis, the vessel is squeezed to where the blood flow runs through a clamp to create a vacuum in the vessel, without releasing the upper end of the vessel, the proximal clamp is released, which cuts off the flow and a rapid flow of blood should be observed running through the anastomosis and filling the empty segment, if it does not flow or there is a leak the anastomosis should be rechecked verifying each stitch. Slow flow with little vessel distention suggests a problem with the anastomosis *(Figure 19)*.

After restoring flow, the anastomoses are inspected for leaks. Large leaks need additional suture, but small leaks will stop spontaneously. After completing the anastomoses, the distal artery should be filled and pulsatile; and the venous anastomosis should be smooth pink or light blue. Arteries that lack turgor and pulse, as well as veins that are firm, distended, and black are likely to be thrombosed. The patency of the anastomosis can also be assessed indirectly by observing the color and amount of bleeding from the flap dermis or its muscle tissue. The blood from the dermal edges of the flap should be bright red when the dermis is rubbed with gauze.

Slow blood flow to the flap suggests an arterial problem. Rapid and abundant flow of dark blood in the flap indicates venous obstruction. Muscle flaps without islands of skin should remain moist and reddish-pink during insertion. When there is any doubt about the patency of an anastomosis, we generally check blood pressure to make sure the patient is normotensive. Sometimes the artery can go into spasm, and we recommend the use of papaverine (antispasmodic) or lidocaine. If there is still concern, the anastomosis should be partially or completely removed and the lumen inspected.[10,57-59]

To prevent thrombus in the suture line, an anastomosis must be constructed which is both anatomically and hemodynamically solid. The flow through a cylinder is mediated by four factors and was expressed mathematically by Poiseuille ($Q = PR4$) in the formula: Q is the flow, P is the pressure per quadrant, R is the radius of

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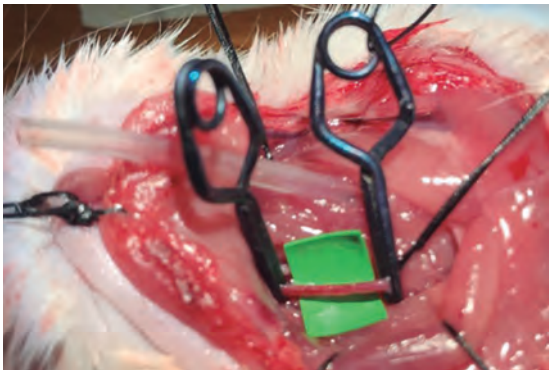


Figure 11: Placement of clamps in the carotid artery of a live animal model.

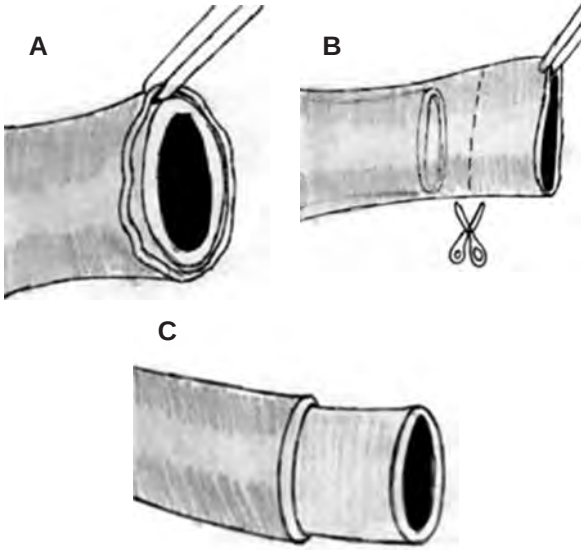


Figure 12: The sequence of removal of excess adventitia is shown to allow a clean anastomosis. **A)** The adventitia is taken from the blood vessel. **B)** The adventitia is tractioned and the excess is cut. **C)** Clean blood vessel from adventitia in the light of it.

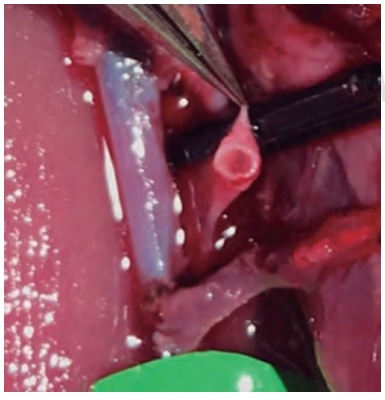
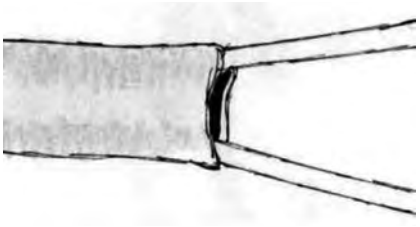


Figure 13:

Check the lumen of the vessel that does not have thrombi or obstructing tissues, always taking it from the adventitia to avoid damaging it.

Figure 14:

Opening of the vessel lumen with a drop of physiological solution applied with the watchmaker's forceps.



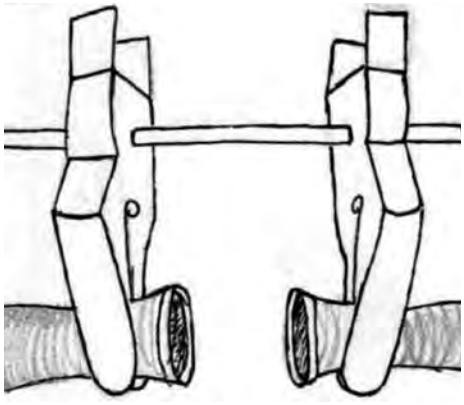


Figure 15: Blood vessel alignment.

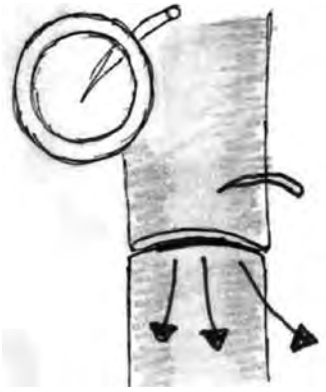


Figure 16:

Placement of the needle perpendicular to the vessel wall.

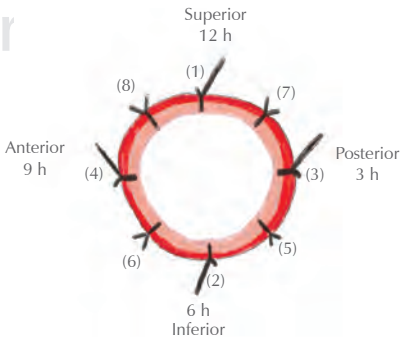


Figure 17:

Suggested sequence of suturing in the anastomosis.

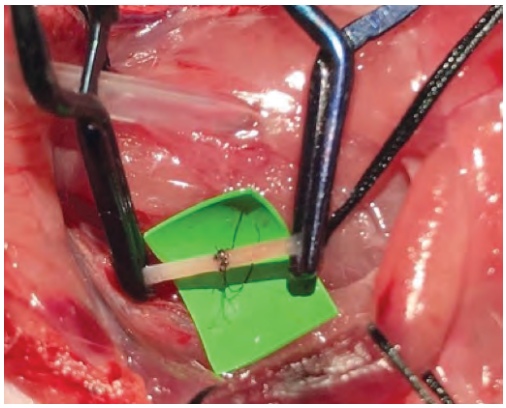


Figure 18: Finished suture sequence.

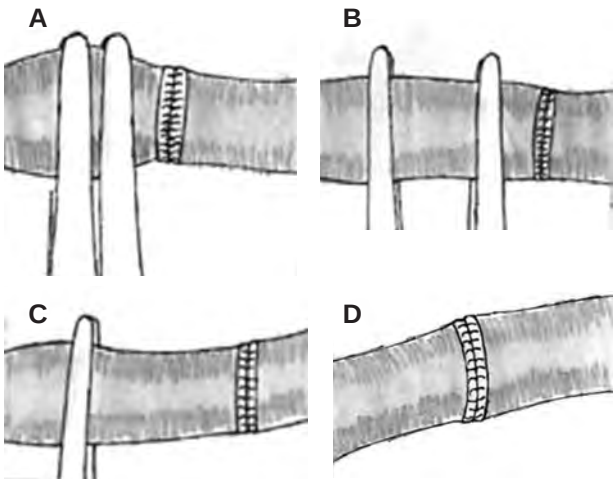


Figure 19: Anastomosis «milking» test sequence. **A)** The blood vessel is clamped with two clamps at the end distal to the flow. **B)** The vessel is squeezed by mobilizing one clamp against the blood flow and the other Leave it at the distal end. **C)** The clamp that obstructs the flow is removed and the blood must flow through the anastomosis. **D)** The filling of the blood vessel should be observed.

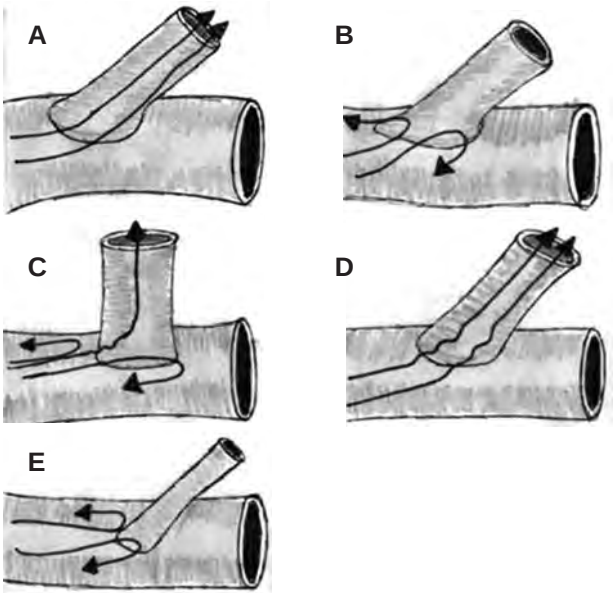


Figure 20: Laminar and turbulent flow due to the difference in vascular diameters. **A)** The angle between two vessels should be as acute as possible for adequate flow. **B)** If the cut in the vessel is linear and not elliptical, a flow is created turbulent. **C)** Right angles between the vessels creates turbulent flow. **D)** If an elliptical cut is created in the vessel wall, a laminar flow is created. **E)** Drastic changes in the diameter of the vessel cause turbulent flows.

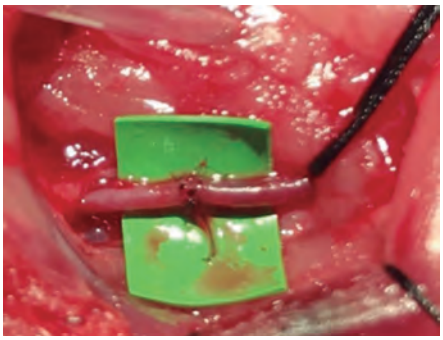


Figure 21:

End to end anastomosis.

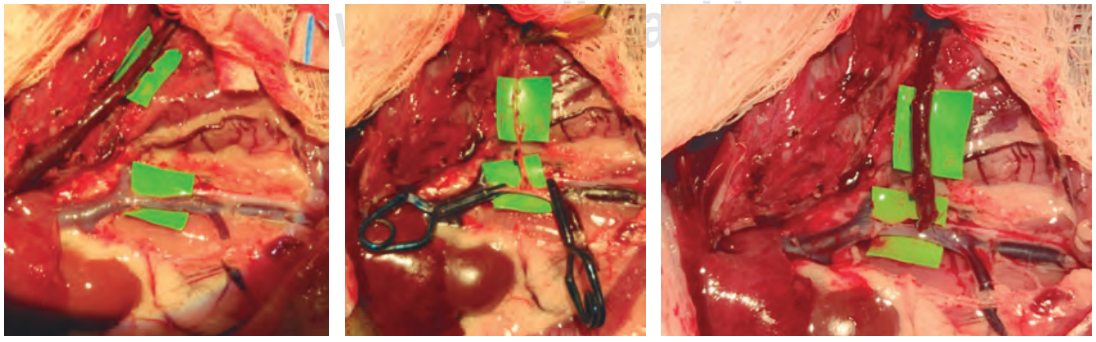


Figure 22:

End to side porto-cava artery anastomosis.

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Figure 23: Medical grade feeding tube in diameters of 2.0, 1.0, 0.5 and 0.3 mm.

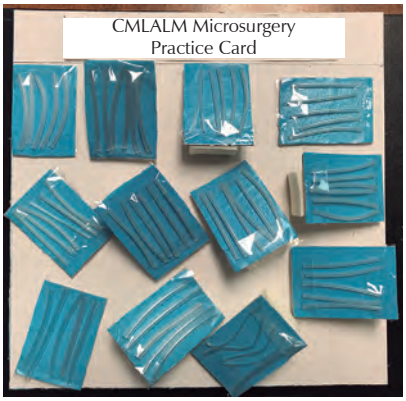

Figure 24: CMLALM practice card.

the cylinder, L is the length of the cylinder, N the viscosity of the fluid, this formula is not entirely applicable to the biological system, however, the general aspects can be transferred. The most important determinant of blood flow is the diameter of the blood vessel, as it is determined by the pressure of the blood and the radius of the vessel to the fourth power. This function is exponential and minute changes in gauge can cause a dramatic increase or decrease in flow. This hemodynamic principle is important in all vascular anastomoses, but its importance is exaggerated as the size of the vessel decreases. For example, a 20 percent reduction in the diameter of the aorta might not produce any clinically significant effect on flow through that vessel, but a similar reduction in a 1 mm diameter vessel would result in thrombosis. Flow is also influenced by changes in direction and size of the vessels. This is especially important since changes in direction and size are common in the vascular field of both man and animal. Flow is reduced under the above-mentioned conditions due to loss of input and output energy and because normal laminar flow of blood becomes turbulent flow which is less efficient.

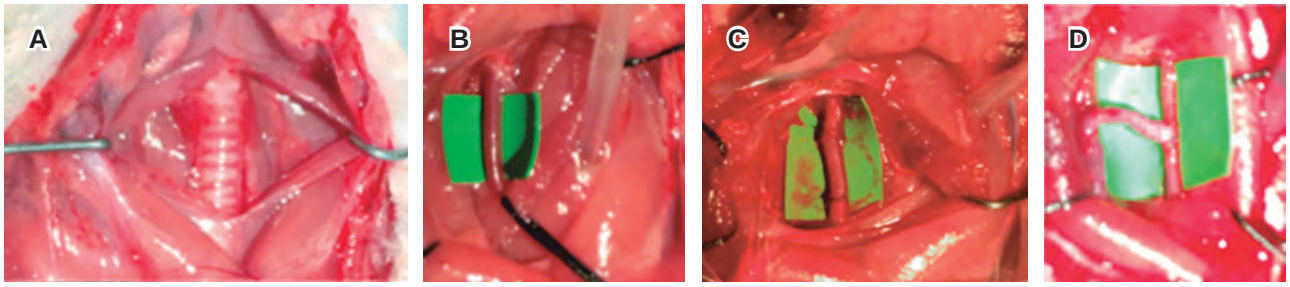

Figure 25: A) Tracheostomy, **B)** carotid dissection, **C)** taking a vascular graft with bilateral end to end anastomosis and **D)** end to side anastomosis.

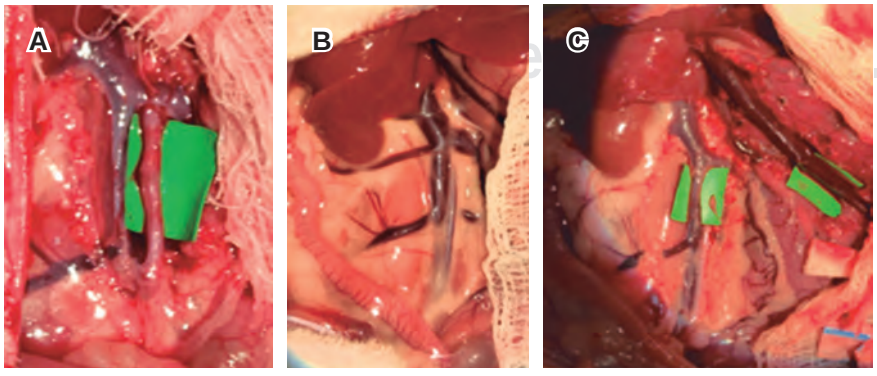

Figure 26:

A) Vein cava dissection, aorta. **B)** Aorta and vena cava. **C)** Portal vein dissection.

Whenever possible, a vascular anastomosis should be created that maximizes laminar flow and minimizes turbulent flow. Laminar flow is the normal type of blood movement within the vascular field. This type of flow is characterized by fluid moving in multiple individual layers that intersect or slide over others. The velocity of the fluid is greater in the center and less in the periphery. A velocity blood gradient in a large glass would be in the shape of a parabola. In a small container, the flow is somewhat fuzzy and the velocity gradient is paraboloid. Turbulent flow is not only less efficient than laminar flow, but it also improves platelet aggregation and thrombus formation. Turbulent flow is created by sharp edges in the blood vessel, changes in direction, sudden changes in vessel size, and uneven endothelial surfaces *(Figure 20)*.

Types of anastomosis

There are three types: end to end, end to side and side to side, which will be explained below:

End-to-end anastomosis: it is the simplest anastomosis concept and consists of the union of two blood vessels in the circumference of their lumen, the cut end of the donor vessel is sutured to the cut end of the recipient vessel. always an anastomosis end to end due to its flow characteristics and technical facility is preferred.[10]

However, an end-to-end anastomosis should not be performed if there is a greater than 50 percent discrepancy in diameter between the two vessels to be joined. In this context, end-to-side anastomosis is preferable. Alexis Carrel, originally described the end-to-end anastomosis for the microvascular anastomosis *(Figure 21)*.

End-to-side anastomosis: an end-to-side anastomosis has many features that could potentially significantly reduce the flow frequently between vessels of unequal size (less energy in and out and creating turbulent flow) however if performed properly this will not it will happen and it will be successful.

A change in flow direction also causes turbulent flow and energy loss. If the lumen of the anastomosis has sharp edges, turbulent flow is also created. These limitations can be minimized by constructing the anastomosis in such a way that an acute angle is formed between two vessels, the smaller vessel dilating to produce a gradual change in size. End-to-side anastomosis is applied in situations where the appropriate size receptor vessels are not available, or the flow pattern of the selected receptor vessel must be maintained rather than sacrificed for the sole purpose of supplying flow to the remaining tissue at the site. of taking the graft. The end-to-side anastomosis is more commonly performed clinically in head and neck reconstruction so that the venous flow from a donor vein goes to the internal jugular vein. To create an end-to-side anastomosis, a venotomy appropriate to the size of the recipient vessel lumen is created slightly larger than the cut end of the donor vessel in an elliptical shape *(Figure 22)*.

End-to-end and end-to-side anastomoses have similar patency rates when performed correctly.[10,58]

The choice of the type of anastomosis is determined by

1. The discrepancy of the size of the vessel.
2. The relative expansion capacity of the receiving vessel.
3. The particular anatomical relationships in the region of the anastomosis.

End-to-end anastomosis can be performed in any recipient vessel that does not have a critical distal vascular distribution and as long as the size discrepancy between the vessels is not greater than 2:1. End-to-side anastomosis is indicated when these conditions are not met.

Postoperative monitoring of the anastomosis

Scheduled observation of the flap by trained personnel during the first days is still considered the best means of postoperative monitoring. A pale flap with poor capillary filling usually indicates an arterial problem, and a blue flap with rapid filling indicates venous obstruction. Muscle flaps with an arterial problem appear dry and flabby, while muscle flaps with venous obstruction appear dark and swollen. In addition, the flap can be punctured with a 20 gauge needle away from the pedicle and the quality of bleeding can be observed. Bright red blood that appears immediately and continues to form after being cleaned is a sign that all is well. No blood flow or serum exudation indicates arterial obstruction, and dark, rapid bleeding indicates venous obstruction. If there is any doubt, it is best to return to the operating room and explore the anastomosis. In addition to monitoring flap color, capillary filling, and temperature, the flap can also be monitored with a portable Doppler.

Microsurgery training protocol that is performed in the CMLALM

Regarding our experience, below, we present a training protocol for the handling of the microscope, instruments, suture and developing the ability to perform the anastomosis, starting from the most basic to the most complex, this being the anastomosis in live animal models.

The first practice is carried out in latex (balloon, rubber dam, gloves) mounted on a square wooden skeleton (tongue depressor), a linear incision is made in the latex and it is used to practice simple stitch, the practices must begin with the handling suture 7-0 and change little by little until reaching a 10-0 suture, in our program 50 simple stitches are performed with 7-0 nylon suture, 50 simple stitches with 8-0 nylon, 50 simple stitches with 10- nylon 0, you can find nylon sutures for practice on the internet, its cost ranges from 87 MXN (4.5 USD) to 100 MXN (5 USD) each, since the 10-0 suture for patients is usually very expensive between 1,200 MXN (60 USD) to 1,500 MXN (75 USD) each.

The second practice is proposed with medical grade silicone tubes, the tubes are available in diameters of 2.0, 1.0, 0.5 and 0.3 mm and the tube walls can have a thickness of 0.05 to 0.1 mm. It should start with diameters of 2.0 and progress to a diameter of 1.0 to refine the skills of the anastomosis, the diameters of 0.5 and 0.1 help the surgeon to adapt to the magnification *(Figure 23)*.

The neurosurgery service of the Tomaya University School of Medicine, Japan,[60] proposes a microsurgical training card, which consists of placing 4 groups of silicone tubes, each group with six tubes of different calibers, each group will be in different position (vertical, horizontal, left oblique and right oblique) which simulates the different positions that a blood vessel could have in a real patient, thus developing the ability to perform anastomosis in different positions and not only in a comfortable position As it is the horizontal, many times in the operating room we cannot move the patient to obtain that horizontal position, we retake that card for microsurgical training and redesign it adding new features, our card has the following characteristics:

A rigid card measuring 21 × 21 cm, each card has 12 sets (each set has six silicone tubes), each set represents a position *(Figure 24)*:

1. Longitudinal without inclination.
2. Longitudinal with posterior inclination.
3. Longitudinal with anterior inclination.
4. Transversal without inclination.
5. Transversal with right inclination.
6. Transverse with left inclination.
7. Diagonal with right drop without inclination.
8. Diagonal with right drop with inclination to the right.
9. Diagonal with drop right with inclination to the left.
10. Diagonal with left drop without inclination.
11. Diagonal with drop left with inclination to the right.
12. Diagonal with drop left with inclination to the left.

The tilt represents an angulation of 15 degrees. There are lines on the back of the card to allow the surgeon to make some annotations.

The practices that must be done in each set are:

1st tube: make a straight line on the tube and make single stitches with 10-0 nylon suture.
2nd tube: end to end anastomosis.
3rd and 4th tube: end to side.
5th and 6th tube: side to side.

The student must finish all the practices on his card to be able to go on to the next practice. Continuous training to perform the anastomosis will allow skills to be improved.

There are other practices with synthetic materials and without the use of a microscope reported in the literature that can help improve suturing skills, and they propose the use of tubes manufactured by the same surgeon with liquid latex giving different calibers to the tube, as well as a magnifying glass with 2.5× magnification and a led desk light lamp, all purchased on internet sales pages, being very easy to access and cheap, giving an option to practice at home.[61] Another option to continue practicing at home is to use of the camera and lamp of an iPad, placing this tool on a support, and developing the sutures in latex materials.[62-65]

With these two practices, the training in synthetic materials is completed and the practices in non-living animal models such as the wing and chicken thigh are completed, in which the blood vessels are dissected and end to end and end to side anastomosis can be done, it is recommended to do a minimum of five of each one to pass to the practice with live animals.

At the end of the practices with a non-living animal model, the practices with live animal models are carried out, taking into account the bioethical

points described above. The procedures that can be performed in live animal models are divided into three modules according to the degree of difficulty, each module lasts one week with a minimum of five practices, below are the procedures performed in each module:

First module: tracheostomy, dissection of the carotid artery, internal jugular vein in which end to end, end to side anastomosis is performed, taking a vascular graft and applying it *(Figure 25)*.

Second module: dissection of the major vein, aorta artery, femoral vein and femoral artery, and in them end to end, end to side anastomosis and porto-major vein shunts are performed *(Figure 26)*.

Third module: kidney transplant, heart transplant and liver transplant.

The diameters of the vessels of living animals models are 1 to 2 mm which helps refine the technique for the anastomosis.[56]

At the end of this anastomosis development training program, you should continue practicing in the microsurgery laboratory at least once a week to continue developing the skills or at home with the proposed methods, then you can move on to the second stage of learning to take microvascular grafts.

CONCLUSIONS

Facial reconstruction has represented a challenge for maxillofacial surgery, therefore all available techniques should be explored to be able to do so, microsurgical techniques coupled with graft taking is an excellent option to solve problems when there are losses of hard tissues and soft, the result of facial trauma, cervicofacial infections, benign and malignant head and neck pathologies among other conditions, however the way to apply these techniques requires special training, remembering that training is not only taking the aforementioned practices. Microsurgical training should be practiced as much as possible and constantly, practicing at least once a week at home or in a microsurgical laboratory. We suggest that microvascular techniques be incorporated into the Academic Programs of the Residencies of the Maxillofacial Surgery Specialty so that the maxillofacial surgeon in training has contact with this type of procedure. At the Medical Center «Lic. Adolfo López Mateos» of the *Instituto de Salud del Estado de México*, Toluca, we have a microsurgery laboratory and it is planned to offer a course on microsurgical techniques, taking and application of microvascular grafts for facial reconstruction for residents and specialists in maxillofacial surgery.

In the Academic Program of the Maxillofacial Surgery Specialty of this Medical Center, three modules of microsurgical techniques were incorporated as of 2019, aimed at residents of the 3rd and 4th year of the specialty. We firmly believe that the Specialty of Maxillofacial Surgery in Mexico should evolve and grow, therefore it is important that trained and training maxillofacial surgeons become familiar with microsurgical reconstruction techniques to offer the best in treatment to our patients.

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Caso clínico

Condromatosis sinovial de la articulación temporomandibular

Synovial chondromatosis of the temporomandibular joint

José Edgar Garduño Mejía,* Claudia Elizabeth Cabrera Arévalo‡

RESUMEN

El presente artículo hace referencia a una revisión bibliográfica de la condromatosis sinovial, siendo esta una patología benigna que se desarrolla a nivel de las articulaciones, con menor incidencia a nivel de la articulación temporomandibular, se han reportado aproximadamente 300 casos desde 1993, con un rango mayor en la quinta década de la vida, predilección al sexo femenino 2:1 con relación al masculino. **Caso clínico:** Se presenta un caso clínico de mujer de la sexta década de la vida con aumento de volumen en región preauricular derecha, asintomática, con antecedente de diabetes mellitus tipo II, a quien se le realiza excisión completa de la lesión, bajo anestesia general balanceada, al momento sin datos de recidiva con seguimiento a un año.

Palabras clave: Condromatosis sinovial, articulación temporomandibular, cartílago hialino.

ABSTRACT

This article refers to a bibliographic review of synovial chondromatosis, this is a benign pathology that develops at the level of the joints, with a lower incidence at the temporomandibular joint, approximately 300 cases have been reported since 1993, with a higher range in the fifth decade of life, predilection for the female sex 2:1 in relation to the male. ***Case report:*** *a female in the sixth decade of life with increased volume in the right preauricular region, asymptomatic, with a history of type II diabetes mellitus, who undergoes complete excision of the lesion, under general anesthesia, at the moment without data of recurrence with follow-up at one year.*

Keywords: *Synovial chondromatosis, temporomandibular joint, hyaline cartilage.*

* Jefe del Servicio de Cirugía Maxilofacial.
‡ Residente de Cuarto año del Servicio de Cirugía Maxilofacial.
Centro Médico «Lic. Adolfo López Mateos»

Correspondencia:
Claudia Elizabeth Cabrera Arévalo
Centro Médico «Lic. Adolfo López Mateos»
Av. Nicolás San Juan, Col. San Lorenzo Tepaltitlán, 50010, Toluca, Estado de México. Tel. 55 8103-6340.
E-mail: claudiaelicabrera@gmail.com

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INTRODUCCIÓN

La condromatosis sinovial es una patología relacionada a las articulaciones del cuerpo, es más común en grandes articulaciones como rodilla, cadera, codo y hombro, y poco común en la articulación temporomandibular.

El primer reporte de esta patología se realiza en el año de 1558 por Ambroise Pare[1] y se documenta a nivel de la articulación temporomandibilar en el año 1993 por Axhausen.[2]

La condromatosis sinovial se puede clasificar en primaria y secundaria, primaria cuando los pacientes no presentan ninguna condición predisponente y secundaria pacientes con antecedentes de trauma, artritis degenerativa, o algún otro desorden.[3]

Se considera una patología benigna de tipo metaplásica, que se caracteriza por la formación de nódulos de cartílago hialino (cuerpos libres), a partir de la membrana sinovial de la articulación temporomandibular, las manifestaciones extraarticulares son poco comunes; sin embargo, existen reportes incluso con extensión a nivel intracraneal.[4]

Si bien su etiología se considera desconocida, se ha visto relacionado con otras condiciones de la articulación como procesos inflamatorios, exceso de función o trauma.

Epidemiología

Rango de edad muy amplio, más común en la quinta década de la vida, según la revisión de casos reportados existe predilección por el sexo femenino 2-1 con relación al masculino.

Características clínicas: aumento de volumen en región preauricular, dolor, crepitaciones, limitación de los movimientos mandibulares.

En algunas ocasiones esta patología se encuentra asintomática, por lo que su diagnóstico sería más complejo y podría tardar meses o incluso años para llegar a él.

Se pueden realizar estudios de imagen complementarios para llegar a un adecuado diagnóstico; de inicio, podría ser una ortopantomografía, en la cual dependiendo del estadio en el que se encuentre, se puede observar la presencia lesiones radiopacas de diferentes tamaños relacionadas a los cuerpos libres en la región de la articulación temporomandibular, irregularidades en el espacio interarticular y alteraciones de la cabeza del cóndilo. Sin embargo, este método diagnóstico puede no ser exacto para dicha patología, ofreciendo mejor efectividad el uso de una tomografía computarizada o resonancia magnética en donde se puede observar una imagen multilobulada en relación con la articulación.

El diagnóstico definitivo de esta lesión se realiza mediante un estudio histopatológico, el cual puede ser mediante artroscopia o mediante una exploración abierta de la articulación.

Las características macroscópicas de la lesión son las siguientes:

1. Múltiples conglomerados de nódulos cartilaginosos (0.1-1 cm).
2. Cuerpos libres.
3. Nódulos osificados.
4. En algunos casos erosión de hueso adyacente.[5]

Características histológicas: Milgram en el año de 1977 clasifica a la condromatosis sinovial en tres estadios dependiendo de sus características histopatológicas, siendo ésta de importancia para determinar lo agresivo que debe ser el tratamiento al momento de su abordaje para evitar la recurrencia del mismo.

Estadio 1: metaplasia de la membrana sinovial, sin la presencia de cuerpos libres.
Estadio 2: separación de cuerpos libres, condrocitos activos.
Estadio 3: sin presencia de metaplasia, calcificación de cuerpos libres.[6]

Estudios de imagen

Son indispensables para el diagnóstico de esta patología, debido a que en ocasiones los pacientes se encuentran asintomáticos, los estudios usuales para esta patología son la tomografía computarizada y la resonancia magnética.

Noyek y colaboradores describen cinco características radiográficas de la condromatosis sinovial en articulación temporomandibular:

1. Ensanchamiento del espacio de la articulación.
2. Movimientos limitados.
3. Superficie articular irregular.
4. Presencia de cuerpos libres calcificados.
5. Esclerosis de la fosa glenoidea o del cóndilo mandibular.[3]

Tratamiento

El tratamiento adecuado para este tipo de patologías hace referencia al grado de afectación que tiene,

Figura 1: Fotografía frontal y de perfil derecho.

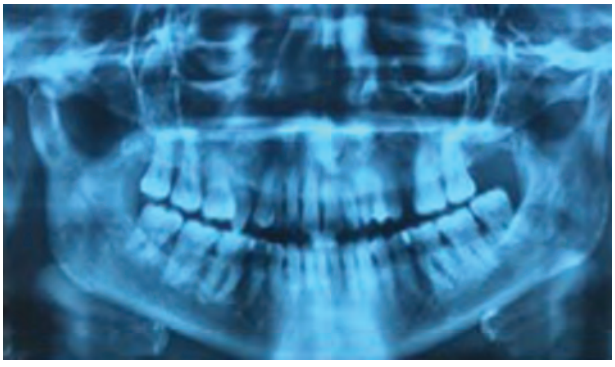

Figura 2: Ortopantomografía.

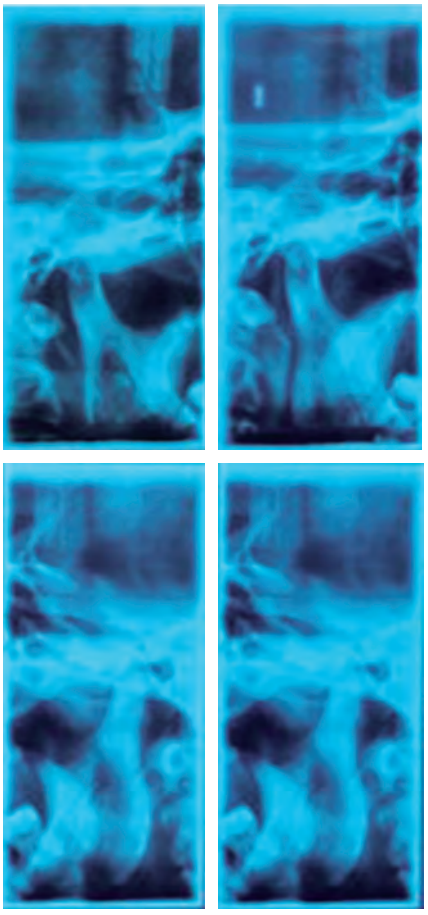

Figura 3:

Schüller dinámica.

tomando en cuenta que muchas veces puede limitarse a la membrana sinovial, existiendo casos en los que se extiende a tejido óseo, llegando hasta la afectación del cóndilo o de superficies articulares, por lo que se puede considerar sinovectomía hasta condilectomía.

PRESENTACIÓN DEL CASO

Se trata de una mujer de 59 años con antecedente de diabetes mellitus tipo II, quien inicia su padecimiento en diciembre de 2018 con aumento de volumen en región preauricular derecha *(Figura 1)*, la cual se mostraba asintomática al dolor y con adecuada función masticatoria, después es referida a hospital de primer contacto donde se le realiza valoración por tumoración, solicitan estudios de imagen y se envía a nuestro Centro Médico «Lic. Adolfo López Mateos», Toluca, Estado de México, para valoración por parte del servicio de Cirugía Maxilofacial para realizar manejo adecuado.

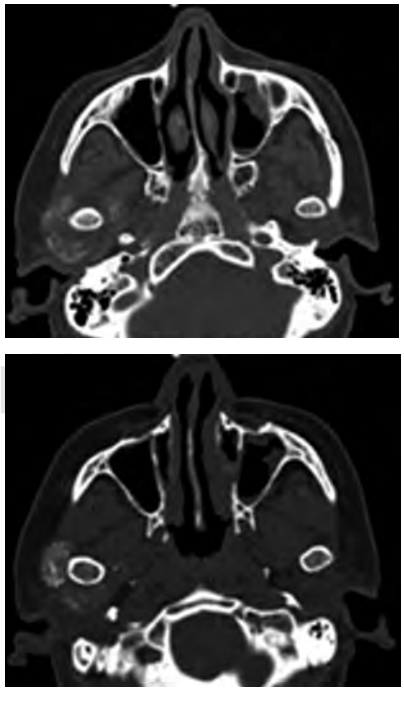

Figura 4:

Tomografía simple de cráneo, cortes axiales.

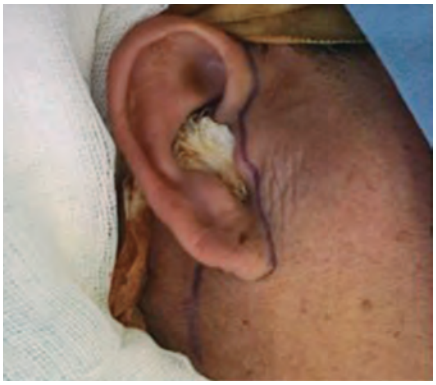

Figura 5:

Marcaje del abordaje endaural.

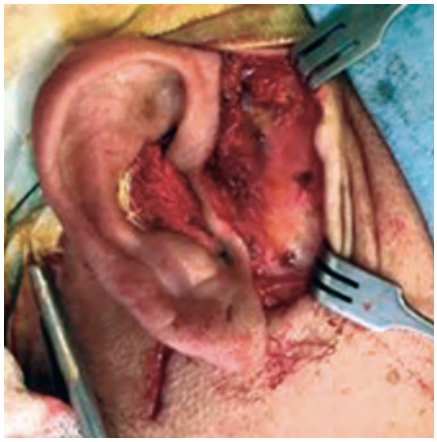

Figura 6:

Incisión y disección de piel.

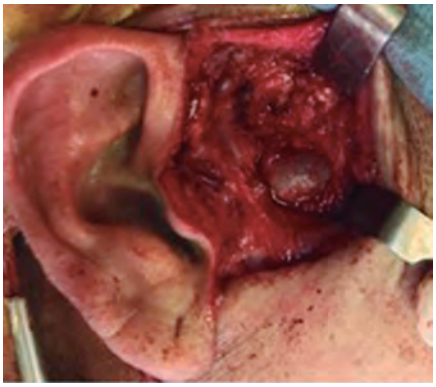

Figura 7:

Exposición de articulación temporiman-dibular.

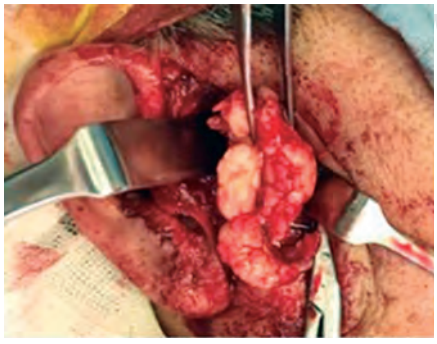

Figura 8:

Disección de la lesión.

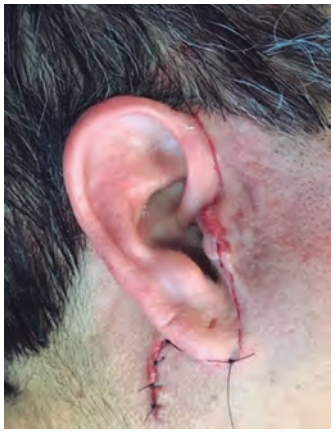

Figura 9:

Cierre de abordaje.

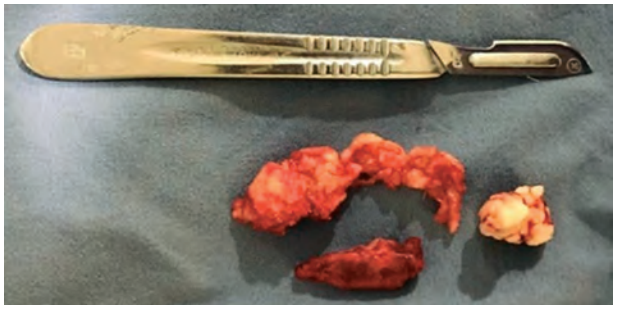

Figura 10: Muestra histopatológica.

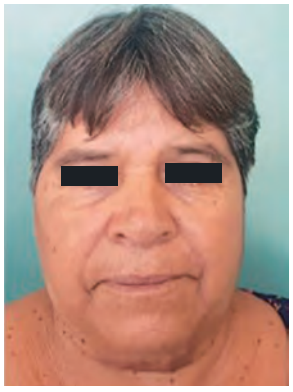

Figura 11:

Fotografía postquirúrgica frontal.

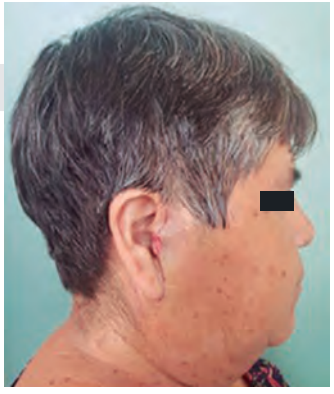

Figura 12:

Fotografía postquirúrgica lateral (dos semanas).

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Se solicitan estudios complementarios, análisis de laboratorio, los cuales se encuentran dentro de parámetros normales, así como ortopantomografía *(Figura 2)* en la cual no se observan datos radiográficos de alteraciones, al igual que en la radiografía Schüller dinámica *(Figura 3)* sin datos radiográficos de lesión. Por lo que se decide solicitar una tomografía simple en donde se observa una imagen relevante en cortes axiales de lesiones hiperdensas a tejidos blandos, rodeando el cóndilo mandibular del lado derecho *(Figura 4)*, sin cambios aparentes a nivel óseo, bien delimitado.

Se inicia la planeación quirúrgica y se decide realizar biopsia excisional de la lesión para confirmación diagnóstica mediante estudio histopatológico, bajo anestesia general balanceada con intubación orotraqueal, previa asepsia y antisepsia se delimita el campo quirúrgico, se protege el conducto auditivo externo con una gasa, con tracción digital de la región preauricular derecha se realiza marcaje de arriba hacia abajo comenzando en la circunferencia del hélix, extendiéndonos endauralmente por la superficie interna del trago hasta la unión con el lóbulo de la oreja[7] *(Figura 5)*, en este caso se realizó una extensión retroauricular. Se infiltra lidocaína con epinefrina de 2% en la región preauricular para mayor vasoconstricción. Realizamos incisión con hoja de bisturí número 15, se diseca por planos iniciando por piel, tejido celular subcutáneo, fascia temporal superficial, teniendo en cuenta que a este nivel encontramos las ramas del nervio facial, se continúa hasta llegar a la cápsula articular, en donde se observa la lesión bien delimitada en el compartimiento superior de la articulación *(Figuras 6 a 8)*. Se valora la adecuada función de la articulación, correcta migración del cóndilo en la cavidad glenoidea, se posiciona el disco articular y se realiza cierre de planos profundos, a nivel de piel se colocan puntos subdérmicos *(Figura 9)*. Se obtiene la muestra completa de aproximadamente 4.5 × 2 × 1 cm *(Figura 10)*, y se envía para estudio histopatológico el cual reporta: «en los cortes histológicos examinados se observa membrana sinovial con hiperplasia de la íntima y que en la subíntima presenta múltiples nódulos compuestos por cartílago hialino maduro. Algunas áreas son hipercelulares con atipia leve de los condrocitos. Entremezclado con áreas de osificación y otras de aspecto mixoide». Con diagnóstico de condromatosis sinovial.

La paciente lleva seguimiento a un año, en donde se observa adecuada evolución, movimientos mandibulares conservados, simetría facial, sin alteración al nervio facial por el tipo de abordaje que se realizó y estéticamente su cicatriz es imperceptible *(Figuras 11 y 12)*.

DISCUSIÓN

La etiología de la condromatosis sinovial aún no es clara, aunque existen reportes de casos dados por trauma, parafunciones e infecciones; sin embargo, muchos casos no presentan una historia clara siendo asintomáticos.[8] Algunos trabajos sugieren que el factor de crecimiento de los fibroblastos 2 (FGF-2) es producido por los condrocitos y se une al receptor 1 del factor de crecimiento de los fibroblastos (FGFR-1), contribuyendo al crecimiento celular a través de una vía autocrina o paracrina.[9] La tríada diagnóstica para esta patología es restricción de movimientos articulares (65%), dolor (57%) e hinchazón (46.5%);[3] estos síntomas no siempre están presentes, sobre todo en estadios tempranos, es importante mencionar que por lo general esta patología se encuentra en el compartimiento superior de la articulación temporomandibular, invadiendo el inferior únicamente cuando ya se ha presentado una perforación del disco articular debido a que estos compartimientos son pequeños, el crecimiento se convierte extracapsular y generan aumento de volumen en región preauricular.[3,8,9] Con relación a la revisión de nuestro caso clínico, no se presentaron todos los síntomas, sólo aumento de volumen, sin limitación a movimientos ni dolor, lo que muchas veces dificulta el diagnóstico, en algunas ocasiones cuando la patología va iniciando no puede ser diagnosticada por medios radiográficos, incluso tomográficos, o pueden ser confundidos con otras patologías de la articulación, la resonancia magnética será considerada el instrumento diagnóstico ideal.[10]

El tratamiento para esta patología dependerá del estadio en el que se encuentre y de la invasión que tenga hacia otros tejidos, se han descrito tratamientos con artroscopia cuando se limita únicamente a lesiones intracapsulares,[10,11] y hasta sinovectomía o condilectomía cuando invaden la membrana sinovial o incluso provocan erosión del cóndilo articular; en cuanto a nuestro caso, se decide realizar excusión quirúrgica total de la lesión conservando estructuras óseas, debido a que no se observa tomográficamente invasión de las mismas y se continúa con vigilancia postquirúrgica en caso de recidiva, la cual se considera poco común.[6,12,13]

CONCLUSIONES

La condromatosis sinovial es una patología poco frecuente, sobre todo a nivel de la articulación temporomandibular, por lo que un buen diagnóstico nos ayudará a llevar a cabo un adecuado plan quirúrgico que nos permita devolver la calidad de vida al paciente, y aunque la recidiva parece ser infrecuente, se debe mantener en constante monitorización.

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Clinical case

Hybrid lesion: management of an unusual pathology

Lesión híbrida: manejo de una patología inusual

Alejandro Alonso-Moctezuma,* Verónica Rivas-Barrionuevo,‡ Fabiola Salgado-Chavarría,§ Carla Monserrat Ramírez Martínez,¶ Carlos Eduardo Jiménez-Jarquin‖

ABSTRACT

Hybrid lesions are considered a rare pathology that present elements of different entities, each of which have a tumor category. There are currently less than ten reported cases of hybrid lesions showing association of a central giant cell lesion and an ossifying fibroma. Since a treatment protocol for this type of pathologies is not well established in the literature, we present a case of integral management, including rehabilitation, based on the review of the literature. This is a 31-year-old female patient with an initial diagnosis of central giant cell lesion in the left mandibular body, who was treated with intralesional triamcinolone, finding no response after six weeks of treatment, so we decided to do a block resection of the lesion and simultaneous reconstruction with a free anterior iliac crest graft, obtaining a definitive histopathological result of a hybrid lesion (central giant cell lesion plus ossifying fibroma), later implant-supported prosthetic rehabilitation was performed. In cases of hybrid lesions, we consider that surgical management is adequate, given the particular behavior of said entity that does not respond adequately to pharmacological management, we recommend avoiding the use of antiresorptive medications since it would prejudice

RESUMEN

Las lesiones híbridas se consideran una patología rara que presenta elementos de diferentes entidades, cada una de las cuales tiene una categoría tumoral. En la actualidad hay menos de diez casos notificados de lesiones híbridas que muestran la asociación de una lesión central de células gigantes y un fibroma osificante. Dado que un protocolo de tratamiento para este tipo de patologías no está bien establecido en la literatura, presentamos un caso de manejo integral, incluyendo la rehabilitación, basado en la revisión de la literatura. Se trata de una paciente de 31 años con un diagnóstico inicial de lesión central de células gigantes en el cuerpo mandibular izquierdo, que fue tratada con triamcinolona intralesional, sin encontrar respuesta tras seis semanas de tratamiento, por lo que decidimos realizar una resección en bloque de la lesión y la reconstrucción simultánea con un injerto libre de cresta ilíaca anterior, obteniendo un resultado histopatológico definitivo de lesión híbrida (lesión central de células gigantes más fibroma osificante), posteriormente se realizó una rehabilitación protésica implantosoportada. En los casos de lesiones híbridas, consideramos que el manejo quirúrgico es adecuado, dado el comportamiento particular de dicha entidad que no responde adecuadamente al manejo farmacológico, recomendamos evitar el uso de

* MSc. Department Head of the Oral and Maxillofacial Surgery Department, National Autonomous University of Mexico. Mexico.
‡ Private practice oral and Maxillofacial Surgery.
§ PhD. Research Responsible in the Oral and Maxillofacial Surgery Department, National Autonomous University of Mexico. Mexico.
¶ MSc. Professor in the Pathology and Buccal Medicine Department, National Autonomous University of Mexico. Mexico.
‖ MSc Professor of the Specialty in Oral Prosthetics at the Latinoamerican University, North Campus.

Correspondence:
Alejandro Alonso-Moctezuma
E-mail: alonsomoctezuma@fo.odonto.unam.mx

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the result of a subsequent surgical and reconstructive treatment.

Keywords: Central giant cell lesion, hybrid lesion, anterior iliac crest free graft, implant-supported rehabilitation.

medicamentos antirresortivos ya que perjudicaría el resultado de un tratamiento quirúrgico y reconstructivo posterior.

Palabras clave: *Lesión central de células gigantes, lesión híbrida, injerto libre de cresta ilíaca anterior, rehabilitación con implantes.*

INTRODUCTION

Hybrid lesions are extraordinarily rare entities that present elements of different pathologies, each of which have a tumor category.[1,2] There are currently less than ten cases reported of hybrid lesions showing association of a central giant cell lesion (CGCL) and a ossifying fibroma (OF). The World Health Organization in 2017 defines CGCL as a benign osteolytic proliferation, but sometimes locally aggressive, consisting of giant multinucleated osteoclast-type cells in a fibrous tissue stroma with hemorrhagic deposits and hemosiderin.[3] OF is defined as a benign bone neoplasm that affects the facial skeleton,[3] it has been divided into conventional OF, also called cement-ossifying fibroma and juvenile OF, which is subdivided into trabecular and psammomatoid *(Figure 1)*.[4] Within the possible pathogenesis of hybrid lesions involving giant cells, it is suggested that CGCL associated with fibrous lesions may be the product of a secondary reaction in response to changes in the original stroma of the lesion, where theoretically there is an activation of the osteoclasts as well as their successive transformation in to multinucleated giant cells all this mediated by paracrine mechanisms.[5] Objective: management of these injuries have not been established to the present day, since cases reported in the literature are scarce,[1,2,5,6] therefore, the objective of this article is to present a case and it's integral treatment of this pathology, based on the review of the literature.

CLINICAL CASE

A 31-year-old female attended our office referred by her orthodontist due to a radiographic finding of a unilocular radiolucident image of approximately 3.5 cm with radiopaque areas and a sclerotic halo, located in the region of the left mandibular body. At the physical examination it presents its dental formula complete, oral mucous with adequate coloration and hydration, absence of dental mobility, without volume increase in it's left mandibular region, the patient denies sensory changes *(Figure 2)*. At the presurgical assessment no alterations were observed; exploratory puncture was performed (without obtaining material), incisional biopsy was subsequently carried out, with the histopathological result compatible with CGCL, which is why parathyroid profile, calcium and phosphate were requested, the results were found within normal parameters, ruling out the diagnosis of a brown tumor. We began with a weekly protocol infiltrating 1 cm^3 composed of a mixture of triamcinolone and 2% lidocaine with epinephrine 1: 100,000 (in a 50/50 ratio) for every cubic centimeter of lesion. After two months of infiltrative treatment, no changes in it's radiographic characteristics were observed, so we decided to escalate to a surgical management. Under the effects of balanced general anesthesia, marginal mandibular resection of approximately 4.5 cm was performed, with simultaneous application of a free anterior iliac crest graft and reconstruction plate placement *(Figure 3)*. The surgical piece was sent for it's histopathological study *(Figure 4)* which reported: a proliferation of a well-vascularized mesenchymal tissue, with the presence of abundant giant cells of foreign body type on a stroma of mononuclear cells, transition areas with a proliferation of cells tapered with bone metaplasia, some with osteoblastic edging and areas with different degrees of basophilia. The definitive diagnosis was: central giant cell lesion (CGCL) with ossifying fibroma (OF). Three weeks after the surgery, the patient presented graft exposure, which was managed with antibiotic therapy, strict oral hygiene, use of chlorhexidine gel and endodontic treatment of the following teeth: central incisor, lateral incisor and second lower left molar, which presented pulp necrosis. The therapeutics used allowed the closure of the exposure by second intention (granulation tissue). After six months of evolution, we observed a loss of 50% in bone volume of the reconstructed area, so we decided to perform guided bone regeneration using lyophilized human graft, platelet-rich plasma and titanium mesh (under local anesthesia); the left lower lateral incisor was removed by grade III mobility; the patient evolved satisfactorily. Subsequently,

a rehabilitation protocol was performed using an implant-supported prosthesis with five implants (DIO, Korea) *(Figure 5)*. Currently, the patient is coursing her third year after surgery with no evidence of recurrence.

DISCUSSION

The CGCL were initially described as an analogous lesions of the ones found in long bones, later Jaffe called them «giant cell reparative granuloma», a term that was used for many years; however, because it show no repair characteristics this term was omitted.[7] These represent the 7-10% of maxillary lesions, showing a predilection for the female gender and being more prevalent before the age of 30. The most frequent site of appearance is the jaw with balanced distribution between the anterior and posterior region; when they appear in the maxilla they are predominantly located in the anterior region.[3,8] CGCL have been classified as aggressive and non-aggressive lesions, Chuong described in 1986 the clinical and histopathological characteristics of each of them. Non-aggressive lesions are asymptomatic and are usually diagnosed as a radiological finding, on the other hand, aggressive lesions are associated with pain, increased volume, sensory abnormalities, cortical perforation and root resorption.[9] For the management of CGCL it is important to consider the possible relationship that they may present with endocrine alterations characterized by the increased of paratohormone secretion, defined as hyperparathyroidism.[10] Less than 2% of this pathology cases debuted with bone lesions in the facial skeleton, known as brown tumor,[11] however it is pertinent to discard this diagnosis by laboratory studies prior to the establishment of a surgical or pharmacological treatment. The treatment of CGCL depends on their clinical aggressiveness. Within the therapeutic options we find different types like surgical, pharmacological, radiotherapy and combined treatment. Other surgical management options have been described for mandibular lesions like curettage with or without adjuvant therapy such as cryosurgery, peripheral osteotomy and Carnoy solution,[12] in aggressive cases the resection with 5 mm margins is recommended; since the lesion is not characterized by presenting invasion to the perineural tissue the preservation of the inferior alveolar nerve should be considered, performing skeletonization if necessary.[13,14] Calcitonin agents (nasal and infiltrated), triamcinolone with different protocols, pegylated and non-pegylated interferon alpha and denosumab[15] have been used as pharmacological agents, with a role in the treatment of aggressive and non-aggressive lesions, limiting their progression in long term follow-up and decreasing the morbidity of surgical treatment.[14] In our case, when obtaining the initial histopathological result of CGCL and given the non-aggressive behavior of the lesion, we initially opted for pharmacological therapy with triamcinolone, since there is evidence in the scientific literature of total remission of lesions in a period of six weeks;[13] the response to the intralesional steroid has been related to the amount of glucocorticoid receptors present in multinucleated giant cells, with a better response to a greater number of receptors,[16] however there was no remission or reduction in our case, so we decided to perform a surgical treatment obtaining the definitive histopathological result of hybrid lesion. We associate the failure of the initial pharmacological

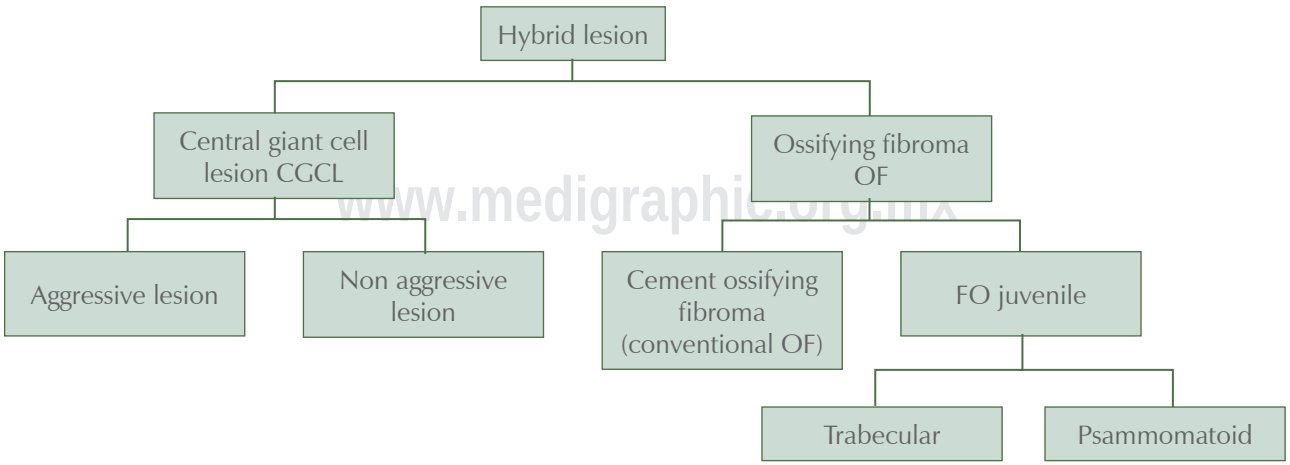

Figure 1: Central giant cell lesion and ossifying fibroma classification.

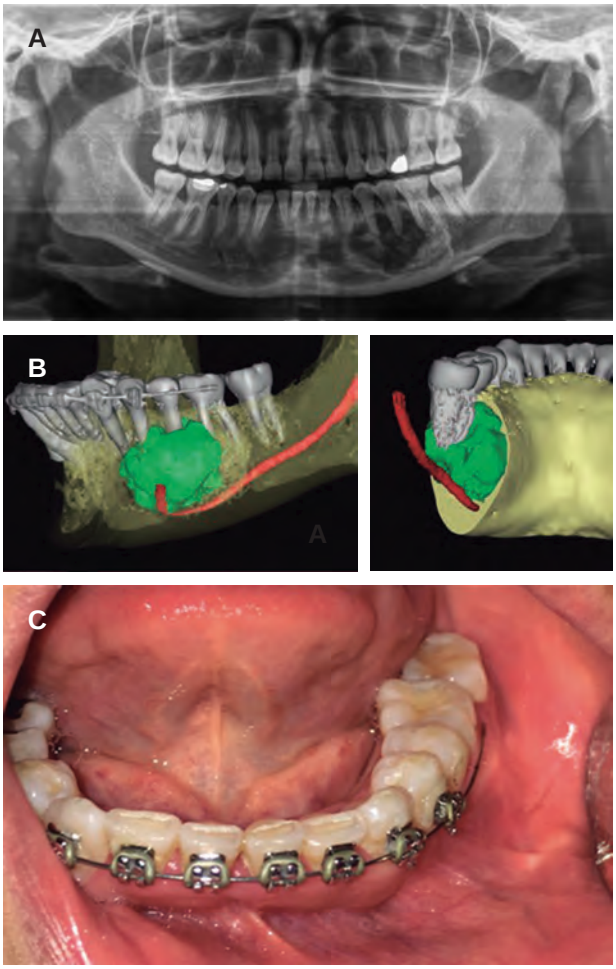

Figure 2: Clinical and imagenologic findings. **A)** Orthopantomography showing osteolytic area in the left mandibular body. **B)** Volumetric reconstruction of the same lesion. **C)** Clinical image, not showing changes in the oral mucosa, or apparent increase in volume in the left mandibular body.

therapy with the presence of cells of different lines in the same pathology. Hybrid lesions of CGCL with other entities such as: odontogenic fibroma,[17,18] aneurysmal bone cyst,[19] fibrous lesions,[5,20,21] ameloblastoma[2,22] and keratocystic odontogenic tumor[23] have been described. Based on the published cases of hybrid lesions of CGCL and OF,[1,2,5,6] a higher frequency is observed in the female gender with five cases, appearing between the ages five to 68 years, with five cases reported in the mandible with a predominance in the posterior region, Kaplan reported the recurrence of one of his cases at a three years follow-up,[2,6] these data is consistent with the characteristics of our patient, which has not presented recurrence at two years follow-up. The differential diagnosis of these lesions is a challenge because they do not have a well-defined behavior.[1] Surgical treatment was proposed in the published cases, in case of marginal mandibular resections, the objective of the reconstruction is to achieve the placement of implants to allow prosthetic rehabilitation. The treatment used for the reconstruction of our patient was a free anterior iliac crest graft, due to literature recommendation of the use of free grafts for defects less than 5 mm. The anterior iliac crest is an adequate source of corticospongeous graft allowing osseointegration of dental implants,[24,25] with survival and success rates of 96.7% and 93.3% respectively.[26] Infection, dehiscence and graft loss, are among the most common complications associated with free grafts for mandibular reconstruction, with a success

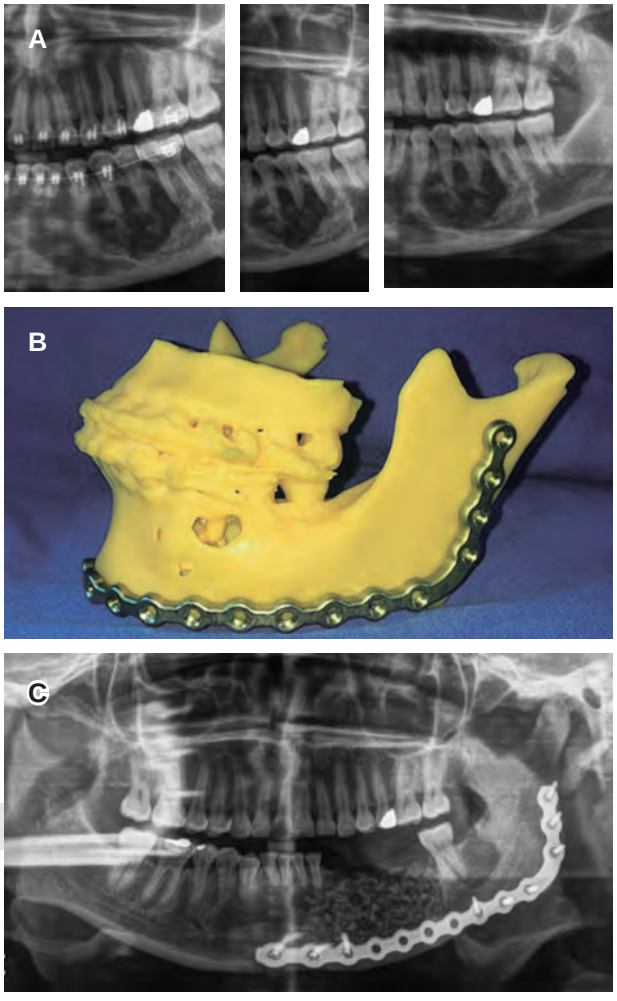

Figure 3: A) Initial comparative orthopantomography, one month and six weeks after infiltration with triamcinolone. **B)** Stereolithography used for adaptation of reconstruction plate. **C)** Immediate postresection and reconstruction image.

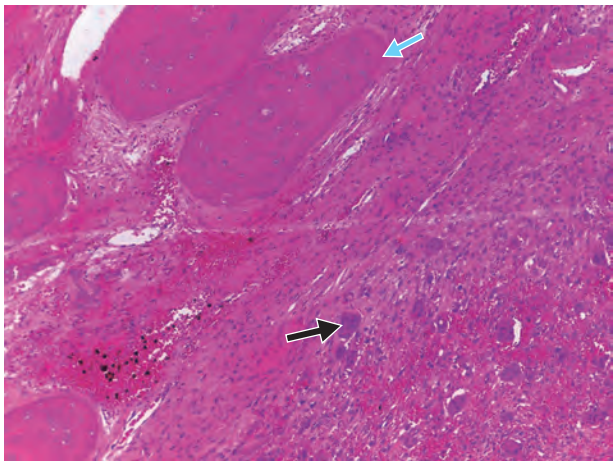

Figure 4: H&E 100× photomicrograph showing a collision tumor consisting of a giant multinucleated cells proliferation (black arrow), separated by a fibroconnective tissue band from a fibro-osseous component displaying osteoid-like material and abundant fibroblasts (blue arrow) consistent with ossifying fibroma.

rate of 87.6%.[27] In our case, graft exposure was presented, in association with a tooth that presented pulp necrosis neighboring the defect, which was solved with endodontics of the teeth involved. In the literature there is different data regarding the reabsorption of free grafts prior to implant placement,[26,28-30] Chiapasco in his publication reports that it is higher in free grafts when compared with microvascularized grafts (3.53 mm vs 0.96 mm), however, this difference is no longer significant after the placement of dental implants;[26] Wilkman, in his study, presented a 2% reabsorption of the anterior iliac crest graft in the first year and a 3% reabsorption in the second year;[31] in our case we lost approximately 50% of the graft in two months, so lyophilized human graft was placed to solve this complication. One year after this procedure, implant placement and rehabilitation was performed without complications. After two years follow-up no evidence of recurrence was seen, and the recovery of the masticatory function was achieved, improving patients life quality.

CONCLUSIONS

Hybrid lesions may not respond to pharmacological management, so surgical treatment should be considered the first option. We recommend avoiding the use of antiresorptive medication, because it could impair the results of a posterior surgical and reconstructive treatment. Immediate reconstruction with a free anterior iliac crest graft is a predictable option in defects less than 5 cm, it is known that this

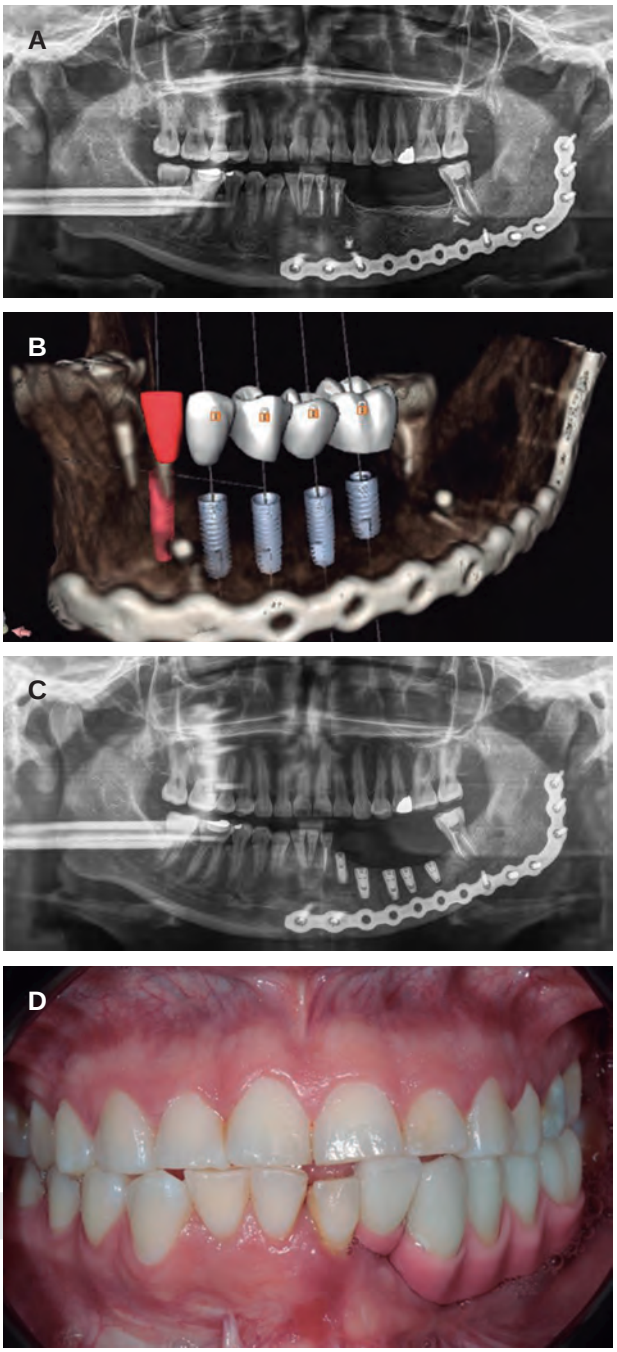

Figure 5: A) Orthopantomography after lyophilized bone graft and titanium mesh placement. **B)** Three-dimensional planning for implant placement. **C)** Control orthopantomography after dental implant placement. **D)** Implant supported overdenture.

option is not a complication free procedure which can be solved with the use of adjuvant grafts. The supported implant prosthetic rehabilitation allows to maintain the patient's masticatory function and quality of life. Finally, close monitoring is essential to detect possible recurrences and give them timely treatment.

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Caso clínico

Rehabilitación de maxilar atrófico con implantes cigomáticos. Presentación de un caso y revisión de la literatura

Rehabilitation of atrophic maxilla with zygomatic implants. Case report and literature review

Juan Peña Lares,* Osmar Adán Cárcamo Idiáquez,‡ Eliot Samuel Velázquez Varela,§ Israel Vivanco Pérez,¶ Adolfo Navarro Zárate,‖ Martín Gilberto Flores Ávila, Gerardo Romero Jasso‡‡**

RESUMEN

Introducción: La rehabilitación estética y funcional en pacientes con secuelas por resección de neoplasias, traumatismos o malformaciones congénitas de la región maxilofacial, así como pacientes con maxilares atróficos por otras causas, es un reto para cirujanos maxilofaciales y rehabilitadores orales debido a la limitada cantidad y

ABSTRACT

Introduction: *Aesthetic and functional rehabilitation in patients with sequelae due to resection of neoplasms, trauma or congenital malformations of the maxillofacial region, as well as patients with atrophic jaws due to other causes, is a challenge for maxillofacial surgeons and oral rehabilitators due to the limited quantity and quality of*

* Cirujano maxilofacial en Hospital Christus Muguerza UPAEP. Puebla, Puebla, México. Profesor colaborador del postgrado de Cirugía Maxilofacial, Hospital Universitario de Puebla. Benemérita Universidad Autónoma de Puebla. Puebla, Puebla, México.
‡ Médico residente de cuarto año Cirugía Maxilofacial, Hospital Universitario de Puebla. Benemérita Universidad Autónoma de Puebla. Puebla, Puebla, México.
§ Cirujano maxilofacial, práctica privada en consultorio CECMI. León, Guanajuato, México.
¶ Cirujano maxilofacial, Jefe de Servicio y Profesor Titular del postgrado de Cirugía Maxilofacial, Hospital Universitario de Puebla. Benemérita Universidad Autónoma de Puebla. Puebla, Puebla, México.
‖ Cirujano maxilofacial, médico adscrito y profesor adjunto del postgrado de Cirugía Maxilofacial, Hospital Universitario de Puebla. Benemérita Universidad Autónoma de Puebla. Puebla, Puebla, México.
** Cirujano maxilofacial, médico adscrito al Servicio de Cirugía Maxilofacial, Hospital Regional «Lic. Adolfo López Mateos», ISSSTE. Ciudad de México, México.
‡‡ Cirujano maxilofacial, práctica privada, Ciudad de México, México.

Correspondencia:
Juan Peña Lares
Dirección: Av. 5 Pte. 715, Col. Centro, 72000,
Puebla, Puebla, México, Tel: 01 222 229-8100.
E-mail: maxilofacial@penalares.com

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calidad de hueso remanente en el proceso alveolar maxilar residual. Los implantes cigomáticos son una opción efectiva y definitiva en el manejo de este tipo de pacientes y su objetivo será proporcionar una retención en la región maxilar posterior en un paciente que no es candidato para la colocación de implantes convencionales debido a la atrofia maxilar, lo que le permitirá una rehabilitación integral con menor grado de morbilidad y en menos tiempo, evitando así procedimientos de injertos óseos. **Caso clínico:** Se presenta el caso de una paciente de 61 años de edad con diagnóstico de atrofia maxilar severa en zonas 1-2-3 según Bedrossian, a quien se le realiza protocolo de rehabilitación con cuatro implantes cigomáticos con carga inmediata. Actualmente la paciente se encuentra asintomática y en espera de prótesis definitiva. **Conclusión:** Los implantes cigomáticos son un recurso que proporciona una solución predecible y rápida al problema de déficit óseo como resultado de una atrofia maxilar o maxilectomía, el implante cigomático no conlleva mayor complejidad protésica para el paciente y ha mostrado resultados clínicos superiores en comparación con el injerto óseo, por lo que representan un nuevo «estándar de oro» en cuanto al tratamiento de los huesos maxilares comprometidos.

Palabras clave: Atrofia maxilar, rehabilitación protésica, implantes cigomáticos, carga inmediata.

bone remaining in the residual maxillary alveolar process. Zygomatic implants are an effective and definitive option in the management of this type of patients and their objective is to provide retention in the posterior maxillary region, in a patient who is not a candidate for the placement of conventional implants due to maxillary atrophy, which will allow an integral rehabilitation with less morbidity and in less time, thus avoiding bone grafting procedures. ***Clinical case:*** *We present the case of a 61-year-old female patient with a diagnosis of severe maxillary atrophy in zones 1-2-3 according to Bedrossian, who underwent a rehabilitation protocol with 4 zygomatic implants with immediate loading. Currently the patient is asymptomatic and awaiting definitive prosthesis.* ***Conclusion:*** *Zygomatic implants are a resource that provides a predictable and rapid solution to the problem of bone deficit as a result of maxillary atrophy or maxillectomy, the zygomatic implant does not entail greater prosthetic complexity for the patient and has shown superior clinical results compared to bone grafting, thus representing a new gold-standard in the treatment of compromised maxillary bones.*

Keywords: *Maxillary atrophy, prosthetic rehabilitation, zygomatic implants, immediate loading.*

INTRODUCCIÓN

Los pacientes con secuelas por traumatismos, resección de neoplasias o malformaciones congénitas de la región maxilofacial, así como los pacientes con atrofia maxilar severa por diferentes etiologías (edad avanzada, pérdida dental no traumática, utilización de prótesis totales por largos periodos, neumatización de senos maxilares) representan un reto para la rehabilitación estética y funcional con implantes dentales convencionales debido a la limitada cantidad y calidad de hueso remanente. El implante cigomático fue introducido por Branemark para la rehabilitación protésica en pacientes con defectos maxilares extensos secundarios a resecciones tumorales, traumatismos y defectos congénitos. Branemark e Higuchi en 1999 reportaron un paciente con secuelas postmaxilectomía rehabilitado con un implante cigomático, a partir de ese reporte numerosos estudios se han realizado demostrando que los implantes cigomáticos son una opción efectiva para la rehabilitación de los casos con déficit óseo maxilar. El objetivo del implante cigomático es proporcionar una retención en la región maxilar posterior en un paciente que no es candidato para la colocación de implantes convencionales en esa zona, la utilización del hueso cigomático como un sitio de anclaje para implantes reduce la morbilidad quirúrgica y simplifica el tratamiento de rehabilitación en este tipo de pacientes.[1-3] El hueso cigomático es un hueso par localizado en la región antero-lateral del esqueleto facial, el cual forma parte del piso y pared lateral orbitaria así como del techo del seno maxilar. Las dimensiones del cuerpo del hueso cigomático a nivel medio-lateral son de 7.6 mm en hombres y 8 mm en mujeres. A nivel anteroposterior 25.4 mm en hombres y 24.9 mm en mujeres y su espesor cortical lateral es de 1.75 mm en hombres y 1.71 mm en mujeres. Su función es transmitir las fuerzas masticatorias, éste no sufre cambios morfológicos aun en presencia de atrofia maxilar severa. La estabilidad inicial del implante cigomático se deriva de la retención mecánica entre la superficie del implante y el tejido óseo. Nkenke y colaboradores concluyeron que el hueso trabecular del cigomático no era favorable para la colocación de implantes y sugirieron que el éxito observado con los implantes cigomáticos es probablemente el resultado de la participación de cuatro corticales (cortical palatina, cortical del piso del seno maxilar en la porción crestal del implante y las corticales óseas cigomáticas en el ápice del implante).[4-6]

El implante cigomático tiene una longitud de 30-55 mm, un diámetro desde 4 mm a nivel apical hasta 5 mm a nivel crestal. La integración del implante se produce en el cuerpo del hueso cigomático (longitud integrada de 15 a 20 mm). La trayectoria del implante recorre la cresta del contrafuerte cigomático-maxilar y su cabeza hexagonal externa aparece en el área correspondiente al primer molar y segundo premolar. La porción protésica o cabeza del implante se encuentra angulada a 45 grados (Nobelbiocare, Zürich, Suiza) o 55 grados (Southern Implants, Irene, Sudáfrica) para orientarlo lo más paralelo posible al plano oclusal. Los implantes son autorroscables y pueden ser de superficie roscada y texturizada, roscada no texturizada o lisos con roscas apicales. La longitud del implante hace inapropiada su rehabilitación sin la utilización de un conector transversal rígido, el cual permitirá estabilizarlo así como distribuir y compartir la carga oclusal.[7,8]

El estudio auxiliar para el diagnóstico y planificación quirúrgica es la tomografía computarizada (TC) helicoidal, pero el bajo costo y los niveles muy bajos de radiación asociados con la TC de haz cónico hacen que esta última sea preferible. La TC es crucial para evaluar el estado sinusal, la cantidad de hueso cigomático y alveolar residual, la trayectoria y angulación, el sitio de colocación y de emergencia del implante así como la relación del cuerpo del implante con el seno maxilar y su pared lateral.[9,10]

Las ventajas de los implantes cigomáticos en un paciente con atrofia maxilar incluyen la capacidad de rehabilitación con menor morbilidad y en menos tiempo, evitando así procedimientos de injerto óseo. En el protocolo original el procedimiento se realiza en dos etapas, para lo cual después de seis meses de oseointegración se retira la prótesis provisional y se comprueba la estabilidad de los implantes. La oseointegración se confirma al no existir movilidad de los implantes con la técnica de par reverso (10 Ncm), igualmente si no presenta sensibilidad durante la percusión. Una vez determinada la oseointegración el paciente está listo para la fabricación de una prótesis perfilada acrílica o una prótesis perfilada de metal-acrílico usando dientes de resina. Sin embargo, el protocolo original fue reemplazado por uno de carga inmediata con buenos resultados a largo plazo. El criterio para la carga inmediata es tener un mínimo de 40 Ncm de torque de inserción de los implantes cigomáticos.[11,12]

Las desventajas del procedimiento quirúrgico incluyen una disección más extensa, la experiencia del operador, conocimiento de la anatomía sinusal, cigomática y orbitaria así como la necesidad de anestesia general o local con sedación para su realización.

Los implantes cigomáticos están indicados en los pacientes con defectos óseos maxilares, ya sea por secuelas de traumatismos, resección de neoplasias, malformaciones congénitas así como pacientes con atrofia maxilar severa. La principal indicación es pacientes completamente desdentados con neumatización significativa del seno maxilar y atrofia severa del reborde alveolar que requieran soporte maxilar posterior para su rehabilitación integral. También se indican para el tratamiento de pacientes en los que han fracasado los implantes convencionales y/o procedimientos de injertos óseos. Los pacientes con atrofia maxilar son a menudo de edad avanzada y pueden tener comorbilidades que los hacen mejores candidatos para una sola etapa quirúrgica y de rehabilitación.[10] Bedrossian y colaboradores[13] clasificaron el maxilar en tres zonas de atrofia potencial, las cuales pueden ser unilaterales o bilaterales, lo que nos permite entender qué pacientes son candidatos para ser rehabilitados con implantes cigomáticos. *(Tabla 1 y Figura 1)*. Las contraindicaciones se pueden clasificar en definitivas y relativas. Dentro de las primeras se incluyen patología sinusal aguda, limitación de apertura oral, contraindicación médica que no permita sedación, anestesia general o cirugía. En las relativas se encuentran: patología sinusal crónica (rinosinusitis alérgica, pólipos nasales, sinusitis fúngica crónica, desviación septal, sinusitis crónica) así como la presencia de dientes mandibulares en región de canino-premolar.

Según la clasificación propuesta por Bedrossian, se recomiendan las siguientes opciones de tratamiento *(Tabla 2)*.

La técnica original descrita por Branemark[7] consiste en realizar una incisión crestal completa hasta la línea media anterior junto con incisiones posteriores con relajantes posterolaterales bilaterales. Esta técnica implica una exposición subperióstica completa de la cara lateral del hueso cigomático, un retractor se coloca en la escotadura cigomática justo en la unión del arco cigomático y el borde orbitario lateral, se crea una ventana ósea de 10 mm de ancho en la parte lateral del seno maxilar siguiendo la trayectoria deseada del implante cigomático. La membrana sinusal se diseca cuidadosamente para permitir el paso del implante justo dentro de la pared del seno maxilar

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Tabla 1: Clasificación Bedrossian.[13]

Zona	Región
3	Molar
2	Premolares
1	Incisivos y caninos

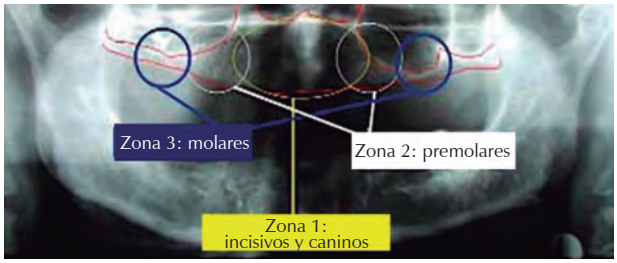

Figura 1: Ortopantomografía del paciente.

Tabla 2: Opciones de tratamiento.

Atrofia maxilar	Tratamiento
Sin atrofia	Implantes convencionales
Atrofia en zona 3	*All on four*, elevación de seno e implantes convencionales
Atrofia en zona 2, 3	2-4 implantes convencionales con dos implantes cigomáticos
Atrofia en zona 1, 2, 3	Cuatro implantes cigomáticos

mientras se dirige hacia el cuerpo del malar. Con abundante irrigación se utiliza una fresa redonda para crear una guía y luego el *drill* inicial de 2.9 mm de diámetro hasta que la punta del mismo sale cerca del arco cigomático, posteriormente se utiliza un *drill* piloto de transición (2.9-3.5 mm) y por último, el *drill* de 3.5 mm. Una vez completada la preparación se utiliza el medidor de profundidad para determinar la longitud del implante a utilizar. El implante es llevado a boca y colocado en su preparación. El dispositivo de transferencia se retira para exponer la orientación de 45 grados de la plataforma del implante. Este abordaje da lugar a que la plataforma se extienda sobre el palatino de la cresta alveolar requiriendo de este modo los pilares angulados (UCLA) para evitar la sobrecarga de la prótesis a lo largo del aspecto palatino. La conexión del pilar suele hacerse después de un periodo de cicatrización de seis meses usando pilares estándar o recto/angulado de Branemark multi-unit.[7]

La técnica propuesta por Stella y Warner[14] permite la colocación del implante en o muy cerca de la cresta alveolar, no es necesaria la disección completa de la cara lateral del hueso cigomático y

Tabla 3: Clasificación Zaga.

Zaga	
0	La pared maxilar anterior es muy plana. La primera osteotomía se coloca sobre la cresta alveolar residual. El cuerpo del implante alcanza el hueso cigomático siguiendo una trayectoria intrasinusual
1	La pared maxilar anterior ligeramente cóncava y la necesidad de colocar la cabeza del implante en el sitio protésico correcto llevan a que la osteotomía perfore la pared maxilar. La mayor parte del cuerpo del implante permanecerá dentro de los límites maxilares
2	En presencia de una pared maxilar más cóncava, la colocación ideal de la cabeza del implante obliga a que la mayor parte del cuerpo del implante sea colocado de forma extrasinusal sin dejar espacio entre la superficie del implante y el hueso maxilar anterior
3	En un maxilar muy cóncavo la primera osteotomía realizada desde la cresta alveolar palatina emerge por la cara anterior maxilar hasta alcanzar el cigomático en una posición más craneal. La parte media del implante no toca el hueso maxilar
4	En un maxilar muy atrófico, la colocación óptima del implante debe ser extramaxilar sin perforar la cresta alveolar residual muy delgada

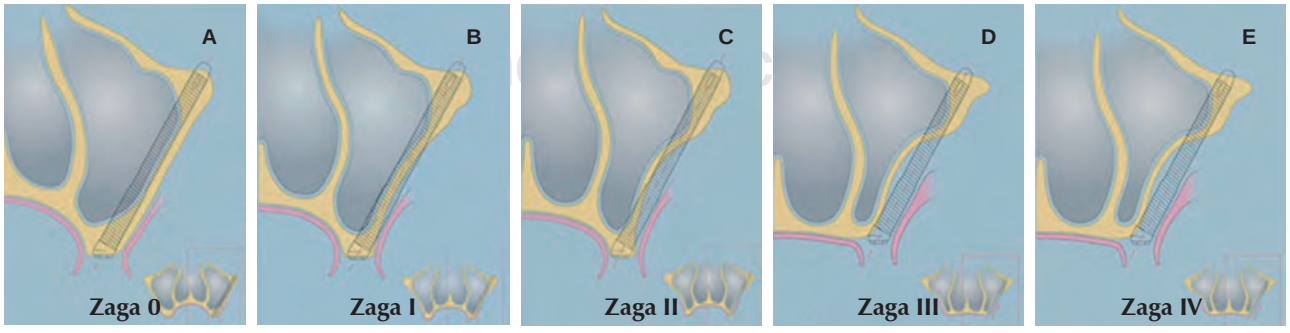

Figura 2: Clasificación Zaga.

el retractor de escotadura no se utiliza. El agujero de emergencia se perfora en la cresta del alveolo al pie del contrafuerte, una ranura oblicua vertical en la cresta del pilar se crea con una fresa de fisura y termina cefálicamente en el hueso más grueso del cuerpo cigomático. En lugar de un agujero de acceso como en la técnica estándar, la ranura se ensancha hasta convertirse en una superficie plana, la cual es esculpida en el hueso más grueso en la base del cuerpo cigomático. En la superficie plana se realiza un agujero con fresa redonda. Se coloca un dedo sobre la escotadura cigomática en lugar de verla directamente con el retractor. La perforación, el paso del implante y la alineación proceden como en la técnica convencional, excepto que el *drill* y el implante pasan a través de la ranura en el pilar con el implante situado a menudo parcialmente fuera del seno maxilar. El implante entonces se encuentra en o cerca de la cresta alveolar.[14] Otra modificación de la técnica original fue descrita por Boyes-Varley y colaboradores,[15] estos autores abogan por el uso de una guía quirúrgica específica y la modificación del diseño del implante para aumentar la angulación de la plataforma a 55 grados en lugar de los 45 grados, su técnica resulta en la colocación del dispositivo en la cresta del alvéolo con una angulación del implante que se aproxima más a la vertical. Chow y colaboradores proponen un protocolo de rehabilitación con implantes cigomáticos usando planeación virtual con utilización de guías quirúrgicas, incisiones mínimas y carga inmediata. También se ha informado de la navegación intraoperatoria asistida por computadora para ayudar en la colocación de implantes cigomáticos.[15]

En pacientes con concavidades bucales pronunciadas en la parte lateral del seno maxilar, el uso

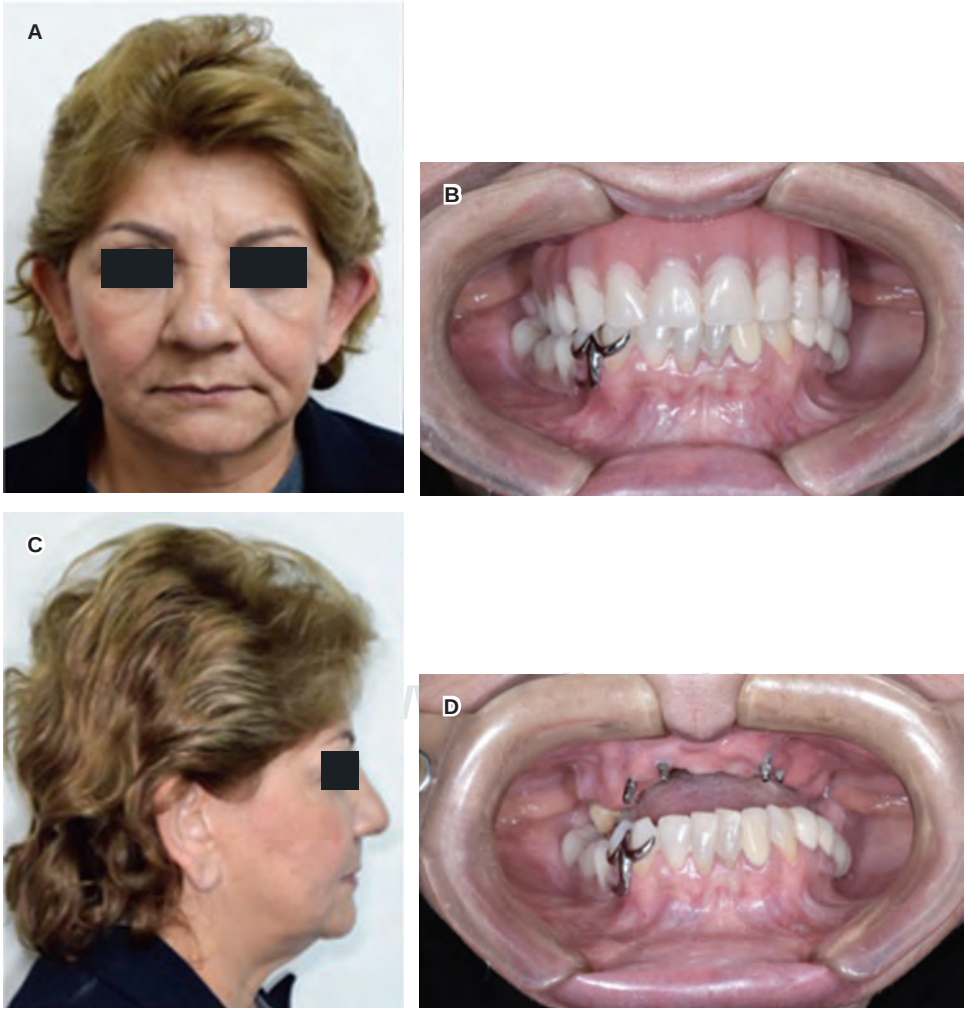

Figura 3:

A) Foto frontal. **B)** Foto intraoral con su prótesis. **C)** Foto lateral. **D)** Foto intraoral sin prótesis.

de la técnica original con un trayecto intrasinusal da lugar a una emergencia palatina excesiva de la cabeza del implante, esto resulta en un puente dental voluminoso en el aspecto palatino que conduce a un malestar en el paciente con problemas de higiene y habla.[17] Con el fin de utilizar una aproximación anatómica y protésica, la técnica original se ha modificado permitiendo una trayectoria extrasinusal para los implantes cigomáticos, centrándose en las diferencias anatómicas de cada paciente. La preparación del sitio del implante se rige por la anatomía del área y no es necesario abrir ninguna ventana o ranura inicial en la pared lateral del seno maxilar. De este modo, dependiendo de la relación entre el contrafuerte cigomático y el punto de inicio intraoral del implante cigomático, la trayectoria del cuerpo del implante variará de ser totalmente intrasinusal a ser totalmente extrasinusal. Este enfoque promueve la colocación del implante cigomático según la anatomía del paciente partiendo de un sistema de clasificación que comprende cinco grupos (ZAGA 0-IV). La colocación del implante cigomático sigue los principios ZAGA y optimiza el soporte proporcionado por el hueso, incluso a nivel de la pared maxilar que es crucial en un paciente que sufre de atrofia ósea extrema. El implante por sí mismo sella la osteotomía de la pared sinusal, lo que minimiza el riesgo de la contaminación sinusal[18] *(Tabla 3 y Figura 2)*.

La colocación de implantes cigomáticos es un procedimiento de cirugía ambulatoria o de corta estancia dependiendo del tipo de paciente. El manejo médico con antibióticos, analgésicos, antiinflamatorios, descongestionantes nasales, entre otros, está reservado a criterio del clínico. Se debe aconsejar reposo relativo, dieta blanda, evitar acciones que aumenten la presión intranasal e intrasinusal. Se recomiendan citas de seguimiento una vez por semana en los primeros seis meses. Dentro de las complicaciones que se pueden presentar se encuentran: dolor, edema, equimosis, hematoma, inflamación, infección, patología sinusal, necrosis ósea, lesiones nerviosas (parestesia, anestesia, paresia), lesión ocular u orbitaria, lesión vascular (arteria maxilar interna, plexo venoso pterigoideo en la fosa pterigopalatina/infratemporal), pérdida del implante, entre otros.[19]

CASO CLÍNICO

Se presenta el caso de una paciente de 61 años de edad con antecedente de resección mamaria por tumoración benigna, tabaquismo activo desde los 10 años de edad, alérgica a penicilina y sulfas, actualmente en tratamiento con benzodiacepinas para control de depresión senil. Acude a valoración al Servicio de Cirugía Maxilofacial del Hospital Christus Muguerza UPAEP en Puebla, Puebla, México buscando una rehabilitación integral. La paciente refiere movilidad en prótesis maxilar, lo que le condiciona dificultad para la masticación y el desarrollo de sus actividades diarias. A la exploración clínica la paciente presenta una prótesis total maxilar desajustada, al retiro de la misma se observa la presencia de cuatro implantes transicionales endoóseos, los cuales se encuentran asintomáticos, pero con evidente movilidad. El reborde alveolar maxilar se encuentra con atrofia severa en sector anterior y posterior, presenta órgano dentario número 16 con movilidad grado III. A nivel mandibular se encuentra parcialmente desdentada con presencia de prótesis parcial removible en sector posterior bilateral, en el sector anterior con presencia de órganos dentarios en adecuadas condiciones presenta también un implante transicional endoóseo en región posterior derecha *(Figura 1)*.

La exploración clínica se complementa con una ortopantomografía y una tomografía computarizada de haz de cono, las cuales revelan atrofia maxilar severa en zonas 1, 2 y 3 según la clasificación de Bedrossian. Presencia de cuatro implantes transicionales con pérdida ósea periimplantar severa, senos maxilares neumatizados y sin evidencia de patologías paranasales y óseas asociadas *(Figura 2)*.

Con base en la historia clínica, exploración física, radiográfica y tomográfica, así como las necesidades funcionales y sociales de la paciente, se propone una rehabilitación con carga inmediata sobre cuatro implantes cigomáticos. La paciente acepta el plan de tratamiento, por lo que se somete al protocolo preoperatorio, no encontrándose contraindicación para la realización del procedimiento quirúrgico ni anestésico.

MATERIAL Y MÉTODOS

Se realiza cirugía virtual con apoyo del programa Mimics Research 17.0 Materialise Company, donde se retiran implantes transicionales endoóseos, se extrae órgano dentario 16 y se colocan cuatro implantes cigomáticos permitiendo una aproximación de la posición quirúrgica ideal respetando estructuras anatómicas adyacentes y diseñando

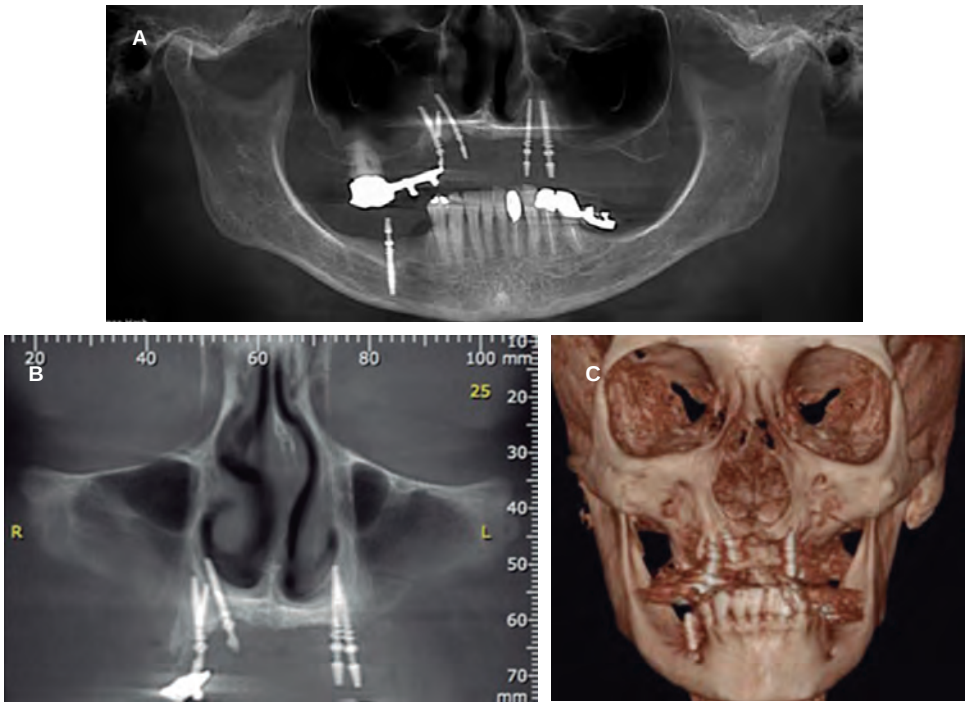

Figura 4:

A) Ortopantomografía inicial. **B)** Corte coronal donde se observan los implantes transicionales. **C)** Reconstrucción volumétrica.

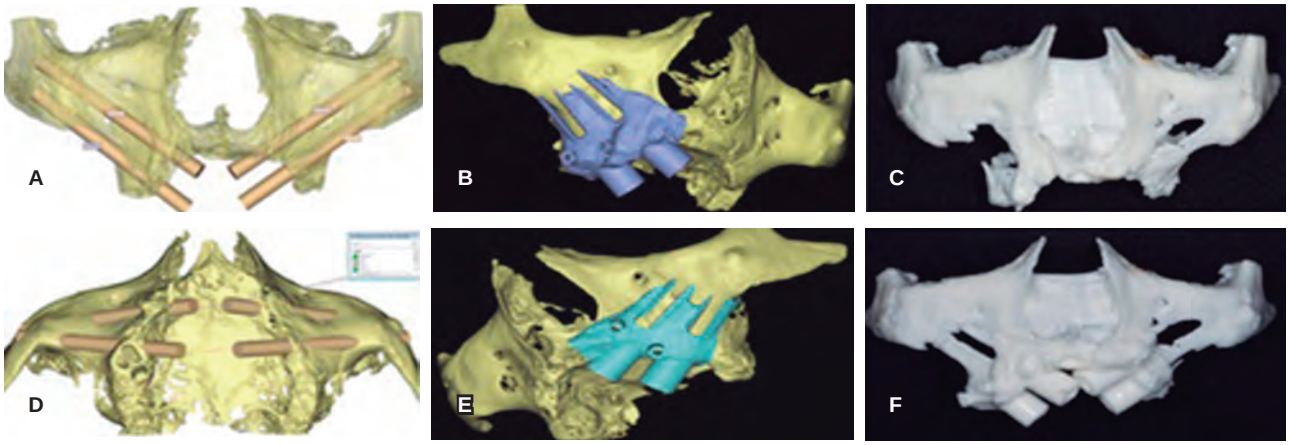

Figura 5: A-F) Planeación digital.

una guía quirúrgica que nos permita determinar el perfil de emergencia de los implantes cigomáticos. Una vez realizada la planeación virtual se fábrica un modelo estereolitográfico así como las guías quirúrgicas que nos orientaran durante el evento quirúrgico *(Figura 3)*.

Técnica quirúrgica

La paciente es llevada a la sala de operaciones y bajo anestesia general balanceada con intubación nasotraqueal, previa asepsia y antisepsia se coloca taponamiento faríngeo, se inicia evento quirúrgico con infiltración de lidocaína con epinefrina al 2%-1:100,000 para hemostasia regional e hidrodisección de la región anterior y crestal maxilar. Se realiza extracción de O.D. 16 así como retiro de implantes transicionales. Se hace incisión con bisturí No. 15 a nivel crestal maxilar continuándose con una incisión relajante posterolateral de manera bilateral, se diseca un colgajo de espesor total paracrestal palatino,

el cual se sutura temporalmente con el contralateral con seda 3-0. Posteriormente se diseca un colgajo de espesor total exponiendo la cara anterior maxilar, pilar maxilomalar y borde inferior del arco cigomático, enseguida con fresa de bola diamantada para baja velocidad y abundante

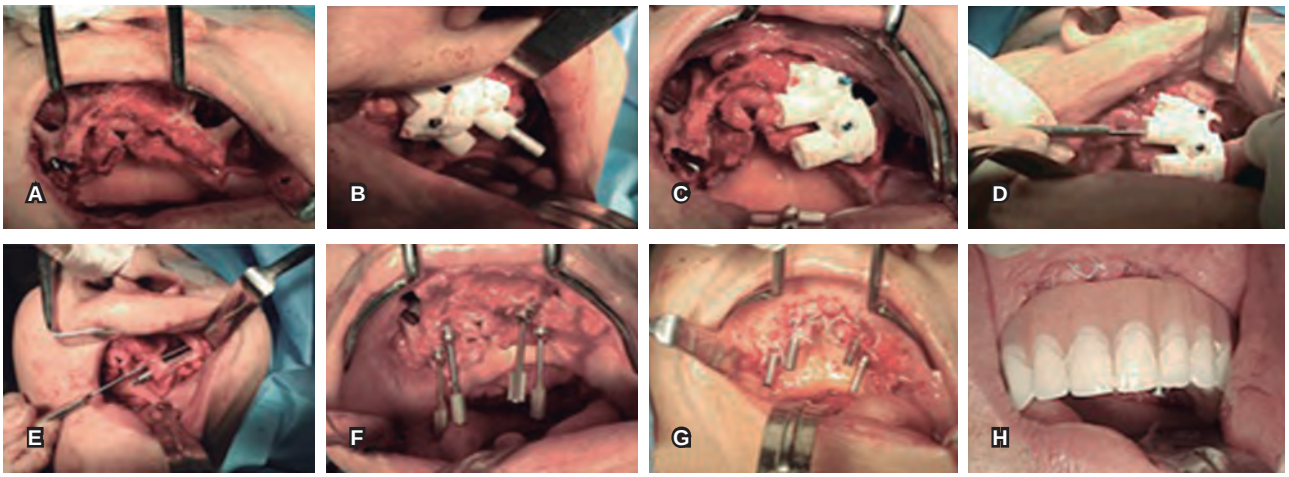

Figura 6: Procedimiento quirúrgico.

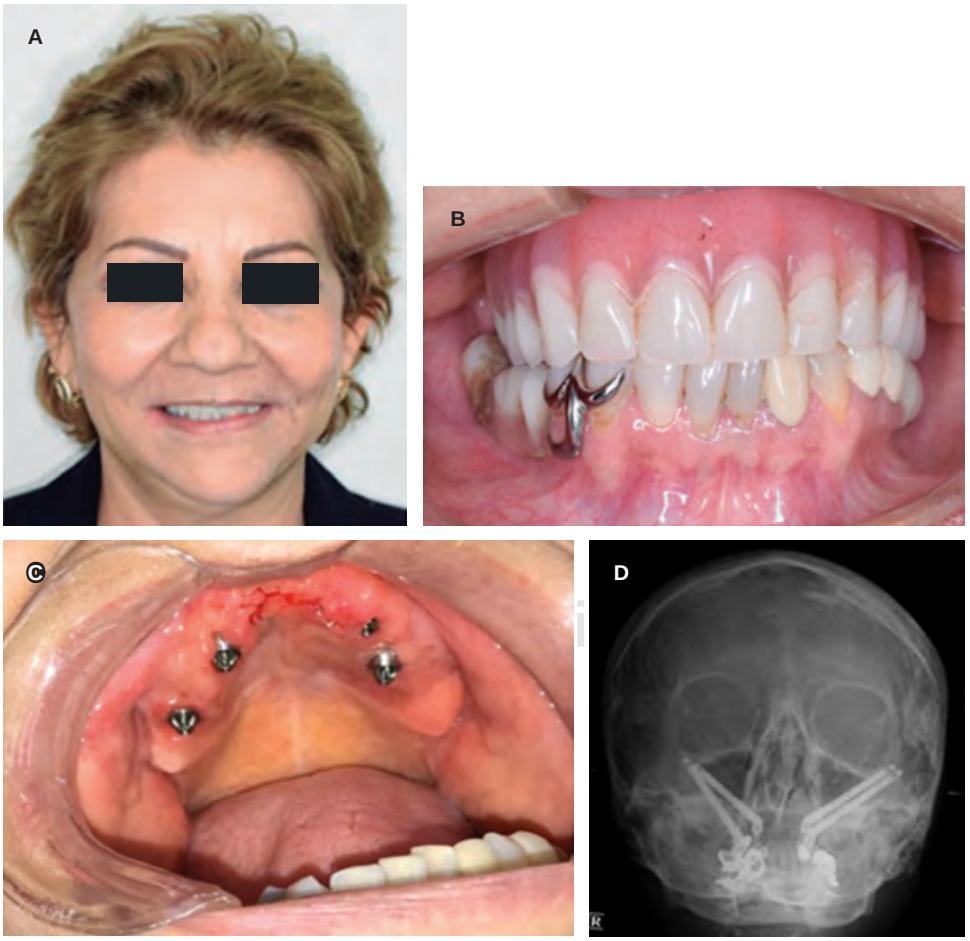

Figura 7:

A) Foto facial, **B)** prótesis provisional, **C)** aditamentos protésicos, **D)** radiografía de Waters de control.

irrigación con S.S. 0.9% se realiza una ventana ósea a nivel de la cara anterior maxilar de 10 × 10 mm aproximadamente, después se diseca la membrana sinusal hasta separarla en su totalidad de la cara lateral antral. A continuación, se coloca guía quirúrgica para determinar localización ideal del implante y se aplica el protocolo de fresado según la técnica original descrita por Branemark (Branemark System Zygoma Surgical Kit, Nobelbiocare, Zürich, Suiza). Se inicia la secuencia con fresa redonda continuando con la inicial 2.9, luego la fresa de transición 2.9/3.5 y por último la 3.5, cada paso se realiza con abundante irrigación con S.S. 0.9%. Una vez completada la preparación se midió la profundidad y se determinó la longitud del implante. Este mismo protocolo se realizó de manera bilateral insertándose cuatro implantes cigomáticos de 45 mm de longitud con un torque de inserción de 40 Ncm cada uno. Se retiró el aditamento de transferencia y se colocaron los pilares angulados de Branemark multi-unit verificando su paralelismo. Se irriga profusamente con S.S. 0.9%, control de hemostasia y se realiza síntesis de herida quirúrgica con sutura no reabsorbible de PTFE 4-0. Una vez suturadas las heridas la conexión de los pilares fue cargada de forma inmediata con una prótesis provisional de acrílico. Se terminó el acto quirúrgico sin incidentes ni accidentes, la paciente egresó de sala de operaciones despierta con su prótesis estable y funcional *(Figura 4)*. Se estableció manejo médico a base de analgésicos/antiinflamatorios y antibióticos así como medidas de higiene oral y cuidados postoperatorios. La paciente se presentó a control postoperatorio a los 10 días con sus heridas quirúrgicas sin ningún dato patológico y prótesis provisional estable. A tres meses de seguimiento la paciente se mantiene asintomática con los implantes y prótesis estables a la espera de la prótesis definitiva *(Figuras 5 a 7)*.

DISCUSIÓN

La rehabilitación estética y funcional en pacientes con secuelas por traumatismos, por resección de neoplasias o malformaciones congénitas de la región maxilofacial, así como pacientes con maxilares atróficos por otras causas, es un reto para cirujanos maxilofaciales y rehabilitadores orales. Se han documentado diversas técnicas quirúrgicas (injertos microvasculares, injertos libres onlay/inlay, injerto con elevación sinusal, etc.), las cuales tienen como objetivo la rehabilitación de los pacientes con implantes convencionales. Se sabe que la tasa de fracaso aumenta con la reducción de la altura ósea residual y la reducción de la longitud del implante.[20-22] La técnica de elevación de seno maxilar con injerto óseo por mucho tiempo fue la de elección para resolver diversos casos de atrofia maxilar posterior, la Academia de Osteointegración estableció en 1994 su documento de consenso referente a los procedimientos de elevación sinusal en el cual establecen, después de revisar los resultados de 2,997 implantes colocados en 1,007 senos injertados con un seguimiento mínimo de tres años posterior a la rehabilitación, que la tasa de fracaso de este procedimiento con implante inmediato es de 61%.[23] Si bien el uso de injertos óseos autólogos es el «estándar de oro» de la regeneración, su utilización en combinación con implantes inmediatos o retardados tiene una tasa de fracaso de 10-30%. A pesar de las numerosas publicaciones, la efectividad de los procedimientos de injerto sinusal sigue siendo controvertida.[24-27]

Se han planteado múltiples alternativas a los procedimientos de injerto óseo. La utilización de la sutura pterigomaxilar ha sido identificada como un sitio alternativo para la colocación de implantes.[28-30] Otros autores han sugerido el uso de implantes inclinados y/o cortos para evitar la necesidad de procedimientos de elevación del seno. En los casos de cantidad de hueso adecuado en las zonas 1 y 2, según Bedrossian, se ha propuesto el uso de cuatro a seis implantes convencionales, inclinando el más distal de cada lado para lograr una buena distribución de la carga y así evitar la necesidad de injerto óseo.[31-35]

Durante las dos últimas décadas se han realizado numerosos estudios que demuestran que los implantes cigomáticos son una opción efectiva en el manejo del maxilar atrófico así como en defectos de postmaxilectomía, pues reducen la morbilidad quirúrgica y simplifican el tratamiento de rehabilitación en este tipo de pacientes.[1-3] El uso de múltiples implantes cigomáticos (2-3 por lado) para soportar una prótesis fue sugerido por Bothur y colaboradores.[36] Los pacientes con atrofia maxilar severa (zonas 1, 2 y 3 según Bedrossian) son candidatos para el uso de implantes cigomáticos bilaterales con rehabilitación inmediata. En pacientes con atrofia maxilar no oncológica, la trayectoria de uno o ambos implantes cigomáticos puede situarse fuera del seno maxilar.[37,38] La

Tabla 4: Clasificación de Lund-Mackay.

Región	Lado	Normal	Opacificación parcial	Opacificación total
Etmoidal Anterior	Derecho	0	1	2
	Izquierdo	0	1	2
Etmoidal Posterior	Derecho	0	1	2
	Izquierdo	0	1	2
Maxilar	Derecho	0	1	2
	Izquierdo	0	1	2
Frontal	Derecho	0	1	2
	Izquierdo	0	1	2
Esfenoidal	Derecho	0	1	2
	Izquierdo	0	1	2
		No obstruido		Obstruido
Complejo Osteo-meatal	Derecho	0		2
	Izquierdo	0		2
Total				

tasa de supervivencia reportada por Davo y su equipo[39] en 36 implantes cigomáticos cargados inmediatamente fue de 100% con un seguimiento de seis a 29 meses, mientras que con los implantes convencionales se perdieron tres de 68 en el mismo tiempo de seguimiento. Balshi y colegas[40] en un análisis retrospectivo de 56 pacientes que recibieron 110 implantes cigomáticos con carga inmediata reportaron un rango de supervivencia de 96% en un periodo de control de cinco años. Branemark y colaboradores[41] en un estudio inicial informaron de 27 pacientes con defectos maxilares tratados con 65 implantes cigomáticos sin ninguna pérdida en un seguimiento de uno a 12 años. En otro estudio este mismo autor reportó una tasa de supervivencia de 94% en 28 pacientes edéntulos con maxilares severamente reabsorbidos tratados con 52 implantes cigomáticos con un seguimiento de cinco a 10 años.[7] Otros autores como Kahnberg y su equipo[42] reportaron en un estudio prospectivo multicéntrico una tasa de supervivencia de los implantes cigomáticos de 96.3% con un seguimiento de tres años. Malevez y colegas[43] encontraron retrospectivamente una tasa de supervivencia de 100% para 103 implantes en 55 pacientes después de seis a 48 meses de carga. Fernández y colaboradores[44] presentan un estudio retrospectivo de 80 pacientes con atrofia maxilar severa, a quienes se les colocaron 244 implantes cigomáticos con un éxito de 99.6% a 48 meses de seguimiento, este estudio representa la serie más grande de implantes cigomáticos publicada en Latinoamérica. En una revisión de 32 estudios clínicos de implantes cigomáticos realizada por Aparicio y su equipo[45] se incluyeron las publicaciones de 1,031 pacientes con 2,131 implantes cigomáticos con un periodo de seguimiento de seis meses a 12 años, en total fracasaron 42 implantes dando una tasa de supervivencia global de 98.1%. La salud del seno maxilar no parece verse comprometida como lo reporta Petrusson,[46] quien realizó rinoscopia y sinuscopia a 14 pacientes que fueron tratados con implantes cigomáticos de 16 a 64 meses postoperatorios y no encontró signos de inflamación sinusal alrededor de los implantes. Davó y colegas[47] evaluaron los senos maxilares mediante TAC preoperatoria y postoperatoria en 26 pacientes a quienes se les colocaron 52 implantes cigomáticos con carga inmediata con un seguimiento promedio de 21.9 meses, estos autores encontraron que entre 15 y 20% de los pacientes tenían engrosamiento asintomático de la mucosa sinusal.

Los datos preliminares de todos estos estudios muestran que el implante cigomático es altamente predecible, presentando buenos resultados clínicos a largo plazo y los hallazgos muestran que la carga inmediata es una modalidad de tratamiento viable cuando se incluyen implantes cigomáticos en el tratamiento.

Aparicio y colaboradores[10] proponen «el código del éxito cigomático», una serie de criterios para describir el éxito/supervivencia de los implantes cigomáticos, el cual detalla los criterios para el éxito de una rehabilitación anclada en implantes cigomáticos. Estos criterios son distintos a los aplicados a la rehabilitación con implantes convencionales.

Tabla 5: Factores asociados con el diagnóstico de rinosinusitis.

Criterios mayores	Criterios menores
Presión o dolor facial	Dolor de cabeza
Congestión facial o plenitud	Fiebre (no aguda)
Obstrucción nasal	Halitosis
Descarga purulenta	Fatiga
Hiposmia o anosmia	Dolor dental
Pus en el examen nasal	Tos
Fiebre (sólo aguda)	Otalgia o plenitud auditiva

Tabla 6: Evaluación del éxito de los implantes cigomáticos.

	Condición y grado de éxito			Fracaso, condición
	I	II	III	IV
Criterio A Estabilidad	Sin movilidad Sin dolor	Ligera movilidad Sin dolor	Movilidad moderada (sin evidencia perdida de integración apical)	Movilidad severa (perdida de integración) Rotación y dolor
Criterio B Patología sinusal asociada	Lanza-Kennedy (-) Lund-Mackay (0)	Lanza-Kennedy (+) Lund-Mackay (0)	Lanza-Kennedy (-) Lund-Mackay (> 0)	Lanza-Kennedy (+) Lund-Mackay (> 0)
Criterio C Condición del tejido blando periimplantar	Sin recesión	Ligera recesión (Cabeza del implante expuesta sin cuerdas expuestas)	Recesión moderada (exposición de hasta 7 cuerdas)	Recesión severa (exposición mayor a 7 cuerdas)
Criterio D Condición protésica	0 mm < D < 6 mm -3 mm < D < 0 mm	6 mm < D < 10 mm -4 mm < D < -3 mm	10 mm < D < 15 mm -5 mm < D < -4 mm	D < 15 mm D < -5 mm

El código del éxito cigomático de un implante específico está representado por el resultado de las siguientes variables.

Estabilidad del implante cigomático (probado individualmente), patología sinusal asociada (valorada por medio de las escalas Lund-Mackay[48] y Lanza-Kennedy[49]) *(Tablas 4 y 5)*, estado de los tejidos blandos periimplantarios y la evaluación del éxito protésico basado en el posicionamiento final del implante cigomático con respecto al centro de la cresta alveolar en la dimensión horizontal (valora la posición de la cabeza del implante con el reborde alveolar residual, valores positivos indican implantes colocados de manera palatina, valores negativos indican implantes colocados vestibularmente)[10] *(Tabla 6)*.

CONCLUSIÓN

Los implantes cigomáticos con carga inmediata son un recurso que proporciona una solución predecible y rápida en una sola etapa al problema de déficit óseo como resultado de atrofia alveolar maxilar o maxilectomía. Son una opción de rehabilitación que evita meses de espera para la consolidación de un injerto óseo de elevación de seno maxilar, seguido del tiempo necesario para la integración del implante antes de la restauración. Un paciente de maxilectomía puede experimentar un plan de tratamiento muy acelerado y simplificado que permitirá la construcción de la prótesis definitiva en el menor tiempo posible después de la resección del tumor. Tanto en los grupos de pacientes atróficos como en los de maxilectomía, el implante cigomático no conlleva mayor complejidad protésica para el paciente y ha mostrado resultados clínicos superiores en comparación con el injerto óseo, por lo que representan un nuevo «estándar de oro» en cuanto al tratamiento de los huesos maxilares comprometidos *(Tabla 6)*.

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