Controlling Systematic Perioperative Anaerobic Contamination During Sinus-Lift Procedures by Using Metronidazole: An Innovative Approach

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Background and Objectives: *Analysis of tomodensitometric controls following sinus grafts clearly demonstrates a quite systematic lack of homogeneity. Sinus contamination by anaerobic bacteria seems almost unavoidable during bone graft surgery, and this problem may jeopardize the healing process. The aim of this study was to characterize in a systematic way the nonhomogeneities observed at 1, 2, or 3 months postsurgery within allogenous sinus grafts, and to assess the possible influence of a 0.5% sterile solution of metronidazole incorporated in the sinus bone graft.*

Materials: *This clinical study was conducted on 72 patients treated with single or bilateral sinus-lifts: 94 sinus elevations performed with freeze-dried bone allograft (Phœnix, TBF, Mions, France), with (test group) or without (control group) metronidazole. In the test group, each bone graft was hydrated with 2 mL of a 0.5% metronidazole solution, i.e., only 10 mg of metronidazole. All the patients went through a first presurgical computerized tomography (CT)-scan followed by a second scan performed at 1, 2, or 3 months postsurgery (which was used as the preimplant reference scan). For 11 patients, 2 postsurgical CT-scans were performed respectively at 10 days and 2 months. Using an arbitrary gray scale (Arbitrary Densitometric Unit) which functions according to the Hounsfield unit principle, the degree of radiographic homogeneity of the grafts was established. Density scattering provides some information on the homogeneity or nonhomogeneity of the bone graft.*

Results: *The 12 grafts performed without metronidazole show significant nonhomogeneities at 1, 2, or 3 months. Moreover, when a CT-scan is performed during the first postoperative days (at 10 days), the presence of air bubbles in the graft is confirmed. The tomodensitometric aspects of all grafts treated with metronidazole in this series are absolutely identical: they show a high degree of homogeneity. Sixty-three cases (76.8%) are homogeneous, and 19 cases (23.2%) are significantly homogeneous. The time at which the control scan is performed (10 days, 1, 2, or 3 months) does not seem to influence significantly the degree of homogeneity assessed. In the control group, some inflammatory events associated with facial oedema were observed in 25% of the cases. In the test group, no such event was recorded for the 82 sinus-lifts treated with metronidazole.*

Conclusion: *A possible correlation may exist between the occurrence of non homogeneities within the bone grafts and the anaerobic bacterial contamination. The local use of a very small quantity of metronidazole (equivalent to only 1/20 of a common 200 mg oral tablet) could provide more security when performing sinus-lift procedures and an improved quality of the graft. This protocol should not be considered as an antibiotherapy, but only as way to limit the initial contamination of bone graft. (Implant Dent 2008;17:257–270)*

Key Words: anaerobic infection, antibiotics, bone graft, metronidazole, sinus-lift

The purpose of bone augmentation procedures is reconstruction of the resorbed edentulous ridges to allow the placement of endosseous dental implants. Sinus lifting is the most common and the most documented application of this concept.[1,2] However, even though the reliability of this technique is widely established,[3–5] the procedure remains very delicate.[6] In fact, secondary parameters may occur and jeopardize the treatment evolution. They are divided into 3 categories: bacterial contamination, delayed healing, and mechanical stress.

Infectious complications are dramatic events, but their frequency remains unknown, due to a lack of reference studies in the literature.[7] They might occur as frequently as 2% to 7%, often leading to the removal of the grafted tissue, thus enhancing the risk for necrotic and infectious sites to develop. To prevent this risk, many antibiotics have been tested, by systemic[8] or local[9–20] administration: penicillins, tetracyclines, and macrolides. However, it was always difficult to emphasize the true effect of these antibiotics on bone graft healing. Moreover, the tested antibiotics offer quite a wide spectrum, whereas the possible bone infections would more logically

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originate from anaerobic bacteria, which are particularly sensitive to metronidazole.[21,22] To our knowledge, among the international english literature, metronidazole has yet never been experimented for this procedure.[23,24]

Metronidazole is an antibiotic which belongs to the nitro-5-imidazole group. Administered orally alone (Flagyl) or combined with macrolides (such as spiramycin in Birodogyl), it has been in use for a long time[25–28] to treat oral infections in general[29] and periodontal infections more specifically, using a systemic[30–34] or topical application (with gels of various concentrations).[35–40] It is often coupled with amoxicillin by systemic administration.[41–43] A small quantity of metronidazole may also be used locally in a pure form (injectable solution), mixed with the graft, at the time of surgery, to limit systematic perioperative contamination by anaerobic bacteria.

According to our experience, the analysis of tomodensitometric controls 3 months after sinus grafts (using allogenous or xenogenous bone granules) demonstrates a quite systematic image: the grafted bone still seems to be non homogeneous (Fig. 1). This irregular appearance does not contraindicate implant placement. In addition, the success rate of implants placed in the subsinus area is very similar to that of implants placed in other regions.[1,2] The heterogeneity is thus considered as "normal." Hence, we have anticipated that these lacks of homogeneity could possibly be related to bacterial contamination during the surgical procedure.

The aim of this study was to characterize statistically the nonhomogeneities observed at 1, 2, or 3 months postsurgery within the allogenous sinus grafts and assess the possible effect of a 0.5% metronidazole sterile solution incorporated in the sinus bone graft.

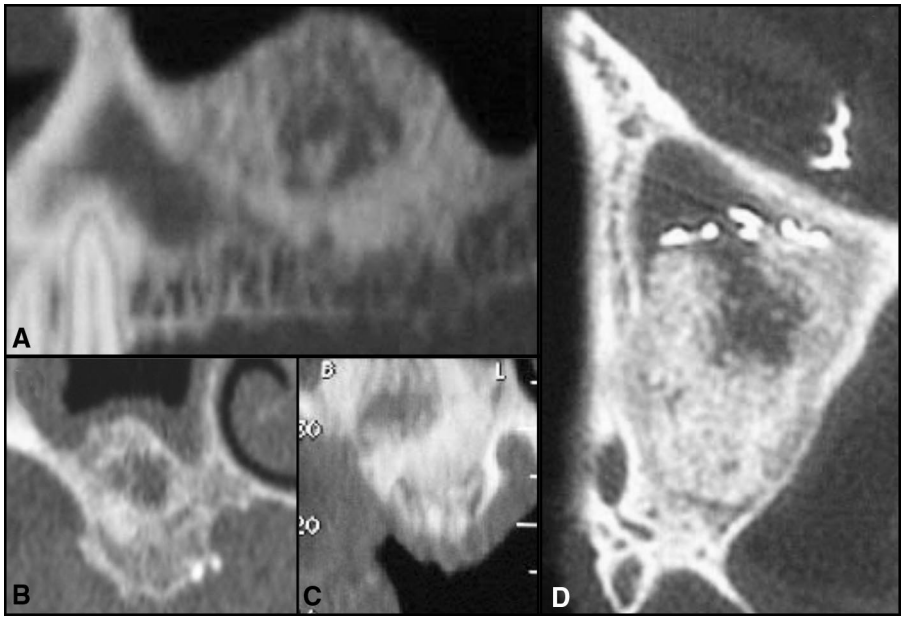

Fig. 1. Postsurgical sinus scans with bone non homogeneity.

Table 1. Distribution of the 83 Scans Performed on the 72 Patients Included in the Study, Depending on the Type of Procedure (Uni or Bilateral), the Use of Metronidazole and the Time of Postsurgical Scan

Treatment	No. Postsurgical CT-Scans At			
	10 d	1 mo	2 mo	3 mo
Unilateral sinus-lift with metronidazole	4	10	14	18
Bilateral sinus-lift with metronidazole	1	5	4	10
Unilateral sinus-lift without metronidazole	3	1	3	4
Bilateral sinus-lift without metronidazole	1	—	1	—
Bilateral sinus-lift 1 side with metronidazole, 1 side without metronidazole	2	—	2	—
Percentage of all scans	13.2	19.3	28.9	38.6

Materials and Methods

Patient Selection

This clinical study was conducted on 72 patients treated with either single or bilateral sinus-lifts: a total of 94 sinus elevations were performed between January 2001 and December 2003 using freeze-dried bone allograft (FDBA, Phœnix, TBF, Mions, France), with or without metronidazole (Table 1). The study was conducted according to the Helsinki Declaration of 1983. The patients were informed on the aim and design of the study, and their written consent was obtained.

Patients with immune disorders, unstable diabetes mellitus, ongoing chemo- or radiotherapy, or with a history of drug abuse were excluded. The inclusion criteria were the following: a thrombocyte blood concentration within the normal range, and no history of maxillary sinus inflammation. Clinical examination and preoperative radiographs showed a severe atrophy of the maxilla.

Surgical Procedure

Surgery was performed under local anesthesia. Access to the lateral maxillary wall was achieved using a soft tissue crestal incision followed by anterior and posterior releasing buccal incisions. A bone window of approximately 15 to 20 mm^2 was outlined using a round bur under constant saline irrigation. It was then moved medial and left attached to the sinus membrane. After careful elevation of the Schneiderian membrane avoiding any perforation, the sinus was filled with a grafting biomaterial.

One to 2 g of Phoenix (TBF, Mions, France) containing FDBA granules (200–800 μm diameter) were instilled to augment the sinus floor in 94 cases. In 12 cases, the sinus was filled with FDBA only (control

Table 2. Analysis of Density Scattering (Calculated in ADU Within FDBA Sinus-Lift With or Without Metronidazole) at 10 days, 1, 2 or 3 months Postsurgery, and Classification of the Radiographic Aspect of the 94 Bone Grafts Included in this Study. Ranges Are Given for Each Series of Sinus-Lift; However, Each Sinus-Lift Is Analyzed and Classified Separately

No. Cases—Postoperative Time for Control CT-Scan	Surface % Average and Range				Radiographic Aspect: Classification of the Grafts
	0–50 ADU	50–65 ADU	65–80 ADU	More Than 80 ADU	
FDBA with metronidazole					
8 sinus—at 10 d	6% (4%–7%)	18% (2%–75%)	64% (16%–81%)	12% (5%–22%)	7 homogeneous (87.5%) 1 unclassified (12.5%)
20 sinus—at 1 mo	5% (0%–7%)	4% (1%–7%)	58% (12%–91%)	33% (8%–75%)	15 homogeneous (75%) 5 significantly homogeneous (25%)
24 sinus—at 2 mo	5% (0%–7%)	9% (1%–21%)	55% (8%–92%)	31% (7%–83%)	19 homogeneous (79.2%) 5 significantly homogeneous (20.8%)
38 sinus—at 3 mo	4% (0%–6%)	5% (1%–7%)	61% (5%–95%)	30% (2%–93%)	29 homogeneous (76.3%) 9 significantly homogeneous (23.7%)
FDBA without metronidazole					
7 sinus—at 10 d	41% (31%–46%)	30% (28%–37%)	28% (26%–32%)	1% (0%–2%)	2 nonhomogeneous (28.6%) 5 significantly nonhomogeneous (71.4%)
1 sinus—at 1 mo	26% (24%–28%)	35% (31%–42%)	33% (28%–36%)	6% (3%–7%)	1 nonhomogeneous (100%)
7 sinus—at 2 mo	31% (24%–37%)	33% (26%–36%)	30% (23%–31%)	6% (4%–10%)	5 nonhomogeneous (71.4%) 2 significantly nonhomogeneous (28.6%)
4 sinus—at 3 mo	23% (19%–32%)	39% (32%–45%)	30% (25%–35%)	8% (6%–12%)	3 nonhomogeneous (75%) 1 significantly nonhomogeneous (25%)

The scattering of the different densities is obviously wider without metronidazole than within the grafts treated with metronidazole. This scattering pattern may be considered as a lack of graft homogeneity. On the scans performed at 10 days postsurgery, the high differences of homogeneity observed are due to the air bubbles, which have occurred within some areas of the graft.

group). In the 82 other cases, metronidazole was added to the bone graft particles (test group).

For 2 patients, bilateral sinus-lifts were performed with unilateral use of metronidazole. This specific situation had not been planned at the beginning of the study, but the volume of the grafting material prepared with metronidazole was not sufficient for the two sinuses. For these 2 patients, 2 postoperative computerized tomography-scans (CT x-ray scanner) were performed respectively at 10 days and 2 months.

Five milliliters of a 0.5% sterile metronidazole solution (25 mg) was used for each treated sinus-lift as follows:

Three milliliters for sinus rinse after membrane elevation;

Two milliliters to hydrate the allogenous bone (mixed with 10% of harvested autogenous bone), i.e., only 10 mg of metronidazole (equivalent to 1/20 of a common 200 mg oral tablet).

All the patients received 60 mg of prednisolone just before surgery, and 2 g of amoxicillin per day (systemic oral administration) during 6 days. Paracetamol was also prescribed when needed.

This study is multicentric: 3 different surgeons participated to this protocol after evaluation of their surgical technique. All applied the same protocol, and were controlled and advised by the same anesthetist, to guarantee the homogeneity of results. Finally, 50 patients out of 72 were treated by the same surgeon.

Long-Term Postoperative Oedema

Often following sinus elevations, 1 or several inflammatory events associated with facial oedema may occur spontaneously between the first and the sixth month postsurgery. They are more often isolated, but sometimes repetitive. They are generally stopped with conventional anti-inflammatory corticoids (such as prednisolone) and antibiotics (such as amoxicillin).

In this study, we accounted the number of treated patients having undergone these late inflammatory events, depending on the use of metronidazole. Evaluation of facial oedema is subjective. It combines an obvious skin swelling (1–5 mm) compared with the treated side, and sometimes pain. For the present evaluation, we only considered the events which were sufficiently severe to render the patient anxious and visit his physician.

Analysis of the CT-Scan Images

This study analyses a total of 83 scans, originating from 72 patients. The surgeons performed 94 consecutive sinus-lifts: 50 unilateral sinus-lifts (42 with metronidazole, 8 without metronidazole) and 22 bilateral sinus-lifts (19 with metronidazole, 1 without metronidazole, 2 with a unilateral use of metronidazole). Patients were all subjected to at least 1 preoperative CT-scan, and 1 control scan at either 1, 2, or 3 months postsurgery (the control scan was also used as a preliminary scan before implant placement). For 11 patients, 2 postsurgical CT-scans were performed respectively at 10 days and 2 months. This protocol was established according to patient consent, and after they had been informed of the possible stochastic risks in relation to a repeated x-ray exposure. Most of the scans were performed at 2 or 3 months postsurgery (Tables 1 and 2).

The Hounsfield units (HU) allow to evaluate the radiographic density of the different tissues on a CT-scan.[44] They represent density values of a tissue compared with that of air, water, and dense bone, for which an arbitrary scale is established, either respectively, −1000 HU, 0 HU, and +1000 HU. The analysis of the sinus grafts using this scale only allows to obtain some information on their radiopacity. With allogenous or xenogenous bone grafts, mainly composed of a mineral-

ized matrix, measurement of HU provides no information on the quality of the bone graft maturation, and hence offers no interest.

The aim of this study was to determine, using an arbitrary gray scale functioning according to the HU principle, the degree of radiographic homogeneity of the grafts. This computer unit is called the Arbitrary Densitometric Unit (ADU). All the coronal reconstructed images of the CT-scans performed at 10 days, 1 month, 2 months, or 3 months were processed using the homemade software (D-TEPv3.5). This software determines a gray scale for each scan according to the same principle as that of the HU: 0 ADU for air, 50 ADU for water, 100 ADU for dense bone. Then, each reconstructed coronal image of the graft is treated separately by performing an analysis circle of 8 mm diameter in the center of the graft. For each analyzed surface, the calculation software for differential density provides the percentage obtained for each of the following density groups: 0 to 50 ADU, 50 to 65 ADU, 65 to 80 ADU, more than 80 ADU. The results expressed in percents are rounded up to the closest (Table 2).

Density scattering gives some information on the homogeneity or non homogeneity of the bone graft. A graft will be arbitrarily considered as:

Nonhomogeneous when at least 60% of its surface is represented equally in 3 different density groups (i.e., at least 20% per group).

Significantly nonhomogeneous when at least 90% of its surface is represented equally in 3 different density groups (i.e., at least 30% per group).

Homogeneous when more than 60% of its surface is represented in only 1 specific group.

Significantly homogeneous when more than 80% of its surface is represented in only 1 specific group.

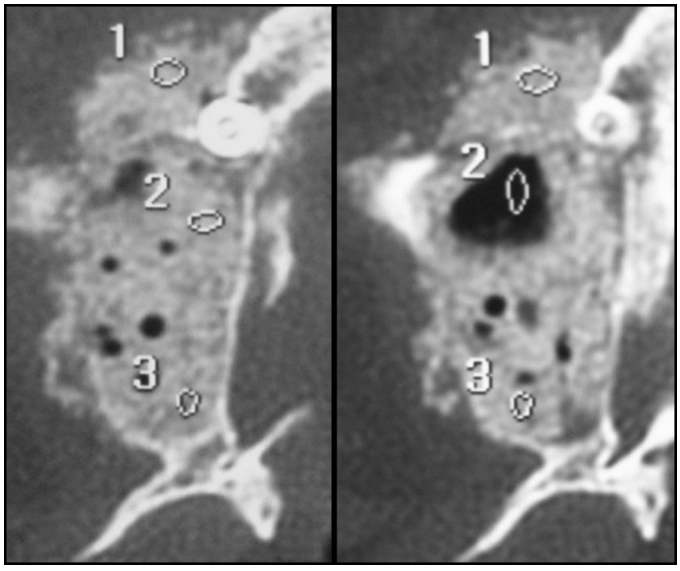

Fig. 2. Air lacunae within the graft at 10 days.

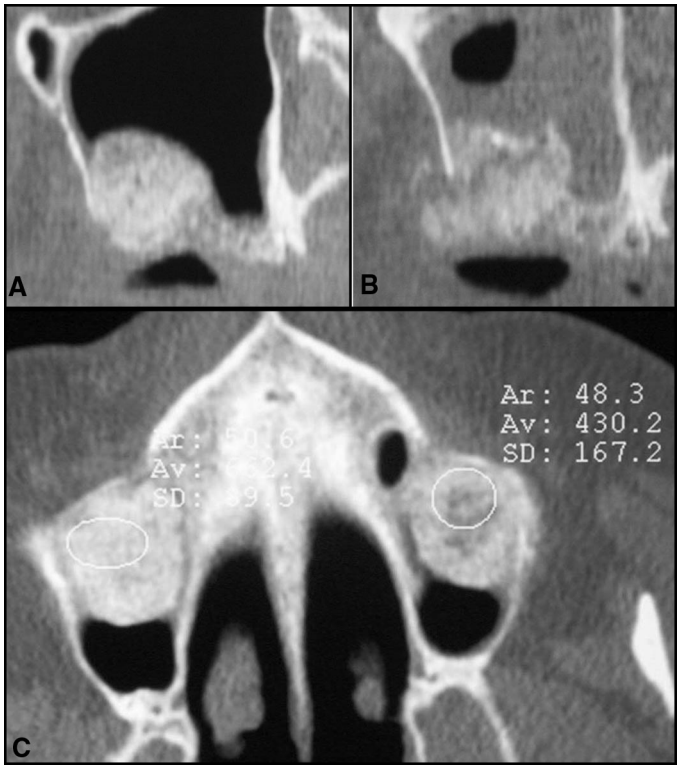

Fig. 3. A and B, 10 days postsurgical x-ray scan of a bilateral sinus-lift. The graft appears homogeneous with metronidazole (A) but nonhomogeneous without metronidazole (B). C, After 2 months, the sinus treated with metronidazole appears homogeneous and dense, whereas the graft without metronidazole shows the nonhomogeneous areas generally described (practitioner 1).

Results

In this series of 94 patients, sinus-lifts were performed by experienced clinicians recruited according to a strict checklist. No severe infectious complications were observed, with or without metronidazole.

The 12 grafts performed without metronidazole show significant nonhomogeneous areas following 1, 2, or 3 months. Moreover, when a CT-scan is performed during the first postoperative days (at 10 days), the presence of bubble-like lacunae within the graft is observed (Fig. 2). The densitometric analysis using ADU confirms a gap in the graft homogeneity. When a second control CT-scan is performed at 2 months postsurgery,

Table 3. Analysis of Density Scattering (Calculated in ADU) at 10 Days and 2 Months Postoperative and Classification of the Radiographic Aspect of Two Bilateral Sinus Grafts With Unilateral Use of Metronidazole

Patient and Grafting Material	Postsurgical Time for Control Scan	Surface % Average 0–50 ADU (%)	50–65 ADU (%)	65–80 ADU (%)	80–100 ADU (%)	Radiographic Aspect of the Grafts
Patient 1						
Right sinus: FDBA	At 10 d	6	22	62	10	Homogeneous
with metronidazole	At 2 mo	5	7	73	15	Homogeneous
Left sinus: FDBA	At 10 d	38	31	30	1	Significantly nonhomogeneous
without metronidazole	At 2 mo	33	35	27	5	Nonhomogeneous
Patient 2						
Right sinus: FDBA	At 10 d	4	65	18	13	Homogeneous
with metronidazole	At 2 mo	3	15	65	17	Homogeneous
Left sinus: FDBA	At 10 d	44	29	27	0	Nonhomogeneous
without metronidazole	At 2 mo	37	35	24	4	Nonhomogeneous

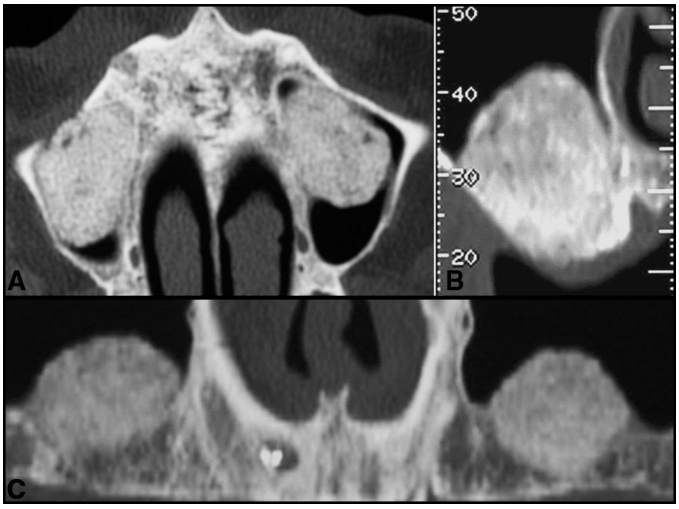

Fig. 4. Radiographic images of bilateral sinus elevation with metronidazole at the first (A), the second (B), and the third (C) postoperative month (practitioner 2).

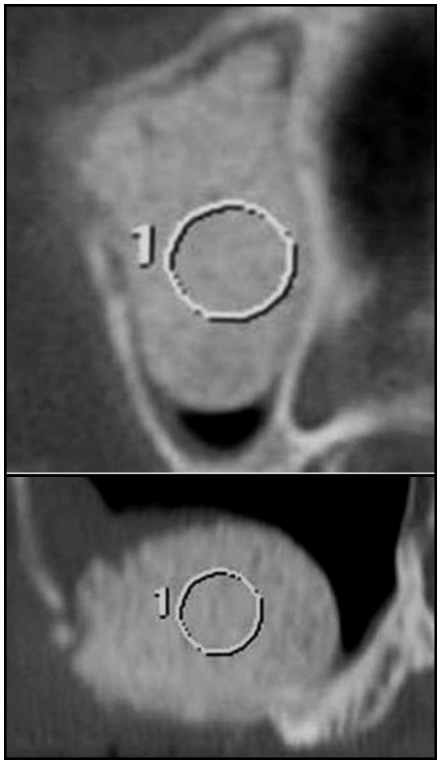

Fig. 5. Radiographic images of unilateral sinus elevations in the second postoperative month with metronidazole (practitioner 3).

the air bubbles observed at 10 days seem super-imposable with the areas showing an obvious significant nonhomogeneity.

The tomodensitometric aspects of all grafts treated with metronidazole in this series are absolutely identical: they show a high degree of homogeneity. Sixty-three cases (76,8%) are homogeneous, and 19 cases (23,2%) are significantly homogeneous. The time at which the control scan is performed (10 days, 1, 2, or 3 months) does not seem to influence significantly the degree of homogeneity assessed.

These results are perfectly obvious in the case of double sinus-lifts with unilateral use of metronidazole, followed by postoperative CT-scans performed at 10 days and 2 months (Fig. 3 and Table 3).

Moreover, the compact and regular radiographic aspect of a graft with metronidazole allows practitioners to perform sinus implantation on the 90th day (Figs. 4 and 5).

In the control group, inflammatory events associated with facial oedema were observed in 25% of the cases, which corresponds to the average generally observed. In the test group, no such event occurred for the 82 sinus-lifts treated with metronidazole (Table 4).

It is not possible to demonstrate significant differences of homogeneity between the 3 different clinicians involved in this study.

Discussion

The oral cavity contains a significant amount of anaerobic flora. The role of bacteria in oral infectious pathologies is already well established. In a healthy gingiva, 18% to 44% of anaerobic bacteria can be found (Gram+ and Gram−). Such levels increase considerably with the presence of slight inflammation, and in acute or

Table 4. Occurrence of 1 or Several Inflammatory Events Associated With Facial Oedema (Generally Solved With Antibiotics and Corticoïds) Between the First and the Third Month Postsurgery, Depending on the Grafting Material Employed (With or Without Metronidazole)

	With Metronidazole	Without Metronidazole
Occurrence of 1 or several inflammatory events between the first and the third month postsurgery	0	3 (25%)
Total no. sinus-lifts	82	12

chronic infections as well.[45] Anaerobic bacteria may also be systematically found in periapical abscesses and associated sinusitis.[46] It was also demonstrated that anaerobic bacteria play a basic role in periodontitis and periimplantitis.[47] The risk of infection associated with this flora is thus obvious. Nevertheless, even following a strict periodontal treatment, it is yet impossible to perform surgery on patients with a perfectly healthy mouth. So, in spite of a strict surgical asepsis, perioperative bacterial contamination by anaerobic bacteria seems unavoidable. But how does this contamination influence the healing of sinus grafts?

The fortuitous discovery of bubble-like lacunae within the graft allows to suggest a new realistic hypothesis concerning infectious risk during sinus grafting: the "septic theory." The presence of air bubbles within the graft confirms anaerobic bacterial activity. Indeed, such vacuoles cannot be due to a lack of condensation in the graft material: given their size and shape, it must be the result of air bubbles formation within the graft, and only anaerobic bacteria may be involved. This "septic theory" suggests that the grafted bone contamination by anaerobic bacteria would be responsible for healing problems, and therefore, any protocol able to stop this silent infection should result in a dramatic improvement for graft quality.

To validate this approach, histological analyses are difficult to perform because these processes occur during the very first weeks postsurgery. And, it seems impossible to harvest coherent bone fragments within the grafts before 3 months, even with highly performing materials such as FDBAs. The use of the ADU seems to be a clever approach to demonstrate these events within the grafts. The ADU replaces favorably the HU, because this computerized unit allows us to analyze, based on the same methodology, coronal reconstructed images originating from different types of spiral CT-scans, and even cone beam CT-scans. ADUs standardization is performed separately for each studied scan, to avoid any bias related to the type of imagery device employed. Moreover, in this study, we wanted to analyze the relationships between the different densities, rather than the densities themselves: the calculation interfaces of the HU developed for radiologists are not adapted for this use at all.

Moreover, the anaerobic contamination process is probably systematic for all types of bone grafts. Nevertheless, this can only be clearly demonstrated on this specific type of sinus graft, due to the large volume of these grafts which are composed of biomaterials (offering a very high mineral phase), very homogeneous, and therefore very radiopaque: any change in their homogeneity is thus easily quantifiable on the scan, which would not be the case for an autogenous graft (iliac, calvarial, chin . . .).

Finally, although it cannot replace the efficiency of strict surgical asepsis associated with antiseptic coverage, the local use of a very small quantity of metronidazole may improve the remodeling process of the graft by avoiding initial infectious development and associated inflammatory reactions. It may thus help to reduce the risk of infected bone formation, and possible necrosis.

Conclusion

This new approach to prevent perioperative anaerobic contamination appears simple and rational. To this day, the antibiotic treatments prescribed during sinus-lift procedures either pre-or postsurgically, by local or systemic administration, were mainly aerobic antibacterial therapies. The local use of a very small quantity of metronidazole (equivalent to only 1/20 of a common 200 mg oral tablet), to protect the graft material from this anaerobic contamination, may lead to a more secure approach when performing sinus-lifts and an improved graft quality. Moreover, the quantity of metronidazole needed to obtain the protective effect is so small, that this protocol cannot be considered as an antibiotherapy with its potential for associated bacterial resistance.

Disclosure

The authors claim to have no financial interest, directly or indirectly, in any entity that is commercially related to the products mentioned in this article.

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ID Abstract Translations

GERMAN / DEUTSCH

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Kontrollmöglichkeiten systematischer perioperativer anaerober Verschmutzung im Verlauf von Sinusanhebungsbehandlungen durch Anwendung von Metronizadol: Ein innovativer Ansatz

ZUSAMMENFASSUNG: Hintergrund und Zielsetzungen: Eine Analyse von tomodensiometrischen Kontrollen nach erfolgter Sinustransplantation weist klar einen recht systematischen Mangel an Homogenität auf. Eine Verschmutzung des Sinus durch anaerobe Bakterien scheint im Verlauf eines chirurgischen Eingriffs zur Knochentransplantation beinahe unvermeidlich. Durch diese Problematik kann der gesamte Heilungsprozess beeinträchtigt sein. Die vorliegende Studie zielte darauf ab, auf systematische Art und Weise die Homogenitätsmängel innerhalb allogener Sinustransplantate nach 1, 2 bzw. 3 Monaten nach dem entsprechenden chirurgischen Eingriff zu charakterisieren und den möglichen Einfluss einer 0,5-prozentigen sterilen Lösung aus Metronizadol bei Einbringung in des Sinusknochentransplantat zu bewerten. ***Materialien und Methoden:*** Diese klinische Studie wurde an 72 Patienten durchgeführt, die sich einer einseitigen oder beidseitigen Sinusanhebung unterzogen: insgesamt wurden 24 Behandlungen zur Sinusanhebung unter Verwendung von gefriergetrocknetem Knochenallotransplantat, Phœnix®, TBFâ, Mions, Frankreich, durchgeführt und dabei entweder mit Einsatz von Metronizadol (Testgruppe) oder ohne (Kontrollgruppe). In der Testgruppe wurde jedes Knochengewebstransplantat mit 2 ml einer 0,5-prozentigen Metronizadollösung, d.h. nur 10 mg an Metronizadol, versetzt. Alle Patienten unterzogen sich einem ersten, der eigentlichen Operation vorgeschalteten CT-Scan, dem 1, 2 oder 3 Monate nach dem Eingriff eine weitere Schichtbildaufnahme folgte, die dann als Vorimplantat-Referenzbild genommen wurde. Bei 11 der Patienten wurden postoperativ nach 10 Tagen bzw. 2 Monaten 2 CT-Scans durchgeführt. Per willkürlicher Graustufenskalierung (Arbitrary Densitometric Unit (ADU) - Gerät zur Ermittlung willkürlicher Densiometrie) nach dem Hounsfield-Einheitsprinzip wurde der Grad der radiographischen Homogenität ermittelt. Die Methodik der Dichtestreuung bringt einige Klarheit in Bezug auf die Homogenität bzw. Inhomogenität des Knochentransplantats. ***Ergebnisse:*** Die 12 Transplantate, die nicht zusätzlich mit Metronizadol behandelt wurden, wiesen bei einer Untersuchung nach 1, 2 bzw. 3 Monaten erhebliche Defizite bezüglich der Homogenität auf. Außerdem wurde dort, wo ein CT-Scan im Verlauf der ersten postoperativen Phase (nach 10 Tagen) durchgeführt wurde, das Bestehen von Luftblasen im Transplantat bestätigt. Die tomodensiometrischen Aspekte aller innerhalb dieser Serie mit Metronizadol behandelten Transplantate sind absolut identisch: sie weisen ein hohes Maß an Homogenität auf. 63 Fälle sind (76, 8%) homogen und in 19 Fällen (23, 2%) ist diese Homogenität sogar bedeutend. Dabei scheint der Zeitpunkt, zu dem der Kontroll-Scan durchgeführt wird (nach 10 Tagen, 1, 2 oder 3 Monaten), den festgestellten Homogenitätsgrad nicht maßgeblich zu beeinflussen. In der Kontrollgruppe wurden in 25% der Fälle einige, mit Gesichtsödemen in Verbindung stehende Entzündungserkrankungen beobachtet. In der Versuchsgruppe dagegen fehlten solche Tendenzen in allen der 82 zusätzlich mit Metronizadol versetzten Sinusanhebungsbehandlungen. ***Schlussfolgerung:*** Es könnte ein Verbindung zwischen dem Auftreten von Inhomogenitäten innerhalb des Knochentransplantats und der anaeroben bakteriellen Verschmutzung bestehen. Die lokale Anwendung einer sehr geringen Menge an Metronizadol, die gerade mal einem 1/20 der oralen Einnahme einer normalen 200 mg-Tablette entspricht, könnte bei der Durchführung von Eingriffen zur Sinusanhebung mehr Sicherheit sowie eine verbesserte Qualität des Transplantats bewirken. Dieses Protokoll sollte nicht als Antibiotikatherapie angesehen werden, sondern ausschließlich als Weg, die erste Verschmutzung des Knochengewebstransplantats zu begrenzen.

SCHLÜSSELWÖRTER: anaerobe Infektion; Antibiotika; Knochengewebstransplantat; Metronizadol; Sinusanhebung

SPANISH / ESPAÑOL

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Control de la contaminación anaeróbica sistemática perioperativa durante procedimientos de elevación del seno usando metronidazol: Un método innovador

ABSTRACTO: Antecedentes y Objetivos: El análisis de los controles tomodensitométricos luego de los injertos en el seno demuestra una falta de homogeneidad bastante sistemática. La contaminación del seno con bacteria anaeróbica parece inevitable durante la cirugía de injerto del hueso y este problema podría comprometer el proceso de

curación. El objetivo de este estudio fue caracterizar de manera sistemática la falta de homogeneidad observada a los 1, 2 o 3 meses posteriores a la operación dentro de injertos del seno alógeno y evaluar la posible influencia de una solución estéril al 0,5% de metronidazol incorporada en el injerto del hueso del seno. ***Materiales y Métodos:*** Este estudio clínico fue realizado en 72 pacientes tratados con elevación del seno simple o bilateral: 94 elevaciones del seno realizadas con FDBA (alógrafo de hueso desecado-congelado, Phœnix®, TBF®, Mions, Francia), con metronidazol (grupo de ensayo) o sin (grupo de control). En el grupo de ensayo, cada injerto de hueso fue hidratado con 2 ml de una solución de metronidazol al 0,5%, o sea, solamente 10 mg de metronidazol. Todos los pacientes completaron una tomografía computada previa a la operación seguida por una segunda tomografía realizada después de 1, 2 ó 3 meses después de la operación (que se usó como la tomografía de referencia previa al implante). En el caso de 11 pacientes, se realizaron 2 tomografías postquirúrgicas respectivamente a los 10 días y 2 meses. Con el uso de una escala gris arbitraria (Unidad Densitométrica Arbitraria, ADU por sus siglas en inglés) que funciona de acuerdo al principio de la unidad Hounsfield, se estableció el grado de homogeneidad radiográfica de los injertos. Los cambios en la densidad proporcionan cierta información sobre la homogeneidad o no del injerto de hueso. ***Resultados:*** Los 12 injertos realizados sin metronidazol demostraron una falta de homogeneidad significativa luego de 1, 2 ó 3 meses. Sin embargo, cuando se realizó una tomografía computada durante los primeros días postoperativos (a los 10 días), se confirmó la presencia de burbujas de aire en el injerto. Los aspectos tomodensitométricos de todos los injertos tratados con metronidazol en esta serie son absolutamente idénticos: muestran un alto grado de homogeneidad: 63 casos (un 76, 8%) son homogéneos, y 19 casos (23, 2%) son significativamente no homogéneos. El tiempo en el que se realizó la tomografía de control (10 días, 1, 2 o 3 meses) no parece influenciar significativamente el grado de homogeneidad evaluado. En el grupo de control, se observaron algunos eventos inflamatorios asociados con una edema facial en un 25% de los casos. En el grupo de ensayo, ningún evento tal ocurrió en las 82 elevaciones del seno tratados con metronidazol. ***Conclusión:*** Podría existir una posible correlación entre la ocurrencia de las faltas de homogeneidad dentro de los injertos de hueso y la contaminación con bacteria anaeróbica. El uso local de una muy pequeña cantidad de metronidazol (equivalente a solamente 1/20 de una tableta oral común de 200 mg) podría ofrecer más seguridad cuando se realizan procedimientos de elevación del seno y una calidad mejorada del injerto. Este protocolo no debe considerarse como una terapia con antibióticos, sino solamente como una manera de limitar la contaminación inicial del injerto de hueso.

PALABRAS CLAVES: infección anaeróbica; antibióticos; injerto de hueso; metronidazol; elevación del seno

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Controlando a contaminação anaeróbica perioperatória sistemática durante procedimentos de elevação da cavidade usando metronizadol: Abordagem Innovadora

RESUMO: Antecedentes e Objetivos: A análise de controles tomodensitométricos em seguida a enxertos da cavidade demonstra claramente uma falta bastante sistemática de homogeneidade. A contaminação da cavidade por bactérias anaeróbicas parece quase inevitável durante a cirurgia de enxerto ósseo e esse problema pode colocar em risco o processo de cura. O objetivo desse estudo era caracterizar de modo sistemático as não-homogeneidades observadas em 1, 2 ou 3 meses após a cirurgia dentro de enxertos da cavidade alógena e avaliar a possível influência de uma solução estéril de metronizadol a 0,5% incorporada no enxerto ósseo da cavidade. ***Materiais e Métodos:*** Esse estudo clínico foi conduzido em 72 pacientes tratados com enxertos da cavidade únicos ou bilaterais: 94 elevações da cavidade realizadas com FDBA (Enxerto Aloplástico Ósseo Seco por Congelamento, Phœnix®, TBF®, Mions, France), com metronizadol (grupo de teste) ou sem (grupo de controle). No grupo de teste, cada enxerto ósseo foi hidratado com 2ml de uma solução de metronizadol a 0,5%, isto é, apenas 10mg de metronidazol. Todos os pacientes passaram primeiro por uma tomografia computadorizada pré-cirúrgica seguida de uma segunda tomografia realizada a 1, 2 ou 3 meses após a cirurgia (que foi usada com a tomografia de referência pré-implante). Para 11 pacientes, 2 tomografias computadorizadas pós-cirúrgicas foram realizadas respectivamente a 10 dias e 2 meses. Usando uma escala cinza arbitrária (Unidade Densitométrica Arbitrária (ADU)) que funciona de acordo com o princípio da unidade de Hounsfield, o grau de homogeneidade radiográfica dos enxertos foi estabelecido. A dispersão da densidade fornece algumas informações sobre a homogeneidade ou não-homogeneidade do enxerto ósseo. ***Resultados:*** Os 12 enxertos realizados sem metronizadol mostraram não-homogeneidades significativas a 1, 2 ou 3 meses. Além disso, quando uma tomografia computadorizada é realizada durante os primeiros dias pós-operatórios (a 10 dias), a presença de bolhas de ar no enxerto é confirmada. Os aspectos tomodensitométricos de todos os enxertos tratados com metronizadol nessa série são absolutamente idênticos: eles mostram um alto grau de homogeneidade. 63 casos (76, 8%) são homogêneos e 19 casos (23, 2%) são significativamente homogêneos. O tempo no qual a tomografia de controle é realizada (10 dias, 1, 2 ou 3 meses) não parece influenciar significati-

vamente o grau de homogeneidade avaliado. No grupo de controle, alguns eventos inflamatórios associados a edema facial foram observados em 25% dos casos. No grupo de teste, nenhum desses eventos foi registrado para as 82 elevações da cavidade tratadas com metronidazol. Conclusão: Uma possível correlação pode existir entre a ocorrência de não-homogeneidades dentro dos enxertos ósseos e a contaminação bacteriana anaeróbica. O uso local de uma quantidade muito pequena de metronizadol (equivalente a apenas 1/20 de um tablete oral comum de 200mg) poderia proporcionar mais segurança quando se realizam procedimentos de elevação da cavidade e uma qualidade melhorada do enxerto. Este protocolo não deveria ser considerado como antibioterapia, mas apenas como um modo de limitar a contaminação inicial do enxerto ósseo.

PALAVRAS-CHAVE: infecção anaeróbica; antibióticos; enxerto ósseo; metronidazol; elevação da cavidade

RUSSIAN / РУССКИЙ

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Снижение системного периоперационного анаэробного инфицирования во время процедур синус-лифтинга с помощью метронидазола: инновационный подход

РЕЗЮМЕ. **Предпосылки и цели.** Анализ данных томоденситометрического контроля, осуществляемого вслед за подсадкой синусного трансплантата, демонстрирует достаточно систематическое отсутствие гомогенности. Инфицирование синуса анаэробными бактериями во время операции по подсадке костного трансплантата кажется практически неизбежным. Эта проблема может замедлить процесс заживления. Цель данного исследования – системно охарактеризовать случаи отсутствия гомогенности, наблюдаемые спустя 1, 2 или 3 месяца после операции в аллогенных синусных трансплантатах, и определить возможное влияние 0,5-процентного стерильного раствора метронидазола, введенного в синусный костный трансплантат. **Материалы и методы.** Данное клиническое исследование проводилось на 72 пациентах, которые проходили лечение с применением процедур одностороннего или двустороннего синус-лифтинга: 94 поднятия синуса, выполненные с помощью лиофилизированного костного аллотрансплантата (Freeze-Dried Bone Allograft (FDBA), Phœnix®, TBFâ, Mions, Франция), с применением (тест-группа) или без применения (контрольная группа) метронидазола. В тест-группе каждый костный трансплантат был гидратирован 2 мл 0,5-процентного раствора метронидазола, то есть всего лишь 10 мг метронидазола. Все пациенты прошли первую дооперационную компьютерную томографию, а впоследствии – вторую томографию через 1, 2 или 3 месяца после операции (в качестве контрольной томографии для сравнения с той, которая была выполнена перед установкой имплантата). Для 11 пациентов 2 послеоперационных компьютерных томографии были проведены соответственно спустя 10 дней и 2 месяца. С помощью условной серой шкалы (денситометр (Arbitrary Densitometric Unit, ADU) которая использует принцип единиц Хаунсфилда, была установлена степень рентгенографической гомогенности трансплантатов. Распределение плотности предоставляет некоторую информацию о гомогенности или отсутствии гомогенности костного трансплантата. **Результаты.** Подсадка 12 трансплантатов, выполненная без использования метронидазола демонстрирует низкую гомогенность спустя 1, 2 или 3 месяца. Более того, при выполнении компьютерной томографии спустя 10 дней после операции было подтверждено наличие в трансплантате пузырьков воздуха. Томоденситометрические данные всех трансплантатов, обработанных метронидазолом в этой серии, абсолютно идентичны: они демонстрируют высокую степень гомогенности. В 63 случаях (76,8%) трансплантаты гомогенны, а 19 случаях (23,2%) гомогенность трансплантатов была высокой. Время, через которое проводилась контрольная томография (10 дней, 1, 2 или 3 месяца), не оказывало существенного влияния на определяемую степень гомогенности. В контрольной группе в 25% случаев наблюдались воспалительные явления, сопровождаемые отеком лица. В проверяемой группе такие явления не были зарегистрированы среди 82 синус-лифтингов с применением метронидазола. **Вывод.** Возможно, существует взаимосвязь между отсутствием гомогенности в костных трансплантатах и анаэробном бактериальном инфицированием. Местное использование очень небольшого количества метронидазола (эквивалентного всего лишь 1/20 обычной таблетки 200 мг для орального применения) может обеспечить более высокую безопасность при выполнении процедур синус-лифтинга и более высокое качество трансплантата. Данный протокол не должен рассматриваться как антибиотикотерапия, а лишь как способ сведения к минимуму

первоначального инфицирования костного трансплантата.

КЛЮЧЕВЫЕ СЛОВА: анаэробная инфекция; антибиотики; костный трансплантат; метронидазол; синус-лифтинг

TURKISH / TÜRKÇE

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Sinüs kaldırma prosedürlerinde metronidazol kullanarak sistematik perioperatif anaerobik kontaminasyonun kontrolü: Yenilikçi bir Yaklaşım

ÖZET: Giriş ve Amaç: Sinüs greftleri sonrasında tomodensitometre kontrollerinin analizi, homojenlikte sistematik bir yetersizliği açıkça göstermektedir. Kemik greft cerrahisi sırasında sinüste anaerobik bakteriyle kontaminasyon neredeyse kaçınılmaz bir olaydır ve bu problem iyileşme sürecini tehlikeye düşürmektedir. Bu çalışmanın amacı, allojen sinüs greftlerinde cerrahiden 1, 2 veya 3 ay sonra gözlemlenen homojensizlikleri sistematik bir şekilde tanımlamak ve sinüs kemik greftine eklenen %0,5 steril metronidazol solüsyonunun olası etkisini değerlendirmekti. ***Gereç ve Yöntem:*** Bu klinik çalışma, tek veya bilateral sinüs kaldırma prosedürü yapılan 72 hastayı içerdi. FDBA (Freeze-Dried Bone Allograft, Phoenix®, TBF®, Mions, Fransa) kullanılarak 94 sinüs kaldırma prosedürü, test grubunda metronidazol ile ve kontrol grubunda ise metronidazol olmadan yapıldı. Test grubundaki her bir kemik greftinde, %0,5 metronidazol solüsyonundan 2 ml (yani, 10 mg metronidazol) ile hidrasyon yapıldı. Tüm hastalarda cerrahi öncesinde birinci BT uygulandıktan sonra, ikinci tomografi operasyondan 1, 2 ya da 3 ay sonra çekildi (bu tomografi, implant öncesi referans BT olarak kullanıldı). Olguların 11 tanesinde 2 cerrahi sonrası BT, sırasıyla 10 gün ve 2 ay sonra yapıldı. Hounsfield birim prensibine göre çalışan gelişigüzel bir gri skala (Arbitrary Densitometric Unit - ADU) kullanılarak greftlerin radyografik homojenlik derecesi saptandı. Yoğunluk saçılımı, kemik greftin homojenliği veya homojenlik yokluğu hakkında bazı bilgiler sundu. ***Bulgular:*** Metronidazol kullanılmadan yapılan 12 greft, 1, 2 veya 3 ay sonra önemli ölçüde homojensizlik gösterdi. Ayrıca, ilk birkaç postoperatif günde (10. gün) çekilen BT, greftteki hava kabarcıklarının varlığını teyit etti. Bu seride metronidazol ile tedavi edilen tüm greftlerin tomodensitometre özellikleri kesinlikle aynıydı: bunların tümü yüksek homojenlik gösterdi. 63 olgu (%76, 8) homojendi ve 19 olgu (%23, 2) önemli derecede homojendi. Kontrol tomografisinin yapılma zamanı (10 gün, 1, 2, veya 3 ay), değerlendirilen homojenliğin derecesini önemli ölçüde etkilemedi. Kontrol grubunda, hastanın yüzünde ödem ile bağlantılı bazı enflamatuvar olaylar olguların %25′inde görüldü. Test grubunda metronidazol kullanılarak yapılan 82 sinüs kaldırma prosedüründe böyle herhangi bir olay görülmedi. ***Sonuç:*** Kemik greftlerinde homojensizlik oluşumu ile anaerobik bakteri kontaminasyonu arasında olası bir korelasyon olabilir. Çok küçük miktarda (sık kullanılan 200 mg'lık oral tabletin 1/20′ine eşit) metronidazolun lokal olarak kullanımı, sinüs kaldırma prosedürlerinde daha fazla güvenlik sağlayıp, greftin kalitesini arttırabilir. Bu protokol, bir antibiyo-terapi olarak değil de, sadece kemik greftinin ilk kontaminasyonunu sınırlamanın bir yolu olarak kabul edilmelidir.

ANAHTAR KELİMELER: anaerobik enfeksiyon, antibiyotikler, kemik grefti, metronidazol, sinüs kaldırma

JAPANESE / 日本語

サイナスリフトにおいてメトロニタゾールを使用した組織的周術期嫌気性菌感染管理：革新的アプローチ

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研究概要: :
背景と目的: サイナスグラフト後にtomodensitometric controlを解析すると、 組織の均質性が著しく欠如していることが明確に現れる。ボーングラフト手術で嫌気性菌によるサイナス感染を回避するのはほぼ不可能と見られ, この問題点が治癒プロセスを妨げている可能性が考えられる。当研究は同種骨サイナスグラフト術後1ヶ月目、2ヶ月目また3ヶ月目の時点で観察した非均質性を組織的に特徴づけ、サイナスボーングラフトに混入した0.5 % メトロニタゾール 無菌溶液のもたらす効力の可能性評価を目的とする。

素材と方法:　臨床研究は片側面あるいは両側面サイナスリフトを受けた72名の患者を対象にして行った: 94ケースのサイナスリフトを FDBA (ヒト非脱灰凍結乾燥骨, Phœnix®, TBFâ, Mions, France)にメトロニタゾールを加えたテストグループと、メトロニタゾールを使用しないコントロールグループに分けて行った。テストグループではボーングラフトをそれぞれ0.5% メトロニタゾール溶液2ml で水和した。すなわちメトロニタゾールは10mgという微量である。 患者全員は術前CTスキャンで一回目の画像診断を受け、さらに術後1ヶ月目、2ヶ月目 または 3ヶ月目に二回目のCTスキャン (インプラント術前の参考用スキャンとして使用)画像診断を受けた。うち11名の患者 は術後10日目と2ヶ月目に二回のCTスキャンを受けた。

Hounsfieldユニット原理に従ってファンクションするarbitrary gray scale (Arbitrary Densitometric Unit (ADU)) を利用して、レントゲン上グラフトの均質性度合を確かめた。密度散乱線がボーングラフトの均質性または非均質性に関する何らかの情報を提供する。

結果: メトロニタゾールを使用せずに行った12ケースのグラフトでは1ヶ月目、2ヶ月目、または3ヶ月目の時点で著しい非均質性が確認された。 そればかりか術後10日目の第一回 CTスキャン検診ではグラフト内部に空気泡の存在が確認されている。この一連の実験において、メトロニタゾールを使用した全グラフトの tomodensitometric aspectは徹底した同一性；つまり高度の均質性を示した。63 ケース (76•8%)は均質、19ケース (23•2%)にもかなりの均質性が見られた。 コントロールスキャンを行った時点 (10日目, 1ヶ月目、2ヶ月目または3 ヶ月目) が検査した均質性に重大な影響を与えているとは考えられない。コントロールグループでは, ケースの25%に顔面浮腫と結びついて考えられる数件の炎症が観察された。メトロニタゾールを使用して行ったテストグループ82ケースのサイナスリフトではこうした炎症の現象は記録されていない。

結果: ボーングラフトでの非均質性発生と嫌気性菌感染に相関作用が存在する可能性が考えられる。 極微量のメトロニタゾール局部使用 (200mg一般経口薬のわずか1/20の量に相当) が、サイナスリフトに一段と安全性を与えグラフトの品質向上を提供する。 ただしこのプロトコールはAntibiotherapyとしてではなく, ボーングラフト初期感染制限手段として考慮することが望ましい。

キーワード:　嫌気性菌感染; 抗生物質 ; ボーングラフト ; メトロニタゾール ; サイナスリフト

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CHINESE / 中国語

在竇增高術期間使用甲硝唑控制系統性的手術期間厭氧菌汙染：創新作法

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摘要：

背景與目的：竇移植後的 tomodensitometric 控制分析明確證明非常系統性的缺乏同質性。厭氧菌所致的竇汙染似乎是骨移植手術期間不可避免的問題，而且可能危害痊癒的過程。本研究的目的是以系統化的方法描繪，在同種異體竇移植手術後 1、2、3 個月內觀察到的非同質性特徵，同時也評估竇移植術中使用 0.5 % 的甲硝唑無菌溶液的可能影響。

資料與方法：本臨床研究涵蓋進行單邊或雙邊竇增高治療的 72 名患者：使用冷凍乾燥異體移植骨 (FDBA，Phœnix®, TBFâ，總部法國 Mions，) 執行 94 次竇增高，並且分為使用 (測試組) 或不使用 (對照組) 甲硝唑兩組。在測試組中，每個骨移植物都浸以 0.5% 甲硝唑溶液 2ml，也就是只含 10mg 的甲硝唑。所有患者都進行第一次的手術前電腦斷層掃描，然後在手術後 1、2、3 個月進行第二次掃描 (用來做為植體植入前的參考掃描)。11 名患者分別於手術後 10 天和 2 個月進行兩次電腦斷層掃描。

利用根據韓森費爾德單位 (Hu) 原理作用的任意灰階 (任意密度單位，ADU)，確立移植物的 X光同質性程度。密度散射提供部分骨移植物的同質性或非同質性資訊。

結果：12 個未使用甲硝唑的移植物，在 1、2、3 個月出現顯著的非同質性。此外，在第一個手術後掃描日 (10 天) 執行電腦斷層掃描時，確認移植物出現氣泡。本系列所有使用甲硝唑治療的移植物，在 tomodensitometric 方面完全相同：它們顯示高度的同質性。63 個病例 (76.8%) 為同質性、19 個病例 (23.2%) 為顯著同質性。對照掃描的執行時間 (10 天，1、2 或 3 個月) 似乎對同質性程度的評估沒有顯著的影響。在對照組中，發現 25% 的病例出現和臉部水腫有關的發炎事件。在測試組中，利用甲硝唑治療的 82 個竇增高術沒有這類事件記錄。

結論：骨移植物內出現非同質性以及厭氧菌感染之間，可能存在關連性。局部使用非常少量的甲硝唑 (僅約等於一般 200mg 口服錠的 1/20) 可能在執行竇增高手術時提供較高的安全性，並能改善移植物的品質。本治療方法不應被視為抗生素治療，僅能做為限制骨移植物最初汙染的方法。

關鍵字：厭氧菌感染、抗生素、骨移植、甲硝唑、竇增高

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KOREAN / 한국어

메트로니다졸을 이용한 동점막거상술에서 전신 수술 전후 혐기성 오염 조절: 혁신적인 접근 방법

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초록:

배경 및 목적: 동이식편 이후 단층밀도계 조절 분석을 통해 균질성이 매우 불규칙하게 나타났다. 혐기성 세균에 의한 동 오염은 골이식 수술 동안 대체로 불가피해 보이며, 이러한 문제점은 치유과정을 위태롭게 할 수 있다. 본 연구의 목적은 동종이형 동이식편 내에서 수술 후 1, 2개월 또는 3개월에 관찰된 비균질성을 체계적인 방법으로 특성화하며 동 골이식에 사용된 0.5% 멸균 메트로니다졸 용액의 잠재적 영향을 측정하기 위함이다.

재료 및 방법: 본 임상시험은 단일 또는 양측성 동점막거상술로 치료를 받은 환자 72명을 대상으로 시행되었다: 총 94건의 동거상이, FDBA(Freeze-Dried Bone Allograft, Phœnix®, TBFâ, Mions, France)를 이용한 그룹과, 메트로니다졸을 사용한 시험군, 메트로니다졸을 이용하지 않은 대조군으로 나뉘어 시행되었다. 시험군에서 각 골이식편은 2ml의 0.5% 메트로니다졸 용액, 다시 말해 10mg 단독 메트로니다졸로 수화되었다. 모든 피시험자들은 수술 전 CT 촬영을 받고, 수술 후 1, 2 또는 3개월째에 2번째 촬영(이식 전 참조스캔으로 사용된)을 받았다. 11명의 환자들은 2회의 수술 후 CT 촬영을 각각 10일 및 2개월에 시행하였다.

하운스필드(Hounsfield) 단위 원리에 따라 작동하는 임의회색점수 (임의밀도계단위 (ADU)) 를 사용하여, 이식편의 방사선학적 균질성 정도를 확인하였다. 밀도 분산은 골이식편의 균질성 또는 비균질성에 대한 일부 정보를 제공한다.

결과: 메트로니다졸 없이 시행된 12회의 이식에서 1, 2 또는 3개월에 상당한 비균질성이 나타난다. 또한, 최초 수술 후 기간(10일째)동안 CT 촬영을 시행했을 때,이식편에서 공기방울의 존재가 확인되었다. 이러한 연속물에서 메트로니다졸로 처치된 모든 이식편의 단층밀도양상은 절대적으로 동일하며 높은 균질성을 나타낸다. 63가지 사례(76.8%)가 균질하고, 19가지 사례(23.2%)가 상당히 균질하였다. 대조 스캔이 시행된 시점(10일, 1, 2 또는 3개월)은 평가된 균질성 정도에 유의한 영향을 미치지 않는 것으로 보였다. 대조군에서는 이러한 사례의 25%가 안면부종과 관련된 일부 염증반응을 보였다. 시험군에서는 메트로니다졸로 처치된 동점막거상술82가지 사례와 관련하여 어떠한 감염도 나타내지 않았다.

결론: 골이식편 내의 비균질성 발생과 혐기성 세균 오염 간의 잠재적 상관관계가 존재할 수 있다. 극소량(일반적인 200mg 경구알약의 1/20에 해당)의 메트로니다졸의 국소 사용은 동거상절차를 시행할 때 더 나은 안전성 및 이식편의 질적 개선을 제공한다. 이러한 프로토콜은 항생요법이 아닌 초기 골이식편의 오염을 제한하는 방법으로 간주해야 한다.

키워드: 혐기성 감염; 항생제; 골이식; 메트로니다졸; 동점막거상술.

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