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ETIOLOGY, INCIDENCE AND PREVALENCE OF OSSICULAR CHAIN EROSION AMONG MUCOSAL AND SQUAMOUS TYPES OF CHRONIC SUPPURITIVE OTITIS MEDIA- AN OBSERVATIONAL STUDY

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Conflicts of Interest: Nil

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Abstract:

Background: Chronic suppurative otitis media (CSOM) implies a permanent abnormality of the tympanic membrane, either in its pars tensa part or pars flaccid part, which is most likely a result of earlier acute otitis media, negative middle ear pressure, trauma or otitis media with effusion.

Objectives: We have conducted this study to evaluate prevalence, incidence and common etiology of ossicular chain erosion among both mucosal and squamous types of CSOM patients.

Methods: Admitted patients with CSOM were subjected to detailed history taking, complete general examination, systemic examination, otoscopic examination, audiological tests like conversation test, whisper test, tuning fork tests, vestibular function tests and examination under microscope. The patients also underwent investigations like PTA and radiological investigations like Modified Mayer X ray, Law's view x ray for all patients or CT scan of the temporal bone when necessary.

Results: Out of 150 patients, mucosal CSOM was found in 87 cases (58%) and squamous CSOM was found in 63 cases (42%). The most commonly affected age group in CSOM patients of our study was between 16 and 25 years. Incus erosion was seen in 42% of cases, stapes erosion in 20.67%, malleus erosion in 15.33%, 24% of cases had discontinuation of malleo–incuidal joint and 37.34% of cases had incudo– stapedial joint discontinuity.

Conclusion: We have successfully observed the ossicular chain status of 150 cases of CSOM to find out the causes of ossicular erosion among the mucosal and squamous types of CSOM. The results were promising and definite for forming any conclusion. This study will help in future research for diagnosing CSOM.

Keywords: Chronic Suppurative Otitis Media (CSOM), Hearing Loss, Incus, Malleus, Stapes, Ossicular Erosion.

Introduction

Chronic suppurative otitis media (CSOM) implies a permanent abnormality of the tympanic membrane, either in its pars tensa part or pars flaccid part, which is most likely a result of earlier acute otitis media, negative middle ear pressure, trauma or otitis media with effusion. The abnormality of the tympanic membrane in CSOM can be in the forms of perforation, retraction, at electasis, Tympenosclorosis or diametric membrane formation.

Chronic suppurative otitis media is a major cause of acquired hearing impairment in children, especially in developing countries.[1] Prevalence surveys, which vary widely in disease definition, sampling methods and methodological quality, show that the global burden of illness from CSOM involves 65– 330 million individuals with discharging ears, 60% of whom (39-200 million) suffer from significant hearing impairment.[2]

CSOM presents with symptoms like otorrhea, hearing loss, tinnitus, otalgia, vertigo, headache, fever, facial paralysis, vomiting etc based on the type of CSOM and disease status for duration of at least 3 months[3-6]

Classification of CSOM:

According to a modern literature,[8] CSOM is classified into five types as follows.

CSOM Classification	Synonyms
Healed CSOM	Tympenosclorosis or healed perforation
Inactive mucosal CSOM	Dry Perforation Syndrome
Inactive Squamous CSOM	Retraction / Epidermization
Active Mucosal CSOM	Perforation with otorrhea
Active Squamous CSOM	Cholesteatoma

In older literatures the mucosal type is referred to as tubotympanic type of CSOM and squamous type is called as anticoantral type.

Hearing Loss in CSOM: Hearing loss in CSOM is because of pathological components of the disease like perforation, retraction or at electasis of the tympanic membrane, ossicular erosion, ossicular fixity, Tympenosclorosis of the membrane or middle ear cleft (all causing conductive hearing loss) and cochlear damage produced by the disease per se or long term usage of cochleotoxic antibiotics like aminoglycosides.[9,10]

Ossicular erosion: Erosion or resorption of the ossicles is a feature which can be seen in both mucosal and squamous CSOM (cholesteatoma). The mechanism of bone erosion is similar in both types of CSOM.[11]

The triggering factors like infection, inflammation, pressure and keratin formation can lead to engagement of various mediators like interleukins 1L-1, 1L-2, 1L-6, tumor necrosing factor alpha (TNF-q), fibroblast growth factors, platelet derived growth factors, prostaglandins and nitrous oxide.[12,13] These factors lead to hypervascularization, activation and recruitment of osteoclasts[15] which initiates and causes ossicular erosion. Erosion is also due to expression of an anti bundling Protein called Fascin by cholesteatoma cells causing protrusion of the cell membrane and destruction of the cells.[12]

Eroded ossicles typically show hyperemia with capillary proliferation and histiocytosis.[12]

Long process of Incus, stapes suprastructure, Body of Incus, Handle of Malleus

The pathology may be limited to the incudostapedial joint, but usually total or partial loss of the long process of the Incus can be seen as well. Long process of Incus and suprastructure of stapes are more frequently affected due to their delicate structure and location than tenuous blood supply.[16] In 1971, Austin classified ossicular chain defects into four categories depending upon the presence or absence of handle of malleus (HOM) and the presence or absence of stapes suprastructure.[13]

In this study we have intraoperatively observed the ossicular chain status of 150 cases of CSOM to find out the causes of ossicular erosion among the mucosal and squamous types of CSOM.

We have conducted this study evaluate prevalence, incidence and common etiology of ossicular chain erosion among both mucosal and squamous types of CSOM in patients visited in the outpatient Department Of Otolaryngology, Rajiv Gandhi Medical College and Chhatrapati Shivaji Maharaj Hospital, Thane, Maharashtra, India.

Material and Methods

The prospective observational study included 150 subjects having CSOM was conducted in the visited in the outpatient Department Of Otolaryngology, Rajiv Gandhi Medical College and Chhatrapati Shivaji Maharaj Hospital, Thane, Maharashtra, India. It was started on January of 2015 and carried on till June of 2016 for a period of 18 months.

Patients diagnosed and admitted with CSOM, both mucosal and squamous types were included in the study. Patients were with past history of middle ear surgeries, abandoned incompletely due to unexpected intra– operative complications were excluded from the study.

Methodology-

All the patients selected for the study were admitted in ENT wards of the college. Admitted patients with CSOM were subjected to detailed history taking, complete examination including general examination, systemic examination, otoscopic examination, audiological tests like conversation test, whisper test, tuning fork tests, vestibular function tests and examination under microscope. The patients also underwent investigations like PTA and radiological investigations like Modified Mayer X ray, Law's view x ray for all patients or CT scan of the temporal bone when necessary. All these were used to make a preoperative diagnosis of mucosal or squamous CSOM with an idea about the ossicular status. The patients were later subjected to different types of middle ear surgery and their intra– operative ossicular status was recorded.

History suggestive of any systemic diseases like Tuberculosis, Diabetes mellitus, Hypertension and Bronchial asthma and past surgical history of previous ear surgery was made and noted down.

Tubotympanic SCOM will have perforation in Pars tensa without involving annulus or anterior and posterior malleolar folds whereas perforation in anticoantral CSOM can be either in pars flaccid or in

pars tensa with involvement of annulus or anterior and posterior malleolar folds.

Middle mucosa should be examined for the presence of any polypoidal changes, granulations or squamosal changes. Normal middle ear mucosa is a wet looking, translucent membrane with visible blood vessels present underneath it. Squamous epithelium will appear as a white, dry membrane with no visible blood vessels.

Margin of the perforation should be checked to see if it is sharp or rounded. Margin is said to be rounded when the squamous epithelium of the outer epithelial layer grows into the inner layer of the membrane through the perforation. Other structures like status of the ossicles, round window niche, Eustachian tube opening, and promontory were also examined for whenever visible through the perforation.

After all the pre-operative preparations patients underwent surgery under general or local anesthesia. According to the disease, surgeries like tympanoplasties with or without simple mastoidectomy, tympanoplasty with mastoid inspection window, combined approach tympanoplasty and modified radical mastoidectomy were done. During surgery ossicles were checked in all cases to identify any features erosions. Whenever erosion of any ossicles is found, the patient was inducted into the study after obtaining consent.

All the data collected from history, examination and intra – operative findings of the subjects were noted down in the master chart attached in the appendix. Follow up of the subjects was also done till 3 months of post operative period. The study included both quantitative and qualitative data that were analyzed using chi square test.

Results

Out of 150 patients 84 patients were males and 66 were females. The study population consisted of patients from different age groups. The patient with the least age was 9 years and the maximum age was 64 years. Table 1 shows the range of age distribution of the patients who underwent the study. More than half of the patients were between 11-30 years of age. The mean age of the patient was 19.5 years.

Table 1: Sex and age wise distribution of patients.

Characteristics	Group	N	%
Sex	Male	84	56
	Female	66	44
Age group (years)	0-10	13	8.67
	11-20	43	28.67
	21-30	37	24.67
	31-40	24	16
	41-50	18	12
	51-60	8	5.33
	60+	7	4.66

Out of 150 patients, 87 patients were diagnosed to have mucosal CSOM and the remaining 63 were having squamous CSOM.

Table 2 shows the number of cases who were having the two different types of CSOM by examination of the tympanic membrane by Otoscopy or otomicroscopy and percentage distribution of patients based on the duration of the longest symptom.

Table 2: Pre – operative diagnosis and distribution of duration of disease amongst 150 patients

	Subgroup	N	%
Pre-operative diagnosis	Mucosal CSOM	87	58
	Squamous CSOM	63	42
Duration in years	3 months to 1 year	9	6
	1-5 years	32	21.33
	5-10 years	59	39.33
	10-15 years	34	22.67
	> 15 years	16	10.67

Main presenting symptomatology of the patients in accordance with the diagnosis is mentioned in Table 3. There were also patients with other symptoms like facial nerve palsy, headache etc depending on the complications of the disease, status of ear discharge. This table also showed type of hearing loss like pure conductive hearing loss, mixed hearing loss and sensorineural hearing loss based on tuning fork tests.

Table 3: Symptomatology and clinical findings of CSOM.

	Subgroups	No. of cases	%
Symptoms	Ear discharge at some point of time	150	100
	Hearing loss	136	90.67
	Tinnitus	37	24.67
	Ear pain at some point of time	77	51.33
	Vertigo	9	6
Discharge status	Discharging at the time of presentation or within last 3 months	127	84.67
	Dry ear for at least 3 months	23	15.33
Type of hearing loss	Pure conductive hearing loss	96	64
	Mixed hearing loss	51	34
	Severe sensorineural hearing loss (Dead ear)	3	2

Table 4 showed x ray findings of the corresponding temporal bone, observed from the mastoid x ray of patients. This also showed relation of duration of disease to squamous conversion and types of surgeries the patient underwent for the treatment of their condition.

Table 4: Diagnosis and surgical procedures.

Test and procedure	Subgroups	No. of cases	%
Hearing loss (Air conduction threshold	> 60 dB	13	8.67
	46-60 dB	83	55.33
	30-45 dB	31	20.67
	<30 dB	23	15.33
X ray finding	Clear mastoid	19	12.67
	Opaque	99	66
	Cavity seen in the mastoid	32	21.33
Type of surgery	Tympanoplasty	17	11.33
	Simple mastoidectomy with tympanoplasty	66	44
	Modified radical mastoidectomy	67	44.67

Incudal involvement was classified as total absence, long process + lenticular process eroded, lenticular process eroded, short process eroded, body + lenticular process eroded, long + short process eroded and lenticular + short process eroded. Incus erosion was seen in 42% of cases, stapes erosion in 20.67%, malleus erosion in 15.33% cases of CSOM in our study, 24% of cases in our study had discontinuation of malleo – incuidal joint and 37.34% of CSOM cases in our study had incudo– stapedial joint discontinuity.

Table 5: Involment of Incus, stapes, malleus, malleo incuidal joint and incudo– stapedial joint in CSOM patients

Sl. No.		No. of cases (n%)	Mucosal CSOM (n%)	Squamous CSOM (n%)
Incus involvement	Intact	87(58)	72 (86.74)	15 (22.39)
	Total erosion	26 (17.33)	7 (8.44)	19 (28.37)
	Long process + Lenticular process erosion	29 (19.33)	3 (3.62)	26 (38.81)
	Lenticular process erosion	2 (1.33)	1 (1.20)	1 (1.49)
	Body + Lenticular process erosion	2 (1.34)	-	2 (2.98)
	Body = Long process erosion	3 (2)		3 (4.48)
	Long + Short process erosion	1 (0.67)		1 (1.49)
Stapes Involvement	Intact	119 (79.33)	81 (97.59)	38 (56.72)
	Superstructure erosion (at least one crura)	31 (20.67)	2 (2.41)	29 (43.28)
Malleus Involvement	Intact	127 (84.67)	82 (98.79)	45 (67.16)
	HOM erosion	13 (8.67)	1 (1.21)	12 (17.91)

	Head erosion	5 (3.33)	-	5 (7.47)
	HOM + Head erosion	1 (0.66)		1 (1.47)
	Total erosion	4 (2.67)		4 (5.97)
Malleo Incuidal joint	Intact	134 (89.33)	81 (97.59)	53 (79.1)
	Discontinuous	16 (10.67)	2 (2.41)	14 (20.9)
Incudo stapedial joint	Intact	94 (62.66)	78 (93.97)	16 (23.88)
	Discontinuous	56 (37.34)	5 (6.03)	51 (76.12)

Discussion

We included a total of 150 patients of CSOM to assess the intra – operative ossicular status and find out the etiological factors of ossicular chain erosion.

Our sample included 84 male patients (56%) and 66 female patients (44%). We observed that CSOM prevalence is almost same among both the sexes in our study. A study done by Vikram BK and Khaja N[29] also showed that CSOM was found in 57% males and 43% females. In our study the youngest patients was 9 year old and the eldest patient was 64 year old as shown in Table – 2 and figure 2. Maximum patients (53.34%) were falling under the age group of 11-30 years. Mean age of the patients in our population was 19.5 years. This shows the diseased patients got operated commonly at the second and third decades of life which was also reported in a study in past by Lasisi AO and Sulaiman OA.[13] The most commonly affected age group in CSOM patients of our study was between 16 and 25 years, as observed by various other studies also.[14,15] Second and third decade is the age of academic progress and occupational foundation. This might be the reason for the patients to present for getting treated maximally at this age group as the hearing loss caused by CSOM will hinder these activities significantly.

Lower levels of hygiene and poor nutritional status found in lower socioeconomic population may lead on to decreased immunity against infective diseases like CSOM. Overcrowding at the residence is commonly seen in lower socioeconomic status population in developing countries. This may lead to increased incidence of respiratory tract infections among the residents including CSOM. Similar findings were reported in an article published by Lasisi AO and Sulaiman OA[13] from Nigeria after a prospective study in 189 CSOM patients.

Out of 150 patients, mucosal CSOM was found in 87 cases (58%) and squamous CSOM was found in 63 cases (42%). This grouping of cases was done by initial assessment by history taking and clinical examination and confirmed by investigations.

Intra – operatively, 4 cases (2.67%) of clinically diagnosed mucosal CSOM were found to have hidden cholesteatoma and / or squamous changes in middle ear. Similar proportion of CSOM patients were having tubotympanic and anticoantral diseases in studies conducted by authors like Varshney S et al[11] and Hanumantha Rao et al[15] Intra – operative changes in diagnosis are due to the conversion of long standing mucosal disease into squamous CSOM.

The conversion of mucosal disease into squamous disease may occur due to migration of squamous epithelium from the outer layer of the remaining tympanic membrane or the external auditory canal into middle ear through the perforation.

The prevalence of mucosal CSOM is higher than the squamous CSOM because of the reasons like conversion of AOM, SOM, traumatic perforation and ventilation tube otorrhea into mucosal type of CSOM is higher rather than conversion into a squamous CSOM as reported by Jessica Levi et al.[13]

Other causes of CSOM like childhood necrotizing otitis media initially will convert more into mucosal CSOM. This is due to fact that Healing of middle ear mucosa from the Eustachian tube is more common than healing from squamous cells.

Ear discharge was the main complaint because it is usually the first symptom that was present in all (100%) patients. Duration of ear discharge ranged from 3 months to even more than 15 years (Mean duration 9.25 years) Fifty nine (39.33%) cases had duration of ear discharge between 5 and 10 years and 34 (22.67%) cases had ear discharge for more than 10 years. Remaining cases had ear discharge for a period of less than 5 years. All the 4 patients who were found to have squamous disease intra-operatively were having a longer duration of disease (more than 10 years). This prolonged duration of disease may have lead to conversion of mucosal type of disease into squamous diseases.

The duration of symptoms in squamous disease was found to be longer. This may be due to minimal ear discharge and relatively better hearing in this type.

But it should also be noted that in a developing country, patients present to the health care facility at a later stage of the disease when it has started to cause significant morbidity.

Varshney and Bisht et al[11] conducted a study in Indian population which inferred that ear discharge was invariably present in all cases of CSOM. A study conducted abroad by Jessica Levi and Robert C'O Reilley et al[13] also showed that all patients presented with ear discharge of which 73% had intermittent history whereas 27% had continuous otorrhea. These reports are in tandem with our results too.

The hearing loss would be noticed only at a later stage when it has progressed to such a severity that it starts causing difficulty in day to day life.

Table – 8 shows 96 cases (64%) in our study had conductive hearing loss of varying grades, 51 cases (34%) were having mixed hearing loss and 3 patients (2%) were having profound sensorineural hearing loss (dead ear). This classification was done based on tuning fork test, which was further confirmed and graded by using pure tone audiometry.

Jessica Levi et all found out in a study conducted on 250 cases of COM in 2013 that conductive hearing loss was seen in 79% of cases and mixed hearing loss was found in 21% of cases. The higher number of mixed hearing loss found in our study may be cause of the reason that the higher portion of patient population in our study presented to Hospital at a later stage of disease. The practice of prolonged usage of ear drops containing oto-toxic drugs for is also a cause for cochlear damage.

The identification of type of hearing loss and its grading plays a vital role in deciding the method of management, planning the type of surgery to be performed to eradicate the disease and hearing restoration, counseling the patient and taking consent for the surgery. Even in our study, 3 patients were having profound sensorineural hearing loss and 34 were having mixes hearing loss. For them the surgery was done with an idea to eradicate the disease rather than hearing restoration.

As shown in table – 13, we found Incus to be intact in 87 (58%) cases and eroded in 63 (42%) cases out of 150 patients. It was partially eroded in 37 (24.67%) cases and completely absent in 26 (17.33%) cases. In Varshney et al[11] study it was eroded in 38.67% of cases of CSOM and in the study by Uddaipurwala et al,[16] the percentage of Incus erosion was 41%. These two reports were almost equal to our study.

In mucosal CSOM, Incus was intact in 72 (86.74%) cases and eroded in 11 (13.26%) cases whereas in squamous CSOM it was intact in 15 (22.39%) cases, eroded in 52 (77.61%) cases.

Kashyap et al[10] reported in their study that Incus erosion was seen in 17% cases of mucosal CSOM. His findings are similar to what we have observed in our study also.

In our study, the commonest defect we found in Incus was erosion of the lenticular process + long process which was seen in 29 cases (19.33%) followed by total erosion of Incus in 26 cases (17.33%). Based on the literature by Varshney S et al[11] and Uddaipurwala et al,[16] long process of Incus is the most common ossicles to get eroded in cases of CSOM. This can be because of the reason that they would have probably considered the lenticular process as a part of the long process of Incus.

Austin et al (1984)[18] reported that the most common ossicular defect in CSOM is the erosion of Incus, with intact malleus and stapes, in 29.50% cases.

The incidence of Incus erosion (that too the long process) is higher because of the reasons like its delicate structure and location rather than its tenuous blood supply as found by Kashyap and Purohit et al[10] in 2015.

Anand V Kasbekar, Virjen Patel et al[24] in their study on 42 cases of CSOM in the year 2014 in India found out that posterior quadrant of tympanic membrane retraction onto the Incus can result in continuous pressure over the long process of Incus leading to its erosion and adhesion of TM to the head of stapes. This can happen in cases of CSOM with Cholesteatoma and in safe CSOM also. As the pocket grows, the stapes superstructure may also get eroded, but often remains intact.[24] Similar theory was suggested by Jahannes Borgstein and Gerritsma TV et al. through their study.[25]

In our study stapes superstructure erosion along with any of the other ossicles was seen in 31 (20.67%) of CSOM. No case was found with isolated stapes superstructure erosion. As shown it table – 14, 2 (2.41%) cases of stapes superstructure were of mucosal type whereas remaining 29 (43.28%) were squamous type.

Austin et al[18] reported erosion of stapes at around 15.50%, Varshney et al[11] mentions that stapes erosion was found in 21.33% cases of CSOM with more number of cases involved in Squamous type. In Uddaipurwala et al[16] study stapedial erosion was present in 21% of cases.

Shreshtha et al[19] found 15% of cases of CSOM. Kashyap et al[10] found that erosion of stapes in 5% cases, whereas we found stapes erosion in lesser number of cases (2.41%). Mathur et al.[20] found erosion of stapes in 15% cases of unsafe CSOM. Sade et al[17] reported stapes involvement in unsafe CSOM to be 36.00% whereas in our study 43.28% cases of Squamous CSOM had stapes involvement.

Stapes super structure is the second commonest ossicle to get involved in erosion due to CSOM. The reason for its involvement is as same as that of the Incus like delicate structure, tenuous blood supply and posterior retractions as mentioned by Wengen and Nishihara et al.[28] But the frequency of involvement is lesser due to the lack of saw like action of Chorda tympani which is present only in Incus.

The study by S. Varshney et al[11] showed that intact Malleus can be found in 80.67% of patients of CSOM and a study by Uddaipurwala from Pakistan[16] found intact malleus in 77% of cases. This shows that malleus is the most resistant ossicle out of all.

In our study, malleus was found to be intact in 127 (84.67%) cases of CSOM and eroded along with any other ossicles in cases 23 (15.33%) cases. It was partially eroded in 19 (12.66%) and absent in 4 (2.67%) cases. Findings similar to our study were also reported in studies by Varshney S et al[11] in which they found malleus to be eroded in 19.33% of cases and Uddaipurwala et al.[16] where it was eroded in 23% of cases. This showed that malleus was the most resistant ossicle to undergo erosion in our study.

Handle of malleus was found to be the most commonly eroded part (either partially or completely) of the malleus in disease process. Out of 23 cases of malleus erosion, 22 were squamous type and 1 case was mucosal type. These observations from our study were matching the findings from the studies by Uddaipurwala et al[16] (intact in 89.2% of cases) and Varshney et al[11] (intact in 80.67% of cases) that malleus is the most resistant ossicle to erosion. A study by Sade et al[17] found erosion of malleus in 6% of cases of mucosal type and in 26% of cases of squamous type. This discrepancy might be because of the higher number of sample he has taken for the study than us.

In our study the lesser incidence of malleus erosion in safe CSOM may be because of the coarse structure and larger size of the malleus. Larger the size of ossicles lesser is the chances for it to get eroded in CSOM. Other reasons for the malleus being the most resistant ossicle are non involvement of malleus in posterior retractions, lesser granulations around malleus handle and relatively good blood supply.

Inter-ossicular joint discontinuity in CSOM and individual types showed this discontinuity of the joint is because of the erosion of the bones involved in the articulation. This joint was found to be discontinuous in 16 (10.67%) cases of CSOM out of which 2 (2.41% of safe) were mucosal CSOM and 14 (20.9% of unsafe) cases were having squamous CSOM.

This discontinuity was seen in cases of Incus body erosion (5 cases) and malleus head involvement, in form of combined erosions or total erosion (11 cases). There was no simple dislocation of the joint without boney erosion. “Incudo– stapedial Joint” was discontinuous in 56 (37.34%) cases of which 5 (6.03%) cases were seen in mucosal CSOM and 51 cases (76.12%) were squamous CSOM.

These findings were in tandem with those of Dasgupta et al[21] in two studies on unsafe CSOM. Varshney et al[11] and Toran et al[22] reported similar findings of ossicular chain discontinuity.

The number of cases with incudo – stapedial joint discontinuity was more because the reason that the number of cases with Incus and stapes super – structure erosion was proportionately high.

Conclusion

Squamous CSOM causes more ossicular erosion than the mucosal type; Incus was the commonly eroded ossicles, malleus or stapes erosion is never encountered in any type of CSOM. Delicate anatomy and tenuous blood supply of long process of Incus and stapes super structure, granulations in middle ear which increase the vascularity around the ossicles, posterior part of tympanic membrane retraction causing direct pressure over the ossicles, retraction pockets in tympanic membrane causing the cholesteatoma which initiates osteoclastic cellular mechanism of bone erosion in the ossicles were the etiological conditions causing CSOM.

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