Humanitarian Maxillofacial mission's success requires experienced surgeons, careful planning and meeting with the local's care needs Short Running Title: Humanitarian Maxillofacial Missions Jebrane Bouaoud MD PhD student 1 (Resident) Mouhamadou Makhtar Ndiaye MD 2 (Resident) Mourad Benassarou MD 1 (Practitioner) Silly Toure MD PhD 2 (Professor, Department Head)

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Short Running Title: Humanitarian Maxillofacial Missions

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All authors have participated to the conception and design, acquisition, analysis and interpretation of data; All authors have participated in drafting and revising the article; All authors have approved the final version for publication; All authors have agreed to be accountable for all aspects of the work, in

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Approval and Confirming Statements

This study was approved by an institutional review board and conducted in accordance with the Helsinki declaration. Data collection and analysis complied with the guidelines of the French National Committee for the Protection of Personal Data (CNIL declaration 2220621v0).

Abstract

Purpose: Meeting with local needs of low- and middle-income countries during maxillofacial humanitarian mission is not easy. This article aimed to report on 5 years of experience in humanitarian maxillofacial surgery missions. In addition, several key points for best practices and meeting the medical needs of local populations are discussed.

Methods: In this retrospective case series, all medical charts of patients managed during humanitarian maxillofacial surgery missions organized within the department of maxillofacial surgery of Le Dantec Hospital (Senegal) were analyzed. Disease characteristics, treatments modality, and outcomes were reviewed. Moreover, missions planning and costs were studied.

Results: Between 2015 and 2018, five humanitarian missions were organized totalizing 177 patients, one third of which were treated surgically. Tumors (35%) and sequelae from previous surgeries, NOMA or trauma (24%) were the most frequently treated disorders. Most patients were treated with free flap reconstructions (35%). Postoperative complications were observed for only three patients (5%). With a median follow-up of 13 months, no sequelae requiring specific treatment was observed. The estimated total cost for each mission was $39,000.

Conclusion: In order to benefit both the locals and the volunteers, humanitarian maxillofacial missions should be carefully planned, and volunteers appropriately prepared. Other keys to the success of such missions are setting up training and support programs, reflecting upon ethical considerations, understanding local cultural customs and ensuring mutual respect with the locals. Frequent self-evaluation and long-term mission sustainability are critical. Finally, mission costs should be evaluated.

Keywords: Humanitarian; Low- and middle-income countries; Surgical mission; Head and Neck Reconstruction; Maxillofacial; Ethics.

Introduction

Five billion people worldwide do not currently have access to safe, timely and affordable surgical care[1]. Indeed, in low- and middle-income countries (LMIC), 9 out of 10 people have no access to even the most basic surgical services[2] (https://www.who.int/surgery/en/). Children and adolescents are particularly vulnerable since 1.7 billion of worldwide did not have access to surgical care in 2017[3]. Moreover, given that only 10% of global health research is devoted to conditions that account for 90% of the global disease caseload (the so-called "10/90 Gap"), there is an urgent need for providing basic surgical care to LMIC populations[4].

Among essential surgical care and main objectives defined by the World Health Organization (WHO), much is related to maxillofacial surgery, such as the correction of congenital anomalies, the treatment of life-threatening injuries and burns and the decreasing of death and disability cases related to road traffic injuries. Thus, humanitarian maxillofacial missions have an important role to play in the treatment of these pathologies, but also in the training of local health professionals, with the ultimate goal of improving access to surgical care for these populations.

The purpose of this study was to report authors experience on 5 years of humanitarian maxillofacial surgery missions. In addition, several key points for best practices as well as other critical considerations allowing to meet the medical needs of local populations are discussed.

Material and Methods

To address the research purpose, the investigators designed and implemented a retrospective case series study. The study population was composed of all patients presenting to and managed for maxillofacial disorders by one of the humanitarian maxillofacial missions (Le Dantec Hospital, Senegal) organized between 2015 and 2018. Patients were excluded as study subjects if they have not been surgically treated during the humanitarian maxillofacial missions. All medical charts of included patients were reviewed to analyze disease characteristics, treatments modality, and outcomes. Moreover, missions planning, and costs were studied. This study was approved by the Pitié-Salpêtrière University Hospital institutional review board and conducted in accordance with the Helsinki declaration. Data collection and analysis complied with the French guidelines.

Results

Mission Planning

Overall, between 2015 and 2020, five 10-day missions were organized as part of a partnership between the departments of maxillofacial surgery of the Pitié-Salpêtrière University Hospital (France) and of the Aristide Le Dantec University Hospital (Senegal).

All missions were organized the same way (Supplementary Figure 1). Patients were seen for the first time, prior to the mission, by the local maxillofacial surgery team. Those requiring surgical treatment which could not be carried out by the local team were reconvened on the first day of the humanitarian mission to be examined.

A first team (Humanitarian Team 1) of three confirmed maxillofacial surgeons begun the mission. All reconvened patients were examined on Day 1 so that Team 1 could collect clinical and imaging data as well as photographs. Patients selected for surgical treatment were those presenting a pathology with significant physical, psychological and/or social repercussions, which could not be treated by the local team and whose surgical treatment represented a real benefit. After obtaining signed consents (detailed information was translated by the local team), patients were managed by the anesthetics team, who carried out complete check-ups and ensured that the necessary conditions for complex surgery were met (checking for anemia, severe malnutrition…). At the end of Day 1, the mission's operative planning was

established. Patient selection was decided by taking into account local needs, seriousness of the disease (vital risk, significant social/psychological impact…) and available resources (surgical material, imaging or histological data…).

From Day 2 to Day 5, Team 1 performed the surgical procedures requiring longer post-operative follow-up (major surgeries), particularly tumor resections with free flap reconstructions. Medical check-ups were completed every morning and evening to check for the absence of postoperative complications. Daily end-of-day virtual meetings were organized between the Team 1 and 2 to discuss the progress of the mission.

On Day 6, the two humanitarian teams visited all surgically treated patients. Then, they organized the second part of the mission for Team 2 and examined patients selected for this second part of the mission.

From Day 7 to Day 11, Team 2 performed less invasive surgical procedures (minor surgeries), particularly secondary reconstructions (sequelae of tumor resection, trauma, NOMA…) and temporomandibular joint ankylosis treatments (sequelae of trauma, infection…). Team 2 completed medical checks-up every morning and evening for surgically treated patients. On the last day, no surgery was performed. All patients were visited, and a debriefing of the mission took place between local teams (maxillofacial and anesthesiology departments), Team 1 (virtual meeting), Team 2, and the hospital's administrative department.

Of note, training and support sessions were organized throughout the whole mission, especially during patient visits, examinations and surgeries.

Patients and Disorder Characteristics

An average of 35 patients were examined in the course of each humanitarian mission, totalizing n=177 patients (Table 1). The median age was 22 (range: 2–69). Twenty-two (11%) patients were children and adolescents. The sex ratio F/M was 1.2.

Regarding disorders, tumors (35%) were the most frequent disorders represented. Two-third were mandibular ameloblastoma (n=42) while other tumors presented clinical/radiological malignant characteristics (Supplementary Figure 2). Sequelae (24%), from previous tumor resection (n=16), NOMA (n=16) or trauma (n=9), were the second most frequently encountered disorders. Temporomandibular joint ankylosis (19%), usually bilateral and caused by condyle infection/trauma during infancy, were also frequent.

Other patients presented vascular malformations (11%), facial neurofibromatosis (5%), facial syndromic dysmorphia (5%) and fibrous dysplasia (1%) (Figure 1).

Surgical Procedures

One third of patients (n=59) were surgically treated during our humanitarian missions (Table 2). Forty procedures were performed under general anesthesia. Reconstructions using free flap, especially fibular free flap, following segmental mandibulectomy for giant ameloblastoma, were the most frequent surgeries (Figure 2). Reconstructions using pedicled or local flaps for the treatment of traffic accident sequelae or for oral fistulas closure were frequently performed (27%). All reconstructions were performed by a double surgical team. Each of the two teams was composed of at least two confirmed senior surgeons and one operating room nurse. Temporomandibular joint ankyloses were usually treated with resection of the ankylotic mass, temporal muscle interposition/costochondral graft (rib) and bilateral coronoidectomy (18%) (Figure 3).

Nineteen procedures were performed under local anesthesia. It waw mainly the conservative treatment of giant unicystic mandibular ameloblastoma, using marsupialisation and drainage (74%) (Figure 4). These conservative treatments were considered as a “temporary solution” when more appropriate treatment was not possible. This generally allows a stabilization, or even a decrease in some cases, of the tumor size, provided that frequent irrigations are performed to prevent drain clogging. Drains were made using a 5cc sterile syringe cut and attached to the teeth with steel wires.

Postoperative Follow-Up

Postoperative complications were reported for three patients (5%), all after free flap reconstructions. One patient presented a cervical hematoma eight hours after the surgery. The surgical drainage of the hematoma led to the survival of the flap. One patient presented a total necrosis of the free flap (arterial thrombosis), which required its removal followed by further free flap reconstruction. Finally, the last patient presented partial necrosis of the free flap skin paddle requiring removal of the necrotic tissue and local care.

Long term follow-up data was available for only twenty-two of the operated patients (37%). The median follow-up was 13 months (range 6–38). No sequelae requiring specific treatment was observed (Figure 5 and 6).

Mission Costs

The total airfare and accommodation costs were $3,700 per volunteer for one week. The reusable surgical equipment for each mission (powerful motors, handpieces, complete lines of attachments...) was purchased thanks to a donation of $50,000. Consumables (sterile drains, titanium plates…) amounted to $1,800 per procedure. Overall, the estimated total cost for each mission was $39,000. Of note, each surgeon had a medical indemnity cover from its own country which has not been take into account for the mission costs.

Discussion

This study aimed to report on 5 years of experience in humanitarian maxillofacial surgery missions. In addition, several key points for best practices and meeting the medical needs of local populations were discussed.

Tumors and sequelae from previous surgeries, NOMA or trauma were the most frequently treated disorders. Complex head and neck free flap reconstructions during humanitarian missions seem to be feasible. Indeed, minimizing the risk of surgical complications and long-term sequelae while delivering high quality care is possible provided a favorable surgical ecosystem which includes different measures. Regarding the preoperative part of this ecosystem, the careful planning of the missions, the appropriate volunteers' preparation, the close collaboration with the local surgical and anesthesia/resuscitation teams and involvement of the patient and family in the care project are fundamental. During perioperative period, optimal operating conditions including operating room asepsis, instrument sterilization and experienced double surgical teams (reduction of surgery duration) are critical. One should remember that this can lead to high mission costs. Finally, an adapted post-operative monitoring within an intensive care unit, in which caregivers are specifically trained for this type of surgery, is important. The surgical monitoring for at least 48 hours allows the early diagnosis and management of free flap vascular complications. Twice daily medical check-ups allow ensuring the absence of postoperative complications.

Other keys to the success of such missions are setting up training and support programs, reflecting upon ethical considerations, understanding local cultural customs and ensuring mutual respect with the locals. Frequent self-evaluation and long-term mission sustainability are critical.

Maxillofacial issues being among the top five medical conditions managed on medical missions to LMIC[5]. Among head and neck disorders, tumors and sequalae are the most common[6].

No patient died during our mission, which is in line with the reported low mortality rate[7]. The risk of post-operative complications was minimized by different processes. For example, surgery duration was minimized by resorting to double surgical teams. While the early complication rate was non negligible, free flap head and neck reconstructions in LMIC seem to be feasible[8]. Post-operative monitoring for at

least 48 hours is necessary since most of vascular complications occur within this time frame. Interestingly, no postoperative infection was observed. This can be explained, at least partially, by some recommendations[9] such patient preoperative assessment, operating room asepsis, instrument sterilization… (Supplementary Figure 3).

Several authors have underlined the importance of long-term follow-up and the negative impact of very short-term missions[5] (Supplementary Figure 4). Indeed, there are several benefits for longer term missions namely longer postoperative care, increased surgeons' familiarity to the unique local environment and culture, increase in local theatre team and maxillofacial surgeons to new surgical techniques and team building, enhanced relationship building and cross fertilization of ideas and techniques between volunteer surgeons and local teams, increased training and teaching to facilitate local capacity building. Considering the different constraints (surgeons' availability, budgetary limitations…), each mission was designed to be present on site for as long as possible (~11 days). Moreover, the low long term follow-up data (37%) reported from our experience was mainly due to poor patient accessibility because of cost of travel, loss of earnings…. Identifying local factors is helpful for future missions and strategies to tackle these well-known and deep-rooted difficulties among patients in developing countries.

In light of the recent technological advances which allows long-term collaboration and follow-up[10], one can only hope that very short-term missions will no longer be undertaken in the future. Welling *et al.,* recently reported on the "seven sins of humanitarian medicine" and provided insights as to how to organize humanitarian missions in order to avoid these mistakes[11]. More recently, Lasker *et al.,* reviewed n=27 guidelines previously published aiming for more responsible humanitarian missions[12]. In the light of these reports and authors experiences, some elements of great importance for the success of missions can be provided.

First of all, humanitarian missions should be thoroughly prepared. A logical planning process and checklist are essential for the mission success[13]. Preparing a mission requires months of careful planning,

involving communicating with local teams (surgeons, anesthesiologists, administrative staff), collecting funds, obtaining equipment and, more importantly, preparing the volunteers[14]. Several international programs, which involve mandatory validation of certain surgical and ethical skills, can facilitate volunteer selection[15].

On the other hand, volunteers should remember that the humanitarian mission is first and foremost educational. Knowledge, unlike equipment, is ~~immaterial~~ non-physical and perennial as long as it is transmitted. Humanitarian teams cannot treat everyone. They must therefore train local teams so that they are able to provide the same care. Humanitarian teams should research and understand local needs, and then respond to them. The objective is to gradually lead local teams towards complete autonomy through training programs[16]. Hopefully one day there will no longer be a need for humanitarian teams. In practice, during each mission, various basic courses, both theoretical and practical, were organized (asepsis/antisepsis, physiopathology and treatment principles). Moreover, working closely with local practicians, especially in the operating room but also during consultations/hospitalizations, has already proven beneficial for the daily practice of local teams[17]. Finally, international surgical training collaborations are of great interest[18]. Authors regularly welcome local junior maxillofacial surgeons for several months within their department in order to train them as thoroughly as possible. As an example, one of these local junior surgeons (M-M.N.), who completed a year of maxillofacial residency, will continue in authors department as a clinical assistant for another year. Such long-term collaborations should allow for quality aftercare, help perform outcome research and build the surgical capacity of local teams, especially for reconstructive missions[19]. Of note, the mission is currently trying to collaborate with the local medical school and nursing college to provide structured teaching and training as part of capacity building for the local hospitals.

Among other standards of good practice, volunteers must consider ethical issues[20]. They must reflect upon how the locals (doctors and patients) perceive their presence and work, but also upon their own perception of the locals. While some perceived benefits are reported by patients, several challenges remain for humanitarian volunteers[21], most importantly the lack of understanding of culture-specific

issues. Understanding and respecting local culture humanitarian missions is of great importance[22]. It is crucial to understand the impact of local culture on the behavior and responses that patients and/or their entourage may have regarding us and our work. Humanitarian volunteers must sweep aside all their certainties/preconceptions in order to open themselves to a world utterly different from theirs. In practice, this means being very mindful of local morals and habits and eradicating any conduct that might be perceived as condescending (music in the operating room...). Moreover, the perpetuation of stereotypes suggesting that humanitarian volunteers possess superior knowledge or skills should be combatted[23]. In order to improve volunteers' cultural competency and ethical consideration, specific training programs have been developed[22]. Other challenges include poor adaptation to low-resource settings (no biology labs or imaging…), communication issues with patients or self-serving and exploitative intentions[21].

Data collection, reporting on mission outcomes[24] and long-term mission sustainability[14] are fundamental. Data collection helps evaluate practices and provide information about humanitarian missions areas in need of improvement[25]. Reporting outcomes allow humanitarian volunteers to fulfill research and ethical obligations[26]. Specific self-evaluation tools to assess mission efficacy, sustainability, and long-term impact have been developed[27]. Overall, the creation of a central database [28] and the inclusion of patients in the missions evaluation process are fundamental[29].

Finally, mission costs are non-negligible. The total financial expenditure reported in this study is elevated, in particular because of the decision to perform all surgical reconstructions with double surgical teams comprising confirmed surgeons. This choice has been made for two reasons. First, this organization is the same as for the care of patients undergoing major surgeries in France in authors' department. Second, double teams enable to minimize surgery and anesthesia durations for patients who are often fragile on the anesthetic level. Respecting the patients, including in terms of material and human resources, is critical to the success of humanitarian missions.

Despite the inherent limitations due to our retrospective data collection and the limited number of patients with follow-up data, which may underestimate long-term sequelae, our results were consistent with other reports. Beside the relatively large number of patients included, we report senior maxillofacial surgeons' experience to bring critical elements allowing the success of humanitarian missions.

Of note, in 2019, due to the serious SARS-CoV-2 pandemic situation authors took the decision to postpone humanitarian missions. Keeping commitment to offer high quality care but always taking into account the basic principle for the preservation of the health and safety of missions' members and locals, authors have considered that Humanitarian missions would not be possible. It was therefore decided to maintain the long-term collaboration with locals thanks to virtual meetings. Author had continued close monitoring of the situation and unfortunately given the negative evolution of the pandemic at this time authors consider that the activity of the Humanitarian Maxillofacial missions is not currently possible.

Conclusion

In order to benefit both the locals and the volunteers, humanitarian maxillofacial missions should be carefully planned, and volunteers appropriately prepared. Other keys to the success of such missions are setting up training and support programs, reflecting upon ethical considerations, understanding local cultural customs and ensuring mutual respect with the locals. Frequent self-evaluation and long-term mission sustainability are critical. Finally, mission costs should be evaluated. Future missions should evaluate the contribution of the missions in terms of training and independence of local practitioners as well as include the creation of a central database including all patients managed during missions.

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Table 1. Patients' and disorders characteristics (n = 177)

Variables	Overall population	
Age (Median, range)	22	2-69
Gender (N, %)		
Male	82	46%
Female	95	54%
Disorders (N, %)		
Tumor		
• Benign clinical/radiological characteristics	42	24%
• Malignant clinical/radiological characteristics	19	11%
Sequelae		
• Previous tumor resection without reconstruction	16	9%
• NOMA (*cancrum oris*)	16	9%
• Trauma (traffic accident…)	11	6%
Temporomandibular joint ankylosis	33	19%
Vascular malformation	19	11%
Facial Neurofibromatosis	9	5%
Facial syndromic dysmorphia	9	5%
Fibrous Dysplasia	3	1%

Table 2. Patients' and disorders characteristics that were surgically managed (n = 59)		
Variables	Overall population	
Age (Median, range)	22	7-69
Gender (N, %)		
Male	23	39%
Female	36	61%
Surgeries performed under general anesthesia (N, %)		
Reconstruction with free flap		
• Segmental mandibulectomy + Fibular free flap to resect a giant mandibular Ameloblastoma	10	25%
• Other free flaps for NOMA sequelae	3	8%
• Fibular free flap for secondary reconstruction	1	2%
Reconstruction with pedicled or local flap		
• Sequelae management (traffic accident…)	4	10%
• Closure of an oral fistula	4	10%
• After resection of a tumor suspected of malignancy	3	7%
Resection of the ankylotic mass, temporal muscle/rib interposition and bilateral coronoidectomy	7	18%
Conservative treatment (bone shaving, limited resection of soft tissue) for fibrous dysplasia, neurofibromatosis, vascular malformation...	7	18%
Biopsy of a tumor suspected of malignancy located in the deep soft tissue	1	2%
Surgeries performed under local anesthesia (N, %)		
Drainage of a mandibular Ameloblastoma	14	74%
Surgical biopsy of deep tumor suspected of malignancy	4	21%
Cheiloplasty	1	5%

Legends

Figure 1. (**A**) Twenty-three years old patient presenting cutaneous and mucosal capillary malformation, namely Sturge-Weber syndrome. (**B**) Thirty-two years old patient presenting facial neurofibromatosis. (**C**) Four years old boy presenting facial syndromic dysmorphia. (**D**) Twenty-one years old patient presenting mandibular mass related to fibrous dysplasia.

Figure 2. (**A** and **B**) Twenty-four years old patient presenting a giant mandibular ameloblastoma. (**C**) After segmental mandibulectomy, reconstruction using fibular free flap was realized. (**D**) Post-operative day three is showed.

Figure 3. (**A**) Thirty-three years old patient presenting a bilateral temporomandibular joint ankylosis causing a lack of mouth opening. (**B**) Ankylosis bloc of the right temporomandibular joint. (**C** and **D)** One-year postoperative photograph of the patients. The treatment comprised resection of the ankylotic mass, temporal muscle interposition and bilateral coronoidectomy.

Figure 4. (**A** and **B**) Nineteen years old patient presenting a giant unicystic mandibular Ameloblastoma. (**C**) Conservative management, *i.e.,* drainage under local anesthesia was realized using a 5cc sterile syringe cut and attached to the teeth with steel wires.

Figure 5. (**A**) Fifty-two years old patient presenting a giant mandibular ameloblastoma managed using segmental mandibulectomy and immediate reconstruction with fibular free flap. (**B, C** and **D**) Patient aspect after twenty-four months of follow-up.

Figure 6. (**A**) Eight years old boy presenting a bilateral temporomandibular joint ankylosis causing lack of mouth opening. (**B** and **C**) One-year postoperative aspect of the patients. The treatment comprised resection of the ankylotic mass, costochondral graft (rib) and bilateral coronoidectomy.

Table 1. Patients' and disorders characteristics that were evaluated during missions

Table 2. Patients' and disorders characteristics that were surgically managed during missions

Supplementary Figures legends

Supplementary Figure 1. Planning of humanitarian maxillofacial missions

Supplementary Figure 2. Twenty-four years old patient presenting a right maxillary tumor poorly circumscribed, osteolytic and with periosteal reaction (**A** and **B**). The diagnostic of high-grade osteosarcoma was realized following biopsy under local anesthesia. Five years old girl presenting a poorly circumscribed soft tissue tumor emerging form right infratemporal fossa (**C** and **D**). The diagnostic para-meningeal rhabdomyosarcoma was realized following biopsy under local anesthesia.

Supplementary Figure 3. New operating room (**A**) and sterilization equipment (**B** and **C**) were installed participating to the prevention of post-operative infections (Le Dantec Hospital, Dakar, Sénégal).

Supplementary Figure 4. (**A** and **B**) Twenty-two years old patient presenting surgical sequelae of previous NOMA management. Surgical reconstruction using local left nasolabial flap and an anterolateral thigh flap was realized by another mission two years before, without any postoperative follow-up. This illustrated the negative impact of very short-term missions.