



# Case Report **Tubo-Ovarian Abscess with** *Actinomyces odontolyticus*: **Case Report and Brief Review of Literature**

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**Abstract:** *Actinomyces odontolyticus* is a strictly anaerobic species, a member of the *Actinomyces* genus and of the commensal flora, especially oral flora, which can trigger severe infections through breaches in healthy tissue or necrotic tissue that are often hard to diagnose clinically and microbiologically. Most infections with this species are pulmonary or pleural, which might hint at a connection with poor dental hygiene, but other locations have been documented. We present a case of a tubo-ovarian abscess with a difficult identification of the etiological agent in a woman with multiple admissions, no significant comorbidities, and a longstanding use of an IUD (intrauterine device). To our knowledge, no previous case of tubo-ovarian abscess with an accurate *A. odontolyticus* microbiological species identification has been reported so far. This case also highlights the importance of considering an anaerobic species as an etiologic agent in an infectious process concerning a previously damaged tissue and the importance of appropriate harvesting and culturing in the accurate diagnosis of such species.



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**Copyright:** © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). Keywords: Actinomyces odontolyticus; abscess; tubo-ovarian

# 1. Introduction

Actinomyces genus belongs to a family called Actinomycetaceae. They are facultative anaerobic or strictly anaerobic, non-motile, non-spore-forming, unencapsulated, straight to slightly curved bacilli of various lengths. The short rods can be seen forming small clusters or diphtheroid arrangements. Longer rods can be straight, wavy, or branched, the branched pattern being the most specific one, also called Actinomyces-like. Although Actinomyces are Gram-positive, irregular staining can cause a beaded or banded appearance similar to *Nocardia* spp. [1]. Actinomyces spp. mainly belong to the commensal flora of the oropharynx, gastrointestinal tract, and urogenital tract [2] but acquire pathogenicity through invasion of breached or necrotic tissue [3], causing actinomycosis.

Actinomycosis is a chronic, granulomatous, infectious disease characterized by the development of fistulous tracts through which the infection can drain pus into another cavity or to the surface. The most frequent genus incriminated for this type of infection is *Actinomyces*, out of which *Actinomyces israelii is* the most frequently isolated species, although actinomycosis can be caused by other genera such as *Propionibacterium* or *Bifidobacterium* [1].

The most common presentation of actinomycosis is the oral-cervicofacial one, accounting for more than half of all actinomycosis cases. Pelvic actinomycosis is usually linked to the prolonged use of IUDs, promoting the ascension of the microorganisms through wires left in the exocervix. In addition, the IUD alters the metabolism of endometrial cells, thus favoring persistent local inflammation [4]. Another probable route of infection is through oral sex practices since *Actinomyces odontolyticus* is a predominant species of the tongue flora and, more importantly, represents an important factor in early plaque development [5]. Infections with *Actinomyces odontolyticus* are rare, with the first case being reported by Batty in 1958 in a patient with advanced dental decay. We hereby present the case of a 48-years old patient with a reported 10-year use of an IUD and delayed treatment due to the patient's refusal of admission.

#### 2. Case Report

A 48-years old woman (gravida 4, term 2, abortion 2) with her last menstrual period started on 10 December 2021 (6 weeks of amenorrhea) presented on 15 January 2022, accusing moderate pain in the lower left quadrant. The pain started 7 days ago with an intensification 3 days prior to presentation. Anamnesis did not reveal any significant comorbidities, no previous dental conditions, recent dental extractions, or other major surgical intervention, and no gynecological condition either. Clinical examination reveals nothing significant other than tenderness in the lower left quadrant and the wires of an IUD at the vaginal speculum examination, which the patient claims she had for 10 years. Ultrasound examination highlights a heterogenous, septate, 61/56 mm cystic process in the left fallopian tube without any signs of intra-cystic vegetation and without a Doppler signal. Abdominal-pelvic computer tomography confirmed the presence of an IUD and described the aforementioned process as being thick-walled and iodophilic, with heterogenous and moderately hyperdense content, suggesting the possibility of a pyosalpinx. Blood work showed leukocytosis (WBC/mm<sup>3</sup>) and high C-reactive protein levels (28.3 mg/dL). Extraction of the IUD was decided. The patient denied admission after the extraction even though she had been well informed of her medical condition and the further investigation required for it.

The patient presents for a second time two weeks later, accusing pain in the lower left quadrant and fever. She had been following antibiotic therapy prior to the admission (Cefuroxime and Ampicillin), which reportedly ameliorated the symptomatology. Ultrasound reveals an enlargement of the cystic process. Blood work shows a milder leukocytosis (WBC/mm<sup>3)</sup> and C-reactive protein levels (12.96 mg/dL). Bacteriological exam from cervical secretions (collected with a swab and transported in Amies medium) came back negative at 48 h. The diagnosis of left pyosalpinx is confirmed, and therapy with antibiotics (Ceftamil, Clindamycin) and NSAIDS is established, with remission of symptomatology. Leukocytosis and C-reactive protein levels normalized. Stationary evolution of the cystic process alongside a 25 mm fluid mass in the Douglas pouch was discovered by an ultrasound conducted 5 days after the admission. The patient is discharged with NSAIDS and a 7-day course of 500 mg orally every 8 h of amoxicillin + clavulanic acid antibiotic therapy.

The patient came back the third time a month later with the same pain in the lower left quadrant, which reappeared 7 days prior to the admission. After an ultrasound confirming the findings from the previous ultrasound, the decision to perform a left salpingo-oophorectomy was taken. Surgery was complicated by the presence of multiple adhesions between the uterus, the left fallopian tube, and left ovary, and the sigmoid colon, causing the cystic fallopian mass to rupture. Green-yellow pus was extracted from the ruptured mass using a sterile syringe and sent for bacteriological examination, and the left fallopian tube alongside the left ovary was sent for histopathological examination. The pus was cultured in both aerobic and anaerobic conditions on Columbia blood agar and on MacConkey agar, mannitol salt agar, and Sabouraud agar in aerobic conditions. Anaerobiosis was provided using an anaerobic jar and anaerobic atmosphere-generating sachet (Thermo Scientific AnaeroGen<sup>TM</sup>, MA, USA). Aerobic media showed no growth at 24 h, 48 h, and 72 h. The blood agar plate placed in anaerobiosis showed significant growth at 72 h of small, grey colonies with a brownish background (Figure 1). Gram stain from those colonies indicated Gram-negative short bacilli disposed of in a branched pattern, characteristic of Actinomyces spp. (Figure 2). Further identification using Vitek 2 Compact by bioMerieux revealed excellent identification (98% accuracy) for Actinomyces odontolyticus. The species was deemed resistant to Clindamycin but sensible to Penicillin

and Metronidazole. Histopathological examination of the surgical piece highlighted large areas of the fallopian tube with densely populated neutrophilic infiltrate and partial cystic transformation of the left ovary with granulation tissue, but no bacterial colonies or sulfur granules present. The patient was started on 250 mg 3 times a day of Metronidazole antibiotic therapy until she was discharged 5 days post-operation. The patient's status improved post-surgery, and she was discharged with complete remission of symptoms. On follow-up, the patient showed no significant symptoms or clinical signs, a good healing of the surgical scar, and normal WBC, C-reactive protein levels and bacteriological exam.



Figure 1. Actinomyces odontolyticus growth at 72 h on blood agar culture media in anaerobic conditions.



Figure 2. Gram stain from culture media showing branched Actinomyces-like Gram-positive bacilli.

## 3. Review of Literature

For the review concerning actinomycosis with Actinomyces odontolyticus and tuboovarian abscesses with the above-mentioned species, we used the electronic databases of PubMed and Cochrane for our review, with the following terms for the search: "Actinomyces odontolyticus" combined with the Boolean operator "AND" along with "case report" "tubo-ovarian", "pelvic", and "abscess". Only studies written in English, Spanish, French, or German were selected for this review. The review was conducted with data available up to 26 June 2022. We found a total of 54 reported cases of actinomycosis with Actinomyces spp., with no previously documented case of tubo-ovarian abscess with A. odontolyticus, one case of ovarian cyst actinomycosis and one previously documented case regarding pelvic actinomycosis with Actinomyces odontolyticus at a patient who simultaneously presented toxic shock syndrome with group A Streptococcus [6]. We also aimed to discover whether actinomycosis is more frequent in immunocompromised patients or not-out of the 54 reported cases, only 16 cases were confirmed to be immunocompromised from various causes (malignancy with chemo- or radiotherapy, chronic liver disease, longstanding corticosteroid therapy, HIV positive serology, post-transplant status, type 2 diabetes). The extended results of our review are displayed in Table 1.

**Table 1.** Review of literature by reference, patient age, gender, site of infection, laboratory technique used for the identification and confirmation of *A. odontolyticus*, relevant comorbidities or invasive procedures connected to the *Actinomyces* infection, immune status, and outcome of the infectious episode.

Reference	Patient Age	Gender	Site of Infection	Microorganism Identification	Relevant Comor- bidities/Invasive Procedures	Immune Status	Outcome
This study	48	F	Tubo-ovarian	Gram stain, culture media aspect, and Vitek	Presence of IUD	Immunocompetent	Complete recovery
Patil SM. et al. [7]	53	М	Disseminated: pelvic and pulmonary	Gram stain and histopathologi- cal exam from pelvic fluid	Poor dental hygiene	Immunocompetent	Complete recovery
Furuya K. et al. [8]	75	М	Cholecist	Gram stain from bile	Recurring cholecystitis	Immunocompetent	Complete recovery
Tu J. et al. [9]	43	F	Pulmonary	N/A	Bronhocoele, Allergic pulmonary aspergillosis, recent tooth extraction, co-infection with <i>L. rhamnosus</i> and <i>S. mitis</i>	Immunocompetent	Ameliorated
Deltenre M. et al. [10]	2	М	Pulmonary	N/A	Acute bronchitis	Immunocompetent	Complete recovery
Razok A. et al. [11]	32	М	Disseminated: cervical and mediastinal	Pheonix technique, Maldi-TOF, DNA restriction analysis	Tooth extraction	Immunocompetent	Complete recovery
Kitano H. et al. [12]	14	F	Renal	MALDI-TOF	Co-infection with A. schaalii and P. asaccarolyticus	Immunocompetent	Ameliorated
Hsu SL. et al. [13]	45	М	Hepatic	MALDI-TOF	HIV infection, co-infection with <i>C. albicans</i> and <i>S. constellatus</i>	Immunodeficient	Died

Reference	Patient Age	Gender	Site of Infection	Microorganism Identification	Relevant Comor- bidities/Invasive Procedures	Immune Status	Outcome
Farah K.M. et al. [14]	54	М	Cardiac	Gram stain	Type 2 diabetes, chronic kidney disease, heart failure, cardioverter defibrillator implanted recently	Immunodeficient	Complete recovery
Marques PM. et al. [15]	75	М	L4–L5 vertebrae	Histopathological exam	Rectal adenocarcinoma with radiotherapy	Immunodeficient	Ameliorated
Jain H. et al. [16]	73	М	Disseminated: cervical, meningeal	N/A	Oropharyngeal carcinoma with chemotherapy	Immunodeficient	Complete recovery
Patel K. et al. [17]	56	F	Cardiac	N/A	Poor dental hygiene, aortic insufficiency	Immunocompetent	Complete recovery
Massey M. et al. [18]	33	М	Pulmonary	N/A	None	Immunocompetent	Complete recovery
Khiatak B. et al. [19]	83	М	Disseminated: sepsis	Gram stain, histopathologi- cal exam with immunofluores- cence technique	Urothelial carcinoma	Immunodeficient	Ameliorated
Wu JJ. et al. [20]	71	М	Mediastinal	N/A	Chronic hepatitis C, hepatocellular carcinoma	Immunodeficient	Complete recovery
Yesilbas O. et al. [21]	2.5	М	Cerebral	Vitek	Abscess on the left hand	Immunocompetent	Complete recovery
Rueda MS. et al. [22]	Newborn	М	Disseminated: sepsis	MALDI-TOF	Dental infection 1 week pre- partum(mother) Premature (26 weeks old)	Immunodeficient	Complete recovery
Cho JJ. et al. [23]	10	F	Cervicofacial	Gram stain, culture media aspect	None	Immunocompetent	Complete recovery
Wang L. et al. [24]	34	М	Pulmonary	High- throughput gene detection	Undefined lung lesions	Immunocompetent	Complete recovery
Diab C. et al. [25]	36	М	Renal	Histopathological exam	Xanthogranulomatou pyelonephritis with calculus and urocutaneous fistula	Is Immunocompetent	Complete recovery
Matsumoto T. et al. [26]	60	М	Pulmonary	MALDI-TOF	Squamous cell lung carcinoma with chemo- and radiotherapy	Immunodeficient	Ameliorated
Crisafulli E. et al. [27]	65	М	Pulmonary	MALDI-TOF	Poor oral hygiene, co-infection with V. atypica	Immunocompetent	Complete recovery
Yun SS et al. [28]	49	М	Pulmonary	N/A	Poor oral hygiene	Immunocompetent	Complete recovery

Table 1. Cont.

Reference	Patient Age	Gender	Site of Infection	Microorganism Identification	Relevant Comor- bidities/Invasive Procedures	Immune Status	Outcome
Schimmel T. et al. [29]	40	М	Disseminated: hepatic, pleural	N/A	Multiple teeth extractions, co-infection with S. anginosus, S.constellatus, P. denticola	Immunocompetent	Complete recovery
Clyde M. et al. [30]	60	М	Pelvic:lymphocele	N/A	Prostatectomy	Immunocompetent	Complete recovery
Palmitessa V et al. [31]	23	М	Esophageal	Vitek	Refractory GERD	Immunocompetent	Complete recovery
Gray A. et al. [32]	11	F	Pulmonary	N/A	Recurrent pneumonia	Immunocompetent	Complete recovery
Prashant N. et al. [33]	N/A	М	2nd phalanx	N/A	Degloving injury of the index finger treated with an anterior chest wall flap	Immunocompetent	Complete recovery
Yanagisawa R. et al. [34]	2	М	Cervical	16S rRNA sequencing	None	Immunocompetent	Complete recovery
Broly E. et al. [35]	52	F	Pericardiac	N/A	Dentigerous cyst	Immunocompetent	Complete recovery
Wu CM. et al. [6]	50	F	Pelvic	Vitek	Presence of IUD, toxic shock syndrome with group A Streptococcus	Immunocompetent	Ameliorated
Weiand D. et al. [36]	36	М	Bacteriemia	Vitek,MALDI- TOF	Intravenous drug user, co-infection with <i>E. coli</i>	Immunodeficient	Ameliorated
NebreraNavaro F. et al. [37]	68	F	Pulmonary	16S rRNA sequencing	Hodgkin's lymphoma with chemotherapy, IgA deficit	Immunodeficient	Ameliorated
Lensing F. et al. [38]	24	М	Laryngeal	N/A	Inhalation injuries with subglottic stenosis	Immunocompetent	Complete recovery
Rich BS. et al. [39]	40	F	Breast	N/A	None	Immunocompetent	Complete recovery
Chao CT. et al. [40]	78	М	Hepatic	API, 16S rRNA sequencing	Dental procedures—tooth remodeling and replacement	Immunocompetent	Complete recovery
Mohan DR. et al. [41]	68	М	Pulmonary	Culture media aspect, Gram stain, biochemical properties	Poor oral hygiene	Immunocompetent	Complete recovery
Davanos E. et al. [42]	39	F	Right foot	Gram stain and culture media aspect	Type 2 diabetes, right foot injury, co-infection with <i>E. corrodens</i>	Immunodeficient	Complete recovery
Pant E. et al. [43]	40	М	Facial	Histopathological exam	Desmoid tumor	Immunocompetent	Complete recovery
Delarbre X. et al. [44]	73	Μ	Vascular (prosthetic aortic graft)	N/A	Periodontal disease	Immunocompetent	Complete recovery

Table 1. Cont.

Reference	Patient Age	Gender	Site of Infection	Microorganism Identification	Relevant Comor- bidities/Invasive Procedures	Immune Status	Outcome
Louerat C. et al. [45]	52	М	Disseminated: cerebral, pulmonary	N/A	Alcoholism	Immunocompetent	Ameliorated
Cone LA. et al. [46]	62	F	Bacteriemia	RapID ANA II System	Acute myelocytic leukmia with chemotherapy	Immunodeficient	Complete recovery
Cone LA. et al. [46]	69	F	Bacteriemia	RapID ANA II System	Giant cell arteritis, Azathioprine therapy	Immunodeficient	Complete recovery
Sofianou D. et al. [47]	32	М	Soft tissue (right femoral area)	API A System, Vitek, API 20NE System	Intravenous drug user	Immunodeficient	Ameliorated
Takiguchi Y. et al. [48]	64	F	Pulmonary	RapID ANA II System	Periodontal disease	Immunocompetent	Ameliorated
Alamillos- Granado FJ. et al. [49]	74	F	Oral mucosa	N/A	Insulin-dependent type 2 diabetes, recent dental extraction	Immunodeficient	Complete recovery
Iancu D. et al. [50]	37	F	Pulmonary	N/A	Sarcoidosis with prednisone therapy, diffuse large (B cell) lymphoma	Immunodeficient	Died
Litwin KA. et. al. [51]	68	М	Disseminated: pleural, pericardial	API 20A/An-IDENT System	Gastric surgery	Immunocompetent	Complete recovery
Pérez- Castrillón JL. et al. [52]	50	М	Pleural	N/A	Pneumectomy, pulmonary tuberculosis	Immunocompetent	Complete recovery
Simpson AJ. et al. [53]	66	F	Cerebral	N/A	Granuloma below a pre-molar tooth	Immunocompetent	Ameliorated
Bassiri AG. et al. [54]	61	М	Pulmonary	N/A	Lung transplant recipient (emphysema)	Immunodeficient	Complete recovery
Bassiri AG. et al. [54]	43	М	Disseminated: pericardial, mediastinal, osseous	N/A	Heart-lung transplant recipient (sarcoidosis, bullous lung disease)	Immunodeficient	Died
Dontfraid F. et al. [55]	52	М	Pulmonary	Vitek	Poor dental hygiene, periodontal disease, left ankle injury, alcoholism	Immunocompetent	Complete recovery
Harvey P. et al. [56]	37	М	Osseous (sacroiliac joint)	BACTEC NR7A	Multiple dental abscesses	Immunocompetent	Complete recovery
Civen R. et al. [57]	45	М	Disseminated: tonsillar, retropharyn- geal, mediastinal	Vitek	Alcohol and cocaine abuse	Immunocompetent	Complete recovery
Verrot D. et al. [58]	52	F	Pulmonary	Gram stain and culture media aspect	Dilated bronchi post-B.pertussis infection	Immunocompetent	Complete recovery
Hooi LN. et al. [59]	38	F	Pleural	Gram stain and culture media aspect	Poor dental hygiene	Immunocompetent	Complete recovery

## Table 1. Cont.

Reference	Patient Age	Gender	Site of Infection	Microorganism Identification	Relevant Comor- bidities/Invasive Procedures	Immune Status	Outcome
Peloux Y. et al. [60]	19	М	Pleural	N/A	Co-infection with <i>F. necrophorum</i>	Immunocompetent	Complete recovery
Peloux Y. et al. [60]	40	М	Right thumb	N/A	Right thumb injury, poor dental hygiene, co-infection with K. pneumoniae	Immunocompetent	Complete recovery
Peloux Y. et al. [60]	54	F	Ovarian	N/A	Ovarian cysts, alcoholic, co-infection with <i>E. coli</i>	Immunocompetent	Complete recovery
Peloux Y. et al. [60]	30	F	N/A	N/A	Co-infection with <i>H. influenzae</i>	Immunocompetent	Complete recovery
Peloux Y. et al. [60]	47	М	Arm	N/A	Co-infection with <i>S. millieri</i> and <i>H. aphrophilus</i>	Immunocompetent	Complete recovery
Peloux Y. et al. [60]	65	М	Submaxillary	N/A	None	Immunocompetent	Complete recovery
Klaaborg KE. et al. [61]	78	М	Sigmoid colon	N/A	Right hemicolectomy (cecum carcinoma), diverticulitis of the sigmoid colon, enterocutaneous fistula	Immunocompetent	Ameliorated
Ruutu P. et al. [62]	37	F	Disseminated: hepatic, renal, pleural	Gas-liquid chromatography	Paradental abscess, presence of IUD	Immunocompetent	Ameliorated
Baron EJ. et al. [63]	61	F	Pulmonary	Gas chromatography, biochemical characteristics	Polyarthropathy with longstanding treatment with prednisone	Immunodeficient	Complete recovery
Mitchell PD. et al. [64]	54	М	Malar	Gram stain, biochemical characteristics	Poor dental hygiene, periodontal disease, repeated injuries in the malar region	Immunocompetent	Complete recovery

Table 1. Cont.

# 4. Discussion

We present the first case of a tubo-ovarian abscess caused by *Actinomyces odontolyticus* in a 48-year-old woman from Cluj-Napoca, Romania. Gynecological involvement of *A. odontolyticus* remains a mystery, with only two other case reports existing in the world, one that involved an ovarian cyst and one case of pelvic actinomycosis. This might be due to the difficulty in correctly harvesting pus and other body fluids for the preservation of anaerobic species, culturing this aforementioned class of microorganisms, and also in accurately diagnosing them prior to the MALDI-TOF and VITEK era. In all existing gynecological cases, the outcome of the patient remains positive. Regarding the risk factors, in our case report, we incriminated the IUD due to the place where the infections are localized; however, in other instances, poor oral hygiene or immunosuppression might be responsible too. Further studies are needed for a proper understanding of the pathogenicity, risk factors, and antimicrobial resistance of this enigmatic microorganism.

In our brief review, we tackled the issue of human actinomycosis and included 54 case reports that present different types of infections caused by *Actinomyces*. In order to be able to draw some conclusions, we grouped them by infection type as follows.

Out of the 54 case reports, almost half of them, 23 to be precise, are either pulmonary or pleural. Male-to-female ratio of these patients is 13:10, with males slightly edging the females. Out of all these cases, only one patient died, and in that case, actinomycosis occurred in an immunosuppressed patient with sarcoidosis, lymphoma, and undertreatment with corticosteroids. Four cases present a disseminated infection with pulmonary or pleural involvement suggesting the invasiveness of this microorganism as well as its capacity to produce secondary distal infections. Considering the risk factors presented in these cases, poor oral hygiene, periodontal disease, and tooth extraction are the most prevalent, with different types of immunosuppression coming in a close second. Based on these observations, it seems that pulmonary infections with *Actinomyces* are in close contingency with oral health issues, and they should be traced together in the future to properly unlock the circumstances of this infection occurrence.

Gastroenterological involvement of *Actinomyces* is much more heterogenous. We found seven case reports that describe infections in this medical field, four case reports of hepatic infections, with two being disseminated infections with hepatic involvement and two only with hepatic involvement. The other three case reports are from infections that occurred in the gall bladder, esophagus, and sigmoid colon. Regarding the outcome, six out of the seven case reports are with a favorable outcome; only one patient died who was also immunodeficient and suffering from an HIV infection. In addition, all cases with hepatic involvement had associated oral health issues. This observation adds another hypothesis regarding *Actinomyces* infections that needs to be further studied, that oral health issues might produce intermittent bacteremia that could lead to organ seedings. The rest of the reported cases have a much closer relationship with the underlying condition (recurrent cholecystitis, refractory GERD, or colon cancer). Interestingly, in this group of infections, males seem to be more affected, with a ratio of 6 males–1 female. However, this might be due to the relatively small sample size, only seven case reports, and definitely more data are needed to properly assess the gender differences in GI Actinomycosis.

Regarding the cardiovascular system and *Actinomyces* infections, we found nine case reports of cardiac, pericardial, or mediastinal involvement with a similar dominance of male patients (a ratio of 7 males–2 females). Additionally, the same risk factors concerning oral health were found in four of them. The rest of them presented either an invasive procedure such as a cardioverter defibrillator recently implanted, gastric surgery, and heart-lung transplant or drug abuse (alcohol and cocaine). Interestingly, only one of these cases had a poor outcome in a transplant patient with immunosuppression. Analyzing the bacteriemia and sepsis reported in five of the cases can argue that systemic isolation of this microorganism is linked to immunosuppression since all these cases are from patients with immunosuppression. This only adds to the idea presented before that *Actinomyces* remains a threat only in high-risk patients.

Neurological involvement of *Actinomyces* remains rare, similar to the genital one. We found only three cases of cerebral or meningeal actinomycosis. Thus, it is difficult to assess the role of this bacteria in neurological infections. All of them presented a favorable outcome, which raises the suspicion of the pathogenicity of this bacterium, contamination versus infection, since, in two cases, there is no report of the method used for microbiologic identification.

The rest of the case reports are much more heterogeneous, with *Actinomyces*being reported from renal, vertebral, cervicofacial, laryngeal, breast, soft tissue, and osseous infections, and thus difficult to assess the relevance of the infections in the overall outcome of each case. However, all of these cases had a favorable outcome and similar risk factors as discussed so far.

Actinomyces odontoliticus has been isolated in 12 cases from infections with more than one microorganism, highlighting the risk that may be associated with this type of infection. Some of the associated microorganisms included yeasts and bacteria, both Gram-positive and Gram-negative, such as *L. rhamnosus*, *S. mitis*, *A. schaalii*, *P. asaccarolyticus*, *C. albicans*, *S. constelatus*, *V. atypica*, *S. anginosus*, *P. denticola*, *E. coli*, group A streptococcus, *E. corrodens*, *K. pneumoniae*, *H. influenzae*, *S. milieri*, and *H. aprophilus*. Treatment in these cases may prove to be a challenge in the context of antimicrobial resistance. However, based on the existing data, only one patient died from an infection that involved *Actinomyces odontolyticus* and another microorganism, and thus, so far, this seems not to be an issue.

Diagnosis of *Actinomyces odontolyticus* in the microbiology laboratory is often a challenge, and for a long time, medical professionals had to rely only on microscopy and bacterial morphology. In 11 instances out of 54, authors reported the use of Gram stain, colony morphology, or biochemical tests. Another important observation is that, in many cases, the diagnosis methods are not presented. In 29 case reports, authors failed to present how this bacterium was diagnosed, and thus their findings come into question. However, the most popular and accurate diagnosis tools that were presented are MALDI-TOF, Vitek, or 16 s RNA sequencing. The technological revolution in the microbiology laboratory has the potential to further explore the involvement of this bacterium in human infections by facilitating diagnosis and, in the long term, analyzing the possible risk factors. The preliminary data of this review show that males seem to be more affected by *Actinomyces odontolyticus*, and oral health issues are the dominant risk factor evaluated. This is available for all types of infections analyzed in this paper. It is of utmost importance to keep a close eye on this understudied pathogen in order to properly assess its involvement in human infections.

#### 5. Strengths and Limitations

**Strengths:** This study is a case report associated with a brief review of literature—this association enables the integration of the data within this case report into a larger context, thus establishing connections between the case report and the currently available data in order to highlight the prevalence and incidence of female genital tract actinomycosis with *Actinomyces odontolyticus* amongst other cases of actinomycosis with the above-mentioned species and to possibly establish a correlation between the infection, the comorbidities of the patients and their immune status. Moreover, this case report features the optimal process of harvesting bodily fluids and pus in order to preserve anaerobic species, the correct way of culturing said species, and a good method of accurately identifying the species, all three stages being essential for a precise diagnosis. Last but not least, the case report includes the histopathological exam as a certification of the presence of inflammatory modifications, suggesting an infectious process, but without the presence of characteristic sulfur granules, which can be seen as another particularity of the case.

**Limitations**: The available data on the patient do not contain pictures from the CT scans and the histopathological exam. We also could not find any gynecological tumoral markers as part of the differential diagnosis of actinomycosis (such as CA-125, alpha fetoprotein (AFP), carcinoembryonic antigen (CEA), human chorionic gonadotropin (hCG), human epididymis protein 4 (HE4), etc.) considering the fact that actinomycosis can mimic neoplastic processes from a clinical and imagistic standpoint [65–67]. Despite their low specificity, their varying degrees of prognostic and predictive value, and the relatively low detection rate of early-stage malignancies, tumoral markers can be a useful tool for the appreciation of the progression of the disease. Fortunately, the histopathological exam is a certification of the absence of any dysplastic or neoplastic modifications. Another limitation is the use of Vitek 2 Compact by bioMerieux system for the identification of the microorganism instead of a MALDI-TOF or 16S RNA analysis, which proved to be more accurate. [68,69]. Ultimately, the literature review was made using only PubMed as a database—a more accurate review could have been established had we had access to larger subscription-based databases.

## 6. Conclusions

Actinomyces odontolyticus and Actinomyces spp. infections are a rare encounter in the current clinical practice; however, that may be caused not only by the many conditions required by this commensal microorganism in order to become pathogenic but also by the difficult diagnosis of this species, requiring correct pre-analytical sample collection in order to preserve an anaerobic environment during transportation and correct and detailed microbiological examination for anaerobic species. This case report and brief literature review, tackling the actinomycosis sphere of infectious diseases, will hopefully provide a solid ground for further, more detailed research into this species.

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