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Revisiting Tonsillectomy Practices in the Light of the COVID-19 Pandemic

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ABSTRACT

With the onset of the COVID-19 outbreak, a limited healthcare force catered to an ever-increasing number of COVID-19 patients on top of non-COVID-19 patients. Over two years after the pandemic, it is evident that medical practice must adapt to COVID-19 to ensure the provision of undeterred, quality medical care. This review intends to re-evaluate the Tonsillectomy protocols that we employed during COVID-19 and explore ways in which we might improve the safety of this frequently performed surgery even after the pandemic. A decrease in the frequency of tonsillitis was observed as lockdown and strict social distancing protocols were followed. Thus, it is concluded that tonsillectomies may be deferred unless urgent and in the best interest of the patient and medical workforce. However, when surgery is necessary, new mitigation strategies, like preoperative COVID-19 screening, minimizing intra-operative staff, widespread use of personal protective equipment (PPE), negative pressure operating rooms, and reducing postoperative hospital stay need to be incorporated into the safety protocols of airway surgeries and minimize aerosolization such as using SES (smoke evacuation system) during surgery and TORS (trans-oral robotic surgery). This narrative review covers an extensive literature review of papers on PubMed, Google Scholar and Medline that highlight the impact of the Pandemic on the surgical practice in patients of recurrent tonsillitis since December 2019.

Keywords: Tonsillitis; Tonsillectomy; COVID-19; SARS-COV-2; Health Policy; Surgical Policy.

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INTRODUCTION

Recurrent tonsillitis in children and adults remains a common cause for otolaryngology consultation[1] accounting for about 50 per 1000 consultations with a general practitioner[2]. Tonsillitis is inflammation of the tonsils, presenting as sore throat when uncomplicated[1,3] consisting of up to 1.3% of OPD visits[3]. Hypertrophy of the tonsils is a common sequela of recurrent tonsillitis among children and adolescents. It may occur alone or along with adenoid hypertrophy especially in children of ages 3-6 years presenting with nasal obstruction, mouth breathing, and snoring, in severe cases with obstructive sleep apnea (OSA) and otitis media if the Eustachian tube is involved[1]. Tonsillitis has bacterial or viral aetiology[1-3]. Feared complications of recurrent Group A beta-hemolytic streptococcal (GABHS) tonsillitis include rheumatic heart disease and post-strepto-

coccal glomerulonephritis[2,3]. Depending on disease severity, the patient's quality of life may be greatly compromised along with a risk of multiple organ involvement in Rheumatic Disease and renal compromise caused by GABHS tonsillitis[2,3].

Therefore, surgical intervention is often necessitated[1]. However, the Covid-19 pandemic made surgeries on the airway highly risky which inevitably came to a halt to reduce the risk of intra-operative transmission[4] and to decrease the burden on healthcare resources. Tonsillectomies are procedures which cause high aerosol exposure and thus can spread viruses. Despite the nature of the surgery, hospitals reduced nosocomial transmission during COVID-19 by adhering to the stated protocols. Henceforth, we can make the treatment safe even after the pandemic. The dangers, diagnostic tools, and mitigation measures are the focus of this study.

DISCUSSION

Surgical practice faced a major deterrent amidst the COVID-19 pandemic[4,5] which caused up to 4.2 million deaths globally by march 2022 [6]. All elective surgeries were inevitably halted for an indefinite period[7,8]. SARS-COV-2 concentrates in the throat and nose of symptomatic as well as asymptomatic patients[6,9] and replicates in the palatine tonsils[6]. This major reservoir of the virus is exposed and disrupted in Tonsillectomy and adenoidectomy (TnA), putting operating room staff at risk of virus inhalation[4]. Contagiousness of the SARS-COV-2 warrants a risk re-evaluation for airway surgeries like tonsillectomies[4]. However, tonsillectomy indications and surgical practice have not been widely discussed in light of the pandemic. This review hopes to discuss the future of tonsillectomy in a post-pandemic era.

During our study, we found that surgical treatment of tonsillitis during a pandemic such as COVID-19 should only be carried out if urgent – such as in hemorrhagic tonsillitis or severe tonsillitis resulting in airway obstruction- or if semi-urgent in a patient who tests negative for COVID-19. For all other cases, it is recommended to delay surgery and treat conservatively. During our study we also found that delaying surgery and practicing social distancing helped relieve symptoms of, and expedite recovery from tonsillitis, thereby removing the need for tonsillectomy altogether in many patients (Figure 1).

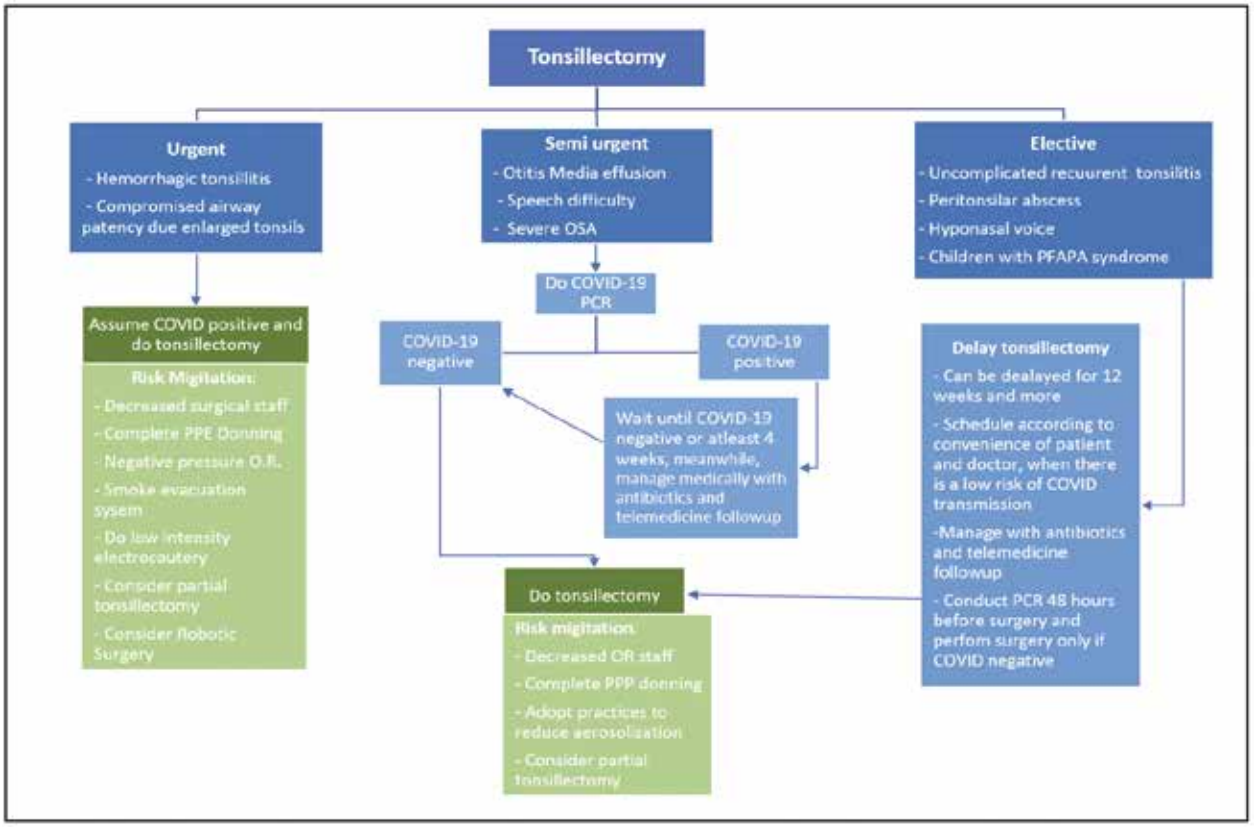

Figure 1: Categorization of tonsillectomy on urgent, semi-urgent and elective cases.

Tonsillectomy: Anatomy of Tonsils

Tonsils are highly vascular lymphoid aggregates acting as the first line of defense. The Waldeyer's ring in the nasopharynx and oropharynx comprises lingual tonsils on the posterior 1/3rd of the tongue, palatine tonsils between the palatoglossus and palatopharyngeus muscles, the pharyngeal tonsils on the roof of the nasopharynx (also called adenoids), and the tubal tonsils in the lateral wall of the nasopharynx. Each tonsil is enclosed by a fibrous capsule, and separating the capsule from the surrounding musculature is the peritonsillar space, a potential space between the capsule and the musculature[10].

Sequelae of Tonsilitis

Hypertrophy of the tonsils is a common sequela of recurrent tonsillitis among children and adolescents. It may occur alone or along with adenoid hypertrophy especially in children of ages 3-6 years, presenting with nasal obstruction, mouth breathing, snoring and in severe cases with OSA[1,11]. Some patients may also develop otitis media if the Eustachian tube is involved[1,11]. In severe cases, the patient's quality of life is greatly compromised. Therefore, to help alleviate their suffering, surgical intervention is often necessitated[1].

Indications of Tonsillectomy

Recurrent tonsillitis in children and adults remains a common indication for otolaryngology consultation. While Tonsillectomy is one of the most routinely performed elective surgeries [12] being one of the most common procedures conducted in USA[11], there are other indications set in place by the American Academy of Otolaryngology – Head and Neck Surgery (AAOHN), the most common of which are recurrent tonsillitis and obstructive sleep apnea[12,13]. However, medical treatment with regular follow-ups is advocated before resorting to surgery, unless the frequency of infectious episodes has been more than or equal to seven in a year, or five in two years, or three in three years[14,15]. Furthermore, peritonsillar abscess commonly seen in adolescents or adults under 40, hypo-nasal voice with symptoms of dysphagia due to hypertrophied tonsils are among other strong indicators for tonsillectomy[14]. Additionally, Children who often suffer from PFAPA syndrome (periodic fever, aphthous stomatitis, pharyngitis, and adenitis) benefit from a tonsillectomy and it is, therefore, also considered an important indication[14,15].

Methods of Tonsillectomies

Tonsillectomy, when necessary, can be done by the hot and cold methods. Cold techniques account for less postoperative pain; however, the risk of intraoperative bleeding is lower with hot techniques[10]. The hot technique employs multiple methods like monopolar electro-cautery (EC), radio-frequency ablation/coblation, or micro-debrider, whereas the cold technique is a sharp dissection method. Monopolar cautery remains the most popular method in the USA[10,13].

Complications of Tonsillectomy

Nausea and vomiting, secondary bleeding, severe pain and velopharyngeal insufficiency are some of the possible complications of tonsillectomies[10,16]. 70% of patients who do not receive preoperative anti-emetics experience nausea and vomiting within 24 hours after a tonsillectomy[10]. This can be managed by an intraoperative dose of dexamethasone[10,16]. The most concerning complication of a tonsillectomy is reactionary or secondary hemorrhage for which up to 33.02% have to revisit ER postoperatively[10,16,17]. Therefore, patients with bleeding tendencies and coagulopathies must be identified and administered precautionary management, preoperatively[10]. The chief cause of mortality following a tonsillectomy is a sequence of events associated with severe pain. Most pediatric revisits to the emergency department owing to severe pain are after tonsillectomy amongst all ambulatory surgeries[18]. Additionally, the glossopharyngeal nerve is at risk of injury during a tonsillectomy which can result in velopharyngeal insufficiency (food regurgitation through nasal pathways while eating and hyper-nasal speech)[10]. Consequently, patients have difficulty eating and drinking, resulting in the diminished oral intake of macro and micronutrients and water, eventually leading to dehydration, weight loss and a difficult recovery[7,16]. All these complications and risk factors must be considered when deciding when and if a tonsillectomy should be performed, and mitigation strategies to avoid complications must be carefully carried out, especially during a pandemic when hospital visits for patients are difficult and hospital resources are limited [7].

COVID-19 Effects on Surgical Practices

Surgical interventions have been subject to many hardships and deterrents since the advent of COVID-19 [19,20]. Due to an overwhelming number of COVID-19 patients, the pandemic caused a severe shortage of ICU and ward beds available for non-COVID-19 patients globally[5,8]. Operation theatres were used as additional ICUs to cater to the upsurge of critical patients[21]. With the worsening pandemic, the already saturated hospitals faced a paucity of medical workforce, as medical staff workers became increasingly COVID-19 positive[5,8]. Around 29% of cases of COVID-19 in the hospital workforce were due to nosocomial transmission at Wuhan University in 2020 [8]. The limited healthcare providers had to cater to both COVID-19 and non-COVID-19 patients, increasing the risk of cross-infection despite segregated COVID-19-positive units[5]. Considering all these challenges, the healthcare facilities needed to reorganize and reallocate the[5,8] limited available resources by canceling all non-emergent and non-cancer procedures to preserve beds[8,21,22], and by reallocating all staff including surgical staff and residents to COVID-19 units to battle the shortage of a medical

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workforce[21,22].

In the pandemic, several surgical societies classified procedures on a priority basis[20]. Jordan released guidelines in the first wave of the pandemic, classifying procedures into elective, non-elective and emergency[5]. Due to the uncertainty and rudimentary knowledge regarding strategies to deal with COVID-19 and ongoing surgical needs, only emergency procedures were prioritized while elective surgeries were indefinitely postponed. It was made essential for all patients to have a negative COVID-19 PCR test before surgery. In emergency cases where there was no time for a PCR test, the patient was considered COVID-19 positive and mitigation strategies were carried out accordingly[7]. As a result, a marked reduction was reported in Jordan in the average rate of elective and emergency surgeries in October 2020 compared to 2019[5].

Another example is Italy where surgical units also took several similar measures to ameliorate the burdens of limited bed and medical workforce shortages during the overwhelming COVID-19 waves. Around 50% of surgical departments that participated in the study had at least one person posted in a non-surgical COVID-19 unit. A marked reduction in surgical activity was observed during the first wave with 59% of surgical units reducing the number of beds dedicated to surgical patients while 11.9% of surgical units were completely shut down. This also reduced the risk of hospital transmission of COVID-19 [22]. However, emergency surgical cases also faced problems when the patient was COVID-19 positive [5]. It was recommended to operate such patients in negative pressure operating rooms with minimal staff, wearing personal protective equipment (PPE) [19].

COVID-19 Response in Pakistan

In Pakistan, a lower-middle-income country (LMIC) with insufficient healthcare services, the effects of COVID-19 have been particularly severe. Planning of Pandemic management and implementation had to be effective[23]. Initial "standard operating procedures" in Pakistan were lacking, and the government had to import testing supplies from China and Japan. Moreover, the rapidly rising number of illnesses also added fuel to the healthcare system because of violations of the lockdown and standard operating procedures (SOPs) [24]. Operating department practitioners (ODPs) categorized as either "box bearers" for surgeons or "handlers" of patients, confronted several difficulties during COVID-19, including inadequate training, lack of professional development, and resource shortages[25]. In Pakistan, the COVID-19 surgical management algorithm used the black, red, and orange codes, and the emphasis was on personal protective equipment (PPE), such as N95 masks and face and eye shields, rather than the operating room's environment. Elective procedures in Pakistan were not halted for as long as in first-world countries like Italy. Elective surgeries conducted in Pakistan were lowest in May 2020 which slowly rose by June 2020 despite significant COVID-19 cases, as Pakistan's surgical practice attempted to adapt to the pandemic as the new normal by adhering to strict SOPs. Following these HIC's recommendations allowed surgical care for patients to continue in Pakistan amidst the pandemic [23].

Diagnostic Delays Amidst Pandemic

Furthermore, the stringent lockdown laws affected accessibility to medical facilities which was evident by the distinctly longer average duration of symptoms before an ER visit during the pandemic than before the pandemic, resulting in diagnostic delays[7, 20, 26]. Consequently, more peritonsillar abscesses were reported with 66% requiring hospital admission of more than 24 hours[26]. Furthermore, provision of neoadjuvant treatment and surgery of neoplastic disorders were delayed[22] , and several ICU admissions increased[7] at a time when hospitals were already facing an upsurge in admissions to intensive care units[27]. Additionally, in ICU where most patients are on mechanical ventilatory support, tracheostomy is routinely performed especially on patients with a prolonged ICU stay to facilitate easy weaning from mechanical ventilator support. Its care often involves aerosol-generating procedures posing a risk of COVID-19 transmission to healthcare workers. Even though COVID-19 is not airborne, virus-laden aerosols lingering in the air increase transmission risk by over 2 meters [27].

Risks Posed by Tonsillectomy in a Pandemic

During the pandemic crisis, all elective surgeries inevitably came to a halt as the contagiousness of the SARS-COV-2 warranted a re-evaluation of risks for airway surgeries like tonsillectomies[8]. The WHO defines airborne particles as less than 5mm. Owing to their small size, they remain suspended in the air for a long and can traverse into the lower respiratory tract upon inhalation[4].

All procedures of the oral cavity and nasal cavity, including the pharynx, larynx and trachea have a great risk of producing aerosols[4,8]. The use of powered instrumentation on tonsils and adenoids during TnA can potentially emit particles of sizes less than 5mm. Therefore, it is inferred that TnA is an aerosol-generating procedure[4]. It is also known that lasers, monopolar and bipolar diathermy, commonly employed in tonsillectomy, cause droplet splatter on the face of the surgeon[28]. They heat tissues to their boiling point creating a surgical plume containing all cellular contents whether viable or non-viable, including viruses and pathogens[4].

Moreover, the SARS-COV-2 virus's major reservoir,

the throat and the nose [9] are exposed and disrupted in TnA, putting operating room staff at risk of virus inhalation[4]. It has also been established that SARS-COV-2 survives on surfaces for around 72 hours and can linger up to 2 minutes in aerosols contaminating more surfaces [9]. Grace Khong's simulation study confirmed that coblation tonsillectomy is also an aerosol-generating procedure. Droplet splatter was found in all surgical quadrants the densest near the surgeon with a significant splatter of droplets observed not just on the face shield of the surgeon but also on his mask and near his eyes which were covered by the visor. Despite it being only a simulation study, sufficient evidence of droplet splatter was detected, therefore the authors deduced that in practice there must be smaller droplets depositing on surfaces or remaining aerosolized for longer that could not be detected in this study[28]. Coronaviruses are transmitted via respiratory droplets [4,6,20] but owing to their small size of approximately 0.125µm[28] and SARS-COV-2 ranging between 60-140nm[29] it is highly probable that aerosols would increase airborne transmission risk of COVID-19 in surgical settings [28].

The high rate of transmission of SARS-COV-2 and its contagiousness to spread via droplets[4,20] made all aerosol-generating procedures such as that of the upper airways and oral cavity more dangerous[9] and placed otolaryngologists dealing with airway illnesses[30] and ENT surgeons[4] at the greatest risk of COVID-19 contraction and subsequent transmission because of high exposure [30] and droplet splatter contamination [9].

Diagnosing COVID-19

The virus that causes COVID-19 is called SARS-COV-2, and viral testing, such as antigen tests and nucleic acid amplification tests (NAATs) like PCR-based tests, were used to determine whether an individual is currently infected [31].

Prophylactic SARS-COV-2 RT-PCR Testing and its Limitations

New mitigation protocols required all surgical patients to be tested for the virus 48 hours before admission[4,6,32], especially when surgeons would be in close contact with their oral or nasal cavities. However, initially, this was not easily possible as many low-income-to-middle-income countries (LMIC) like India did not have widespread availability of RT-PCR tests for COVID-19 detection[30], and hence, the limited resources could not be spent on every surgical patient prophylactically. These logistical strains posed an added serious challenge to ENT specialists and otolaryngologists[30].

RT-PCR test also depends heavily on the viral load at the sampling site [21]. Theoretically, an RT-PCR negative patient might just be in the early phases of disease with a viral load not enough to be detected in a PCR test[4,21] but sufficient to be transmitting live virus intraoperatively, especially with aerosolization. Inadequate sampling also accounted for false negative results [21].

Adherence to such protocols was easy before tonsillectomy, a non-emergency procedure. However, post-tonsillectomy complications like hemorrhage leave little to no time for such protocols. The incidence rate of post-tonsillectomy hemorrhaging is about 2-4% [33]. About 2-8%, according to Ruiz and Dedhia [5] and about 6.4% after a trans-oral robotic surgery (TORS) for tonsillar cancer[33]. A physician has to look closely inside the patient's mouth to spot the bleeding. Blood may aspirate, triggering a cough reflex. This proximity to a patient's oral and nasal cavities put physicians at a high risk of contracting the virus and risked exposure to the patient's body fluids. Bleeding intervention requires suctioning of blood with electro-cauterization of the bleeder, both of which are aerosolizing procedures. As discussed above such emergent procedures should be managed in negative pressure rooms but most outpatient ENT departments do not have negative pressure rooms. In the case of post-tonsillectomy hemorrhaging patients would have to be transported from OPD to negative pressure operation theatres increasing the risk of transmission on the way if the patient was COVID-19 positive. Therefore, even while tonsillectomy could be done safely with the right precautions, managing any post-operative problems presented a high COVID-19 transmission risk if the patient was positive for the virus [33].

Moreover, there are rare times and cases that entail urgent tonsillectomy with no time to spare for RT-PCR testing. A case report of hemorrhagic tonsillitis in a COVID-19-positive patient with kissing tonsils, (tonsillar hypertrophy graded 4+) brings to light a rare surgical emergency of Haemorrhagic tonsillitis. It is defined as tonsillar bleeding for more than 1 hour or loss of 250ml blood, commonly caused by Haemophilus Influenzae, EBV and Beta Haemolytic Streptococci. Owing to the advent of antibiotics its incidence rate is only 1.1% amongst all cases of tonsillitis globally[34]. Infectious mononucleosis also causes huge tonsillar enlargement with edema of the pharynx, epiglottis, arytenoids and the uvula all of which causes fatal airway obstruction[35]. Maintaining hemostasis and airway patency is vital to the initial management of such emergencies[34,35]. Silver nitrate is applied for chemical cauterization to stop bleeding followed by antibiotics to reduce inflammation[34]. In cases of fatal airway obstruction, patients may present in critical states to the emergency departments requiring urgent tracheostomy and thyroidectomy to maintain airway patency[35]. An emergency tonsillectomy is often necessitated in such cases of uncontrollable bleeding or failure to

maintain airway patency, presenting a dilemma of performing a high-exposure surgery and management on the airway of a possibly SARS-COV-2 positive patient[34,35]. Similarly, certain head and neck malignancies like tonsillar cancer when presents at an early stage, need to be resected without delay as deferring such surgeries worsen prognosis [8,19, 20, 32].

Solutions: Mitigation Strategies

To evolve with the pandemic many countries have now set up exclusive COVID-19 isolation units, ICUs, HDUs and even hospitals with medical workers exclusively dedicated to these units only (20). With RT-PCR testing for COVID-19 detection more widely available, these measures have greatly curbed the strain on medical resources and eased an undeterred provision of non-COVID-related medical care.

While elective procedures can be deferred when there is a huge influx of COVID-19 patients or a strain of medical resources, new mitigation strategies need to be incorporated into surgical practices to cope with similar strains in the future. Patients of recurrent tonsillitis should be categorized as 'prioritized' and 'non-prioritized' cases based on the severity of their symptoms[9,36]. Patients with mild symptoms should be managed conservatively, with follow-ups via telemedicine. For semi-urgent cases and urgent cases, tonsillectomies can be performed with mitigation strategies in places such as the use of PPEs, negative pressure rooms and smoke evacuation systems. The use of robotic surgery should also be considered where possible.

Social Distancing and Waiting

In the U.K. average waiting time for elective surgery was 12.2 weeks in April 2020 compared to 7.2 weeks in April 2019 [12]. However, this delay came with an improvement in symptoms observed by several studies. Tonsillitis bouts were less frequent during the two months of lockdown, with a mean of 0.84 against a mean of 1.8 before the lockdown. Only 32% of patients required antibiotic treatment for acute tonsillitis, a substantial decrease from the 70% recorded in the months before to lockdown. No one in the study's patient population visited the hospital during the lockdown, which may have been owing to improved symptoms or a fear of getting the illness, COVID-19 [12].

Another Italian study had similar findings. With the schools shut there was a significant reduction in respiratory tract infections as well as in medicinal need or visits to emergency departments for symptoms of respiratory infection[1]. The study showed marked reductions in symptoms of nasal secretions and obstruction. Improvement in snoring and apnea were respectively around 58.3% and 60.3%. Despite improvements in symptoms, mouth breathing and nasal voice persisted in more than half of the children. This could be because of long-established habits as most children need speech therapy even after tonsillectomy to correct their breathing and talking habits[1]. Moreover, it is pre-established that schools increase exposure to pathogens that often causes recurrent upper respiratory tract infections, accordingly, children in daycares are at higher risk of contracting respiratory infections than children kept at home[1]. Hence, it is deduced that improvements in tonsillitis symptoms, reduction in medicinal use and hospital visits were because of reduced exposure to pathogens like bacteria and viruses owing to school closure and strict social distancing protocols. The pandemic kept entire families safe within their homes, minimizing any pathogenic transmission even among siblings [12].

Additionally, before the pandemic Heward et al. also established that some children recover from recurrent tonsillitis while on the waiting list for the surgery[12]. The AAOHNS also advocates for a period of watchful waiting with medical treatment for patients of recurrent tonsillitis[14]. The fewer tonsillitis outbreaks during the COVID-19 pandemic also resulted in shorter wait times for patients dealing with various illnesses that require surgical treatment. With the aforementioned findings combined with the high risk of COVID-19 transmission during ENT surgeries and management, it is deduced that delaying tonsillectomies at a time when medical resources are scarce and the medical workforce is overworked, is a safe treatment plan, especially when due to social distancing protocols pathogenic exposure remains low. This shall alleviate the patient's tonsillitis symptoms as well as prevent unnecessary burdens on the medical workforce while minimizing the transmission risk of COVID-19.

With these findings, it can be deduced that social distancing had an indirect benefit for patients suffering from recurrent tonsillitis with a significant reduction in infectious episodes. Therefore, individuals with recurring tonsillitis should continue to exercise social distancing or adherence to wearing masks in public places to alleviate their symptoms even in a post-pandemic era.

Medical Management and Telemedicine

Patients with mild symptoms of OSA can be managed medically for up to 6 months[37]. Such patients can be successfully counseled to stay home with regular telemedicine follow-ups, as 96.9% concordance between telephonic treatment plans and physical appointments has been reported[38]. For telemedicine in otolaryngology, the available literature is from a wide time range which makes any comparison and definitive conclusion hard, especially because its success greatly depends on technological advancements over time. However, the

available data strongly suggests that most of the time telemedicine in otolaryngology produces satisfactory images for diagnoses with 90% and 96% satisfaction of clinicians and patients respectively[39,40]. Telemedicine has already been employed in remote areas to avoid traveling over long distances[20]. Therefore, telemedicine health care should be explored as a viable method for regular follow-up and consultation of patients with mild to moderate tonsillitis, to mitigate the risk of unnecessary exposure to patients as well as health workers[8].

Telemedicine was able to change the long-standing surgical practice in addition to providing acceptable aid in the management of surgical patients during the elective care moratorium imposed by the COVID-19 pandemic[41]. It is clear from the above text that telemedicine can be effectively employed in managing patients for tonsillitis from home, further aiding in keeping their pathogenic exposure low, but the high implementation costs of telehealth systems are a deterrent in utilizing its full potential in LMIC-like Pakistan[41].

Making Tonsillectomy Safer

Only patients with either otitis media effusion, speech difficulty, cochlear implant[36], or severe OSA confirmed via polysomnography[15,37] should be prioritized for TnA on a semi-urgent basis after due multidisciplinary discussion[37].

As all procedures under general anesthesia are aerosolizing, and asymptomatic patients also pose a risk of pathogen transmission [9]. All patients undergoing any non-emergent surgery should be preoperatively screened for SARSCOV-2, 48 hours before admission to the hospital irrespective of their symptoms[4,36]. The RT-PCR requires a nasal swab from the patient, therefore, should be conducted with proper PPE [36]. If the patient has recovered from COVID-19 recently or tests positive for the virus before admission, tonsillectomy should be delayed for a minimum of four weeks because even with a negative RT-PCR, SARS-COV-2 is detectable in tonsils and detritus of the patient's specimen till 3 weeks after infection [6,36].

RT-PCR test depends heavily on the viral load at the sampling site [21]. Theoretically, an RT-PCR negative patient might just be in the early phases of disease with a viral load not enough to be detected in a PCR test [4,21] but sufficient to be transmitting live virus intraoperatively, especially with aerosolization. Therefore, appropriate PPE should be donned for all tonsillectomy or airway procedures[4]. PPE including goggles, N95 mask, sterilized surgical gloves, caps and gowns should be worn by all operating room staff [8, 9, 28, 32, 33,36]. However, as mentioned above even a face mask with a face shield is not sufficient in preventing droplet splatter on the surgeon's face during highly aerosolizing procedures such as EC and coblation. Therefore, air-purifying respiratory systems should be the obvious choice, especially in airway surgeries[28]. The risks of transmission with aerosol-generating procedures in the pandemic mandate the need to mitigate the use of such procedures as EC [36]. EC emits fewer aerosols on low-intensity settling, however, employing a smoke evacuator system (SES) with EC emits even lesser particles than low-intensity EC alone[4,8]. Removal of the surgical plume by SES has proven to be the most effective method yet to mitigate the production of surgical smoke in the operation theatre and should be adopted globally[4,8,29].

Moreover, operative measures should be optimized with due consideration by competent surgeons before surgery to reduce post-operative hospital stay without compromising medical care, for example in patients of severe OSA in whom the postoperative risk of respiratory collapse is high, warranting a prolonged hospital stay[37,42]. This should be of vital concern to surgeons amidst the pandemic. There is sufficient evidence that post-tonsillectomy pain and bleeding are markedly less in partial tonsillectomy compared to total tonsillectomy. Therefore, wherever possible surgeons should opt for a partial tonsillectomy to reduce potential hospital stay that will not just benefit the healthcare system but also prevent nosocomial transmission of COVID-19 to the patients[4].

Robotic Surgery

Robotic surgery has the potential to emerge as the socially distanced way of surgery, especially in emergency cases where there is no time to spare for an RT-PCR test or immunocompromised patients[32]. Trans-oral robotic surgery (TORS) is a branch of robotic surgery that deals with the oral cavity, pharynx and larynx. Now, more than ever, it is pertinent to think beyond the traditional approach to ENT surgery and consider the advent of TORS not just to protect the medical workforce but also to prevent unnecessary pathogenic exposure of possibly immunocompromised patients like that of tonsillar cancer or severe recurrent tonsillitis[32]. It is a minimally invasive surgery with higher precision, minimum damage to the surrounding tissues and shorter duration of hospital stay compared to traditional tonsillectomy[43,44]. TORS not just prevents the surgeon's exposure to the patient's body fluids and surgical smoke but also ensures distance among the health care workers who would otherwise be in much closer proximity to each other during open surgery. However, an assistant who needs to be by the patient's side is exposed to his bodily secretions and surgical smoke during TORS. Therefore, with TORS not all but most of the surgical staff can benefit from the distance between the patient and the surgical field[32].

The risk to assistant can be mitigated by using the highest

level of PPE and with an air-purifying respiratory system[32]. Moreover, TORS often eliminates the need for highly aerosol-generating procedures like tracheostomy and shortens hospitalization. However, it employs expensive equipment which would also require trained personnel; these factors will pose a challenge to the widespread availability of TORS. TORS also produces sufficient droplet splatter and aerosols which have a propensity for metal surfaces of the robotic equipment[32]. Therefore, all surgical staff should wear proper PPE regardless of the patient's COVID-19 status and it is essential to conduct the surgery in an excellently ventilated room to get rid of surgical fumes with post-operative decontamination of all the equipment[32].

A recent study at the University of Hong Kong explored the use of plastic drapes with watertight seals to create a sterile operating space where robotic arms would be free to move around while also preventing aerosol and droplet scatter on the assistant surgeon as well as in the operating room. The set-up employed two sterile sheets draped over the operating field, clamped in place using a wishbone frame and with 3M tapes. Each robotic cannula was also covered in a separate plastic sheet with an airtight seal created using 3M tape around each cannula. This provided another physical barrier against surgical smog whilst allowing a spacious closed field for the robotic arms movements. The study found droplet splatter on all plastic sheets being the densest over the site of operation. However, no droplet splatter was traced on the face shields of the operating room staff. Therefore, this model can be used in the future to ensure further safety in TORS surgery. An SES may also be placed under the drapes to further the safety of TORS surgery[45].

Lastly, *in-vitro* models have demonstrated that 0.5% Povidone-iodine (PVP-I) successfully inactivates SARS-Cov-2 on flat surfaces in 15 sec. It can be hypothesized that it may inactivate the virus when applied to the surface of tonsils and adenoids with cotton swabs. However, its efficacy in inactivating viruses present deep within tissue with just topical application is yet to be explored in *in-vivo* model [4]. In any situation when surgery is required, robotic surgery can be the most effective because it requires the least interaction with the patient and delivers a potentially effective treatment (Table 1).

Table 1: Various treatments for tonsillectomy patients: relative benefits and drawbacks.

Intervention	Pros	Cons
Watchful waiting	Self-resolution	Temporarily reduce the quality of life
Telemedicine	Less exposure, and high patient satisfaction rate.	Technology dependent- deterrent in LMIC
Hot method of surgery*	Less risk of intra-op bleeding	More post-op pain Risk of exposure to HCP, staff and other patients
Cold method of surgery**	Less post-op pain	Higher risk of intra-op bleeding Risk of exposure to HCP, staff and other patients
Robotic surgery	No COVID exposure to HCPs	Very expensive

**Hot Methods: monopolar electrocautery (EC), radio-frequency ablation/coblation or micro-debrider **Cold Method: Sharp dissection method.*

The authors, therefore, conclude that patients with recurrent tonsillitis should be managed medically with watchful waiting as per American Academy of Otolaryngology - Head and Neck Surgery (AAOHNS) guidelines because there is sufficient evidence to believe many patients might never need surgical intervention. This can be supplemented with the use of surgical masks in schools for children prone to developing sore throats. Only people with complications and severe disease as per AAHONS guidelines should be considered for an elective tonsillectomy. Before the surgery patients should undergo screening for infections that can be transmitted via aeroionization and droplet splatter.

Utmost care is being taken; starting from the pre-operative period comprising COVID-19 screening, in the peri-operative period, in the operative theatre surgical staff exposure time is kept to a bare minimum, with only limited people inside OR, and reducing aerosol generation, along with maintaining negative pressure. Post-operatively after an approximately 4-hour-long vigilant monitoring patient is discharged, carefully withholding only those that need observation. Possible post-operative complications should be discussed before surgery and surgical care should be optimized accordingly to reduce post-operative hospital stay. Mitigation strategies introduced during the pandemic such as widespread use of PPE, SES and

TORS should be incorporated into the safety protocols of airway surgeries especially tonsillectomy (a highly aerosolizing procedure) irrespective of the pandemic status to optimize patient and surgeon safety in the future without having to delay the provision of surgical care.

CONCLUSION

After two years of the pandemic, the safety deficits of routine surgeries such as tonsillectomies and treatment guidelines have been brought to light. Throughout COVID-19. Robotic surgery, telemedicine, and social isolation are a few major approaches that have reduced pathogen exposure and, thus, the risk of infection. These strategies should not only be used during pandemics; they should also be put into practice afterward when disease outbreak is a common occurrence due to subpar sanitary conditions in many areas of the nation. This will help reduce the spread of other diseases as well as have a positive impact on the healthcare sector.

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CONFLICTS OF INTEREST

No conflicts of interest to declare.

AUTHORS' CONTRIBUTION

All authors equally worked on literature search and drafting the manuscript.

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