

## POSTOPERATIVE INFECTION *MYCOBACTERIUM ABSCESSUS* ASSOCIATED WITH LIPOSUCTION AND AUTOLOGOUS FAT GRAFTING: A NARRATIVE REVIEW

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### SUMMARY

*Liposuction and autologous fat grafting are common aesthetic procedures these days. Although these procedures are relatively safe, some severe complications sometimes happen affecting aesthetic results and the patient's quality of life. Postoperative infection of Mycobacterium abscessus after liposuction and autologous fat grafting is an uncommon complication along with untypical symptoms. This results in misdiagnosis and delays in proper diagnosis and treatments, prolonging the treatment period. This narrative review summarises cases of M. abscessus infection associated with liposuction and autologous fat grafting, then presents causes, diagnoses, preventive care, and treatments of such cases. This aims to enhance the awareness of this infection after aesthetic surgery and contributes to the appropriate prevention and treatment.*

**Keywords:** *Mycobacterium abscessus, liposuction, autologous fat grafting*

### 1. BACKGROUND

In 2020, there were about 2.3 million people undergoing aesthetic procedures worldwide with liposuction being one of the top five popular (211,067 procedures) [1]. Modern liposuctions including power-assisted, ultrasound-assisted, and laser-assisted liposuctions have developed in

addition to manual liposuction [2-5]. These procedures are mostly safe, but severe complications could happen due to improper manipulations [5]. Among liposuction-associated complications, infection is rare with < 1% of total cases mostly caused by staphylococci or streptococci [5-7]. Non-tuberculous Mycobacteria (NTM), namely *Mycobacterium abscessus*, *M. chelonae*, and *M. fortuitum*, were often detected as infections after surgery including liposuction. This negatively impacted aesthetic results and the patient's quality of life [8, 9]. Improper and delayed treatments were caused by difficulty in

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differential diagnosis and the use of empiric antibiotics. These prolonged the hospital stay, worsened clinical results, and caused recurrences [10].

*M. abscessus* infection post-liposuction is rare and hard to differentiate from other infections with untypical symptoms. Until now, there has been no standard treatment guideline. This narrative review collects 46 cases with *M. abscessus* after liposuction and autologous fat grafting from 25 clinical reports and case series. Among those, there were 28 cases (60.9%) of liposuction,

27 cases (58.7%), and 9 cases (19.6%) of combined liposuction and autologous fat grafting (Table 1.1). Liposuction at the abdomen and the back was performed in a majority of cases. Liposuction of the thigh, neck, arm, flank, and face is less common. Fat grafting is often conducted at the face, breast, buttock, and hands. Common combinations of liposuction and fat grafting included liposuction at the abdomen, flank, neck, arm, or thigh and fat grafting at the breast, buttock, or face.

**Table 1.1. Summary of 46 cases with *M. abscessus* infection after liposuction and/or autologous fat grafting**

Author/Year	Gender/age of patients	Liposuction/Fat grafting position	Onset time of symptoms from the surgery	Time from cosmetic procedure to resentation at the hospital	Time to detect <i>M. abscessus</i> after presentation
Murillo/2000 [43]	F/35	Liposuction: Abdomen	35 days	NR	NR
	F/37	Liposuction: Abdomen	30 days	NR	NR
	F/47	Liposuction: Abdomen and thighs	10 days	R	NR
	F/49	Liposuction: Abdomen	45 days	NR	NR
Akers/2000 [45]	F/63	Liposuction: Face	6 weeks	6 weeks	10 weeks
Newman/2005 [26]	F/46	Liposuction: Abdomen	3 months	3 months	2 months
Furuya/2008 [40]	F/38	Liposuction: Upper back	2 weeks	2 months	NR
	F/44	Liposuction: Abdomen	1.5 months	1.5 months	NR
	F/58	Liposuction: Abdomen	2 months	2 months	NR
	F/45	Liposuction: Upper back	3 months	3 months	NR
Galea/2009 [23]	F/55	Fat grafting: Hand	NR	4 days	NR
Engdahl/2014 [46]	F/42	Liposuction: Back, flank	NR	5 months	6 days
	F/40	Liposuction: Abdomen Fat grafting: Buttocks	NR	4 months	13 days
Ruegg/2015 [24]	F/39	Liposuction: Abdomen Fat grafting: Buttocks	2 months	5 months	NR

Author/Year	Gender/age of patients	Liposuction/Fat grafting position	Onset time of symptoms from the surgery	Time from cosmetic procedure to re-sentation at the hospital	Time to detect <i>M. abscessus</i> after presentation
Hui/2015 [36]	F/41	Liposuction: Neck, upper arms, lower abdomen, thighs	NR	1 month	NR
Cai/2016 [39]	F/43	Liposuction: NR	3 weeks	4 months	NR
Yang/2017 [27]	F/29	Fat grafting: Face	5 days	NR	NR
Tung-Chen/2017 [22]	F/22	Liposuction: NR	5 months	6 months	NR
Cusumano/2017 [10]	F/31	Liposuction: NR	2 months	2 months	NR
Chang/2018 [34]	F/40	Liposuction: Abdomen Fat grafting: Face	6 weeks	3 months	NR
Lee/2019 [17]	F/49	Liposuction: Upper back	2 weeks	3 months	1 month
Escuredo/2020 [11]	F/66	Fat grafting: Breast	1 month	1 month	NR
	F/29	Fat grafting: Breast	NR	NR	NR
Chen/2020 [44]	12 females / 23-48	Fat grafting: face	6 - 90 days	NR	NR
Tan/2020 [35]	F/39	Liposuction: Abdomen Fat grafting: Breast	20 days	NR	NR
Su/2020 [37]	F/30	Fat grafting: Buttocks	2 weeks	11 weeks	NR
Moreno-Izquierdo/2020 [19]	F/42	Liposuction: arms and neck	2 weeks	5 weeks	NR
Yang/2021 [20]	F/28	Liposuction: Abdomen	8 days	3 months	45 days
Safe/2021 [38]	F/65	Liposuction: Abdomen Fat grafting: Buttocks	NR	NR	NR
Motawea/2022 [21]	F/23	Liposuction: abdominal flanks and back Fat grafting: gluteal region	2 weeks	2 weeks	25 days
Yeh/2022 [41]	F/34	Liposuction: Thighs and abdomen Fat grafting: Breast	3 weeks	3 weeks	5 weeks
Hill/2023 [47]	F/33	Fat grafting: Buttock	3 months	9 months	2 weeks
Tuán/2023 [42]	F/32	Liposuction: Underarm, thigh, back Fat grafting: Buttock	1 month	2 months	3 weeks
	F/43	Liposuction: Abdomen, back	1 month	1 month	2 weeks

Author/Year	Gender/age of patients	Liposuction/Fat grafting position	Onset time of symptoms from the surgery	Time from cosmetic procedure to resentation at the hospital	Time to detect <i>M. abscessus</i> after presentation
		Fat grafting: Buttock			
	F/32	Liposuction: Abdomen, flank	1 week	2 months	2 weeks

This review aims to summarize the causes, and common symptoms caused by *M. abscessus* after liposuction and fat grafting, diagnosis method, preventive care, and treatments of this complication.

## 2. CAUSES

Liposuction and fat grafting are deemed to be safe with lower rates of complications. These complications are avoidable or self-limited [5, 12, 13]. Even though, poor infection control or ineffective surveillance systems in unlicensed beauty centers might cause site surgical infection. Particularly, the centers might not allow patients to carefully bath with an antiseptic solution, or wash surgical tools with contaminated water. Additionally, residual fat on the used cannulas is also a cause if they are not properly processed [14].

### Preventions

Currently, there has been no standard prevention of surgical site infection of NTM after liposuction. Nevertheless, the adherence to surgical site infection prevention by WHO and the US Center for Disease Control and Prevention (CDC) could contribute to minimizing surgical site infection of NTM [15,16]. Careful bathing with appropriate antibiotic solution, preoperative prophylaxis, maintenance of a clear surgical environment, and careful

sterilization of surgical tools help effectively prevent NTM. Because of the alcohol resistance and acid resistance of Mycobacterium species, normal antiseptic solutions for sterilizing surgical tools may not be effective and could diffuse pathogens via surgical tools. A recent study suggested effective agents against NTM including glutaraldehyde, 3-chlorhexidine, and povidone iodine [17]. However, further studies are required to confirm the applications of these agents.

### Common symptoms of *M. abscessus* infection after liposuction and autologous fat grafting

In general, clinical symptoms of *M. abscessus* infection after liposuction and autologous fat grafting are untypical. After these procedures, non-infectious inflammation may occur as a body reaction against surgical trauma, leading to swelling or edema postoperatively [5]. Neira et al [18] suggested that modern techniques (e.g. laser-assisted liposuction) might cause milder inflammatory reactions than classical liposuction. However, our experience revealed that inflammatory reactions were equally less common for all types of liposuction, and no clear discrepancy of inflammation grades between different liposuction techniques.

Surgical site abscesses accounting for 60.9% (28 of 46 patients) and fever accounting for 47.8% (22 of 46 patients) were the most common symptoms. Less common symptoms consisted of red inflammatory foci (32.6%), pain (26.1%), and surgical site exudate (28.3%). In addition, some cases manifested with surgical nodes (13.0%), swelling (15.2%), allodynia (10.9%), or induration (8.7%). Sometimes, patients felt fatigued or uncomfortable [19, 20]. Other patients could have a sense of burning hot or ulcers at the surgical sites [10, 11, 21].

#### Paraclinical characteristics

All patients had normal blood tension and heart rates [22]. Blood examination showed normal ALT, total bilirubin levels, and electrolyte levels [20, 22, 23]. However, on one hand, some studies indicated normal levels of white blood count, and other studies showed a mild elevation in the other hand [19, 22-27]. The level of C-reactive protein was also normal in some investigations [19, 22-25]. A few reports demonstrated that the inflammatory reaction was just transient postoperatively and did not cause any significant changes in inflammatory markers via examinations, even when a large amount of fat was aspirated [28-31]. Nevertheless, in cases of surgical infection, it could lead to distinct inflammatory reactions due to the activation of immune system reactions to protect the body from pathogens (e.g. viruses, bacteria) via a variety of biological pathways [32, 33].

On ultrasound results, there could be scattered abscesses, fluid fat foci, or heterogeneous irregularity and hypoechoic injuries [22, 24, 27, 34-36]. Histopathologic images showed ulcerous or granular lesions [23, 34, 37, 38]. Meanwhile, fluid collection, abscesses, and air foci were seen in CT scans [10, 21, 26, 39-41].

#### Diagnosis

Often, patients visited hospitals lately for the treatment of complications caused by liposuction (83 days on average) [42]. Besides, the time to first symptoms and time of diagnosis of *M. abscessus* were often long (33 days on average), sometimes taking 3 months [42]. These reasons could result in treatment failure using initial antibiotics, high treatment costs, and failure in diagnosis.

Common samples for diagnosis were exudate, abscess fluid, necrotic/debrided tissues, culture/ biopsy of injured skin, or fluid collections. Diagnosis of *M. abscessus* was mainly based on the positive results to AFB or via 16s rRNA PCR [10, 19, 21, 24, 27, 35, 36, 42, 43]. Nevertheless, AFB results might be negative in some cases. This test could be really specific and might be negative at the first test until the transformation to positive in the following tests. Motawea et al. revealed that it took 8 days after the first negative results for the samples to be positive afterward [21]. Culture was the most frequent diagnosis method of *M. abscessus* which was used in 41 of 46 cases [10, 11, 19-23, 26, 34, 36, 37, 40-45].

However, the first results were often negative and required several following cultures [11, 20, 21, 23, 25-27, 36, 42,45]. Meanwhile, routine cultures often showed no bacteria developed. Yang et al. reported that it demanded 3 times culture to obtain a positive result of *M. abscessus* [20]. Additionally, the time to diagnosis of *M. abscessus* from the first visit due to *M. abscessus* infection after liposuction/autologous fat grafting was 6 - 70 days [20, 21, 25, 26, 41, 45-47]. It often took about 2 – 4 months from the first symptom to diagnosis. Some less common methods such as panel-reactive antibody and high-performance liquid chromatography were utilized to reinforce the diagnosis of *M. abscessus* [19, 40].

### Antibiotics and treatment regimens

The response to antibiotic treatment was different between studies. It could be 7

days, 2 - 4 weeks, 8 weeks, or 3 months after the treatment [20, 21, 27, 35, 42, 45, 47]. When the patient was presented at the hospital, empiric antibiotics were often prescribed while waiting for susceptibility testing results. The most common antibiotics for treating *M. abscessus* were beta-lactam antibiotics which were reported in 35 of 46 cases (76.1%) (Table 3.2). Most antibiotic regimens included 1 – 2 drugs [10,20,23,24,26,27,34,36,38,39,41,42,44,45]. Even though, some authors preferred to use 3 drugs and above [37,41,42,47]. These empiric antibiotic regimens were poorly effective, resulting in antibiotic changes when *M. abscessus* had still not been confirmed [27, 41]. Sometimes, antifungal medicine such as fluconazole was added to the regimen [37]. These medicines were almost ineffective against *M. abscessus*, leading to long treatment times and high costs.

**Table 3.2. Treatment regimens for *M. abscessus* infection after liposuction and/or autologous fat grafting in 46 cases collected**

Author/Year	Gender/Age	Liposuction/Fat grafting position	Empiric antibiotics	Treatment regimen	Antibiotic treatment course	Follow-up time	Complications
Murillo/2000 [43]	F/35	Liposuction: Abdomen	NR	• AMK + CLR* • Abscess drainage	4 months	At least 12 months	NR
	F/37	Liposuction: Abdomen	NR	• CLR + CIP* • Abscess drainage	9 months	At least 12 months	NR
	F/47	Liposuction: Abdomen and thighs	NR	• AMK + CLR + CIP* • Abscess drainage	5 months	At least 12 months	NR
	F/49	Liposuction: Abdomen	NR	• AMK + CLR + CIP* • Abscess drainage	18 months	At least 12 months	NR
Akers/2000 [45]	F/63	Liposuction: Face	CFR (7 days)	• CIP + EMB + RIF + CLR* -> IMP (3 weeks) + CLR* (6 months) • Drainage	6 months	12 months	NR
Newman/2005 [26]	F/46	Liposuction: Abdomen	AMC + AZM	• Abscess drainage • FOX + IPM + AMK + AZM	NR	NR	NR
Furuya/2008	F/38	Liposuction:	NR	• FOX + AMK +	6 months	NR	Rash and

Author/Year	Gender/Age	Liposuction/Fat grafting position	Empiric antibiotics	Treatment regimen	Antibiotic treatment course	Follow-up time	Complications
[40]		Upper back		CLR -> LZD • Drainage			leukopenia due to FOX Nephrotoxicity due to AMK
	F/44	Liposuction: Abdomen	NR	• CLR • Drainage	6 months	NR	NR
	F/58	Liposuction: Abdomen	NR	• LVX + CLR -> CIP • Drainage	6 months	NR	NR
	F/45	Liposuction: Upper back	NR	• AZM -> FOX + AMK + IPM • Drainage	22 months	NR	NR
Galea/2009 [23]	F/55	Fat grafting: Hand	Flucloxacillin	• Surgery and drainage • CLR + IPM + AMK	9 months	NR	NR
Engdahl/2014 [46]	F/42	Liposuction: Back, flank	NR	• AMP + FOX • Drainage • Debridement	6 months	NR	NR
	F/40	Liposuction: Abdomen Fat grafting: Buttocks	NR	• CLR + SXT + LVX • Drainage	6 months	NR	NR
Ruegg/2015 [24]	F/39	Liposuction: Abdomen Fat grafting: Buttocks	AMC + CIP	• CLR + TGC (12 days) + LZD (30 days) + AMK (12 days) *-> CLR + MXF (6 weeks)* • Drainage/NPWT • Debridement	20 weeks	5 months	Nausea owing to AMK and TGC Rash, hepatitis owing to LZD
Hui/2015 [36]	F/41	Liposuction: Neck, upper arms, lower abdomen, thighs	Flucloxacillin + TZP	• Debridement • AMK + CLR + LZD* • Corticosteroid	18 months	NR	Pancytopenia, liver disorders owing to LZD
Cai/2016 [39]	F/43	Liposuction: NR	FOX + CLR	• Debridement (delay) • AMK + LZD + IPM	8 months	6 months	Mild headaches and photophobia owing to AMK Peripheral neuropathy owing to LZD
Yang/2017 [27]	F/29	Fat grafting: Face	PEN +MTZ (3 days) -> TZP	• PZA + EMB + RIF + INH + LVX + AMK (at hospital) • MXF + CLR + EMB (12 months at home)*	15 months	2 years	Leukopenia due to AZM
Tung-Chen/2017 [22]	F/22	Liposuction: NR	AMX + cloxacillin	• AMK	4 weeks	NR	NR

Author/Year	Gender/Age	Liposuction/Fat grafting position	Empiric antibiotics	Treatment regimen	Antibiotic treatment course	Follow-up time	Complications
Cusumano/2017 [10]	F/31	Liposuction: NR	SAM, VAN	<ul style="list-style-type: none"> <li>• Surgery and drainage</li> <li>• AMK+ FOX+ AZM -&gt; AMK + TGC + AZM -&gt; AMK + AZM + IPM-cislastatin-&gt; CLO + AZM*</li> </ul>	30 weeks	NR	Intolerance to antibiotics. Leukopenia owing to FOX. Hyperpigmentation owing to CLO
Chang/2018 [34]	F/40	Liposuction: Abdomen Fat grafting: Face	AMC + GEN	<ul style="list-style-type: none"> <li>• CLR + MXF</li> </ul>	1 year	6 months	NR
Lee/2019 [17]	F/49	Liposuction: Upper back	CFR	<ul style="list-style-type: none"> <li>• Radical surgical debridement</li> <li>• MXF + CLR -&gt; AKM + IPM-cislastatin*</li> </ul>	6 months	NR	NR
Escuredo/2020 [11]	F/66	Fat grafting: Breast	AMC	<ul style="list-style-type: none"> <li>• Drainage, fistulectomy</li> <li>• AMK + TGC*</li> </ul>	16 weeks	NR	Recurrence
	F/29	Fat grafting: Breast	NR	<ul style="list-style-type: none"> <li>• AMK + TGC*</li> </ul>	3 months	NR	NR
Chen/2020 [44]	12 females / 23-48	Fat grafting: NR	Cephalosporin	<ul style="list-style-type: none"> <li>• Surgery</li> <li>• AMK + cephalosporin + CLR/CIP*</li> </ul>	1.5 years	3 – 7 years	Gastrointestinal discomfort, Abnormal liver function
Tan/2020 [35]	F/39	Liposuction: Abdomen Fat grafting: Breast	CXM + MTZ	<ul style="list-style-type: none"> <li>• Debridement, curettage, drainage</li> <li>• CLR + IPM + AMK (at the hospital)</li> <li>• AZM + EMB + RIF + (at home)</li> </ul>	7 months	8 months	Recurrence of masses after 8 months
Su/2020 [37]	F/30	Fat grafting: Buttocks	SXT + FLC + CLI + AMC	<ul style="list-style-type: none"> <li>• TGC + AMK -&gt; TZD + AMK + AZM *</li> </ul>	NR	NR	NR
Moreno-Izquierdo/2020 [19]	F/42	Liposuction: arms and neck	NR	<ul style="list-style-type: none"> <li>• AMK + IPM (1.5 month each) + CLR (7 months)</li> <li>• Incision and drainage</li> </ul>	7 months	NR	NR
Yang/2021 [20]	F/28	Liposuction: Abdomen	CFP + MXF	<ul style="list-style-type: none"> <li>• FOX + AMK + CLR + LVX + sulfamethoxazole</li> <li>• Incision and drainage</li> </ul>	146 days	6 months	Liver function abnormalities
Safe/2021 [38]	F/65	Liposuction: Abdomen	LEX (7 days)	<ul style="list-style-type: none"> <li>• CLR + MFX*</li> </ul>	6 months	12 months	NR



Author/Year	Gender/Age	Liposuction/Fat grafting position	Empiric antibiotics	Treatment regimen	Antibiotic treatment course	Follow-up time	Complications
		Fat grafting: Buttocks					
Motawea/2022 [21]	F/23	Liposuction: abdominal flanks and back Fat grafting: gluteal region	CLI	<ul style="list-style-type: none"> <li>Irrigation, debridement, sterile dressing</li> <li>DOX (10 days) + AZM</li> </ul>	NR	NR	NR
Yeh/2022 [41]	F/34	Liposuction: Thighs and abdomen Fat grafting: Breast	CFR + CIP - > TEC + DAP + CIP - > LVX	<ul style="list-style-type: none"> <li>CLR -&gt; CLR + DOX + TGC + AMK</li> <li>Debridement</li> </ul>	9 months	6 months	Diarrhea, nausea, vomiting
Hill/2023 [47]	F/33	Fat grafting: Buttock	DOX+ LVX+ AMX + CLI + MIN + SXT + LEX + RIF	<ul style="list-style-type: none"> <li>In hospital (2 days): AMK + TGC + IMP-cilastatin + LZD*</li> <li>Outpatient clinic (6 – 12 months): AMK + IPM + TZD + OMC*</li> <li>Surgery</li> </ul>	12 months	NR	Tinnitus and teeth discoloration
Tuan/2023 [42]	F/32	Liposuction: Underarm, thigh, back Fat grafting: Buttock	SAM + CIP + IPM-cilastatin	<ul style="list-style-type: none"> <li>Debridement, antibiotic irrigation, drainage.</li> <li>AMK (3 weeks) + CIP (6 weeks) + Sulfamethoxazole (6 weeks) + CLR (6 months)</li> <li>Methylprednisolone 1 mg/kg/day (2 weeks) then tapered by 1 mg/week during 2 months</li> </ul>	6 months	6 months	Hyperpigmentation
	F/43	Liposuction: Abdomen, back Fat grafting: Buttock	SAM + CIP + IPM-cilastatin	<ul style="list-style-type: none"> <li>Debridement, antibiotic irrigation, drainage.</li> <li>AMK (3 weeks) + CIP (6 weeks) + CIP (3 months) + CLR (6 months)</li> <li>Methylprednisolone 1 mg/kg/day (2 weeks) then tapered by 1 mg/week during 2 months</li> </ul>	6 months	6 months	Nephrotoxicity, hyperpigmentation
	F/32	Liposuction:	Not applied	<ul style="list-style-type: none"> <li>Debridement,</li> </ul>	4 months	6 months	Hyperpigmen-

Author/Year	Gender/Age	Liposuction/Fat grafting position	Empiric antibiotics	Treatment regimen	Antibiotic treatment course	Follow-up time	Complications
		Abdomen, flank		dressing changes • AMK (3 weeks) + IPM-cilastatin (3 weeks) + CLR (6 months) • Methylprednisolone 1 mg/kg/day (2 weeks) then tapered by 1 mg/week during 2 months			tation

Abbreviations: AMC: Amoxicillin-clavulanate potassium, AMK: Amikacin, AMP: Ampicillin, AMX: Amoxicillin, AZM: Azithromycin, CFP: Cefoperazone, CFR: Cefadroxil, CIP: Ciprofloxacin, CLI: Clindamycin, CLO: Clofazimine, CLR: Clarithromycin, CXM: Cefuroxime, DAP: Daptomycin, DOX: Doxycycline, EMB: Ethambutol, FLC: Fluconazole, FOX: Cefoxitin, GEN: Gentamicin, INH: Isoniazid, IPM: Imipenem, LEX: Cephalexin, LVX: Levofloxacin, LZD: Linezolid, MIN: Minocycline, MTZ: Metronidazole, MXF: Moxifloxacin, PEN: Penicillin, PZA: pyrazinamide, OMC: Omadacycline, RIF: Rifampicin, SAM: Ampicillin-sulbactam, SXT: Trimethoprim-sulfamethoxazole, TEC: Teicoplanin, TGC: Tigecycline, TZD: Tedizolid, TZP: Piperacillin-tazobactam, VAN: Vancomycin.

*\* Based on susceptibility testing results*

Despite difficult differential diagnosis, most *M. abscessus*-infected cases after liposuction and autologous fat grafting were not complicated as was shown by the high rate of successful treatments, and uncomplicated regimens, even with long treatment periods. Some cases demanded to change initial antibiotics because of

intolerant side effects, high cost, or undetected antibiotic resistance due to no susceptibility testing previously conducted [25, 27, 40, 45]. Time for the antibiotic treatment could last from 4 weeks to 18 months. However, the most frequent of regimens in current reports was 12 months (32.6%). Regimens of 6 months (15.2%), 9 months (6.5%), or 18 months (6.5%) were less frequent. Only 21.7% of cases required a regimen not more than 6 months [11, 20, 22, 24, 42, 43]. In addition to antibiotics, surgical debridement and lesion irritation combined with drainage were recommended.

After *M. abscessus* was identified, most of the authors selected antibiotics with a spectrum covering *M. abscessus* without susceptibility testing results [21, 23, 26, 27, 39]. These antibiotics included doxycycline, macrolides (Azithromycin or Clarithromycin), Amikacin, Linezolid, beta-lactam antibiotics (e.g., Imipenem, Cefoxitin), Fluoroquinolones (Moxifloxacin, Levofloxacin), and Tedizolid. In the meanwhile, susceptibility testing played a critical role in effective regimens in 63.0% of cases. These patients were cured without significant complications [10, 11, 24,

25, 27, 36-38, 42-45, 47]. Among those, Lee et al. demonstrated the important role of susceptibility testing as it helped to detect Moxifloxacin resistance that caused treatment failure [25]. The author changed the regimen to Amikacin and Imipenem-cilastatin following susceptibility testing results.

Among reported regimens, authors preferred to use a macrolide-based regimen following the recommendation of ATS/IDSA [48]. The macrolide-based triple regimen was the most common which consisted of amikacin, clarithromycin/azithromycin, and another antibiotic (e.g., linezolid or imipenem). Macrolide-based dual regimen was also widely used. Monotherapy with clarithromycin or amikacin also showed good results in some cases [22, 40]. There were still cases of failure treatment using macrolide-based triple drugs, macrolide-based multiple, or non-macrolide-based triple drugs [10, 40, 45]. This proved that multiple drug regimens did not ensure a successful treatment. The selection of antibiotics and regimens should be based on susceptibility testing and the response to antibiotics of the patient.

Common adverse effects caused by oral amikacin include gastrointestinal discomfort, nausea, abnormal liver function, headaches, photophobia, and nephrotoxicity. Linezolid could cause rash, hepatitis, pancytopenia, ototoxicity, or peripheral neuropathy. Azithromycin could cause leukopenia whereas cefoxitin might result in maculopapular rash and leukopenia. Besides, clofazimine might be

a cause of hyperpigmentation [10, 20, 24, 27, 36, 40, 41].

Some complicated *M. abscessus*-infected cases requiring special treatment or longer treatment time were reported [10, 36, 40, 42]. Furuya et al. reported a case of unrecovered despite prolonged treatment time (22 months) combined with debridement [40]. Cusumano et al. [10] presented a case of multiple drug resistance with a regimen based on susceptibility testing results, leading to treatment failure. In this report, the patient was prescribed empiric antibiotics without any improvement during 2 weeks of waiting for susceptibility testing results. Then, the first regimen based on the susceptibility testing results did not improve symptoms while new abscesses still developed. Antibiotic regimens were changed many times because the patient was not tolerant to tigecycline and many complications caused by cefoxitin happened. Finally, clofazimine and azithromycin was the last choice after other antibiotics were ineffective and limited source of antibiotics in the hospital. The patient recovered with minor complications.

In addition, Hui et al. [36] noted a case of paradoxical reactions during the treatment based on the susceptibility testing results. In this case, symptoms did not improve after 2 weeks of treatment whereas no bacteria isolated. The authors added a corticosteroid to the regimen that significantly improved the symptoms. This patient recovered well after 18 months of treatment. The benefits of corticosteroids to the treatment of *M. abscessus* after liposuction/autologous fat grafting were

also shown in three cases reported by Tuan et al. [42]. A triple regimen combined with methylprednisolone 1 mg/kg/day then tapered by 1 mg every 2 weeks for 2 months, initiating 3 weeks after antibiotic regimen or immediately combined with antibiotic regimens, resulted in promising results and shortened hospital stay (2 - 4 months). Some mild complications such as hyperpigmentation or bruising at the surgical sites were recorded. The hyperpigmentation could be addressed by 4% hydroquinone cream. These patients were satisfied with the results.

### 3. CONCLUSIONS

*M. abscessus* infection is a less common complication but causes troubles in diagnosis because of untypical symptoms and the requirement of many times of cultures. This could lead to treatment failure or improper treatment regimen, long hospital stays, and high costs. The awareness of NTM infection after liposuction/autologous fat grafting could contribute to the timely diagnosis and effective treatment regimen. Samples for diagnosis should be cultured many times before excluding NTM from pathogens. Adhering to the recommendation of surgical site infection prevention by the WHO or CDC could minimize the probability of NTM infection postoperatively. Macrolide-based dual or triple regimens were frequently used and effective against *M. abscessus* infection after liposuction and/or autologous fat grafting. The follow-up time should be long enough because of the high chance of recurrence.

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