



Odontogenic neck abscesses caused by *Streptococcus anginosus* group bacteria: emergency MRI findings

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Objective. *Streptococcus anginosus* group (SAG) bacteria have been associated with severe illness in patients with odontogenic neck abscesses. Magnetic resonance imaging (MRI) offers excellent diagnostic accuracy in neck abscesses. We sought to explore whether MRI findings could predict SAG-positivity.

Study Design. We included patients who had received emergency MRI for an acute odontogenic neck abscess and subsequent surgery with pus sampling. From the MR images, we measured abscesses and determined patterns of retropharyngeal, mediastinal, submandibular space, sublingual space, and visceral space edema. SAG-positive and -negative patients were compared regarding MRI findings along with demographic, clinical, laboratory, and surgical parameters. Data were analyzed using univariate models and a multivariate binary logistic regression model.

Results. Of 93 total patients, 46 patients (49%) were SAG-positive and 47 (51%) SAG-negative. The SAG-positive patients had larger maximal abscess diameters (36.2 vs 31.7 mm, $P = .036$) and a higher prevalence of mediastinal edema (ME) (43% vs 15%, $P = .003$). In the multivariate model, ME was the only statistically significant predictor of SAG positivity (OR = 7.455, $P = .004$). Regarding surgical outcomes, SAG-positive patients required transcervical incisions more often than SAG-negative patients (61% vs 36%, $P = .004$).

Conclusions. ME detected on emergency MRI is highly suggestive of the involvement of SAG in odontogenic neck abscesses. These findings highlight the clinical utility of emergency MRI in patients with acute neck infections. (Oral Surg Oral Med Oral Pathol Oral Radiol 2025;139:594–599)

Odontogenic infections (OI) are a frequent cause of deep neck infections (DNI).^{1–3} Periapical periodontitis and postoperative infections are common causes of DNI. OI is usually local, but it can spread to deep neck spaces along the fasciae from the skull base to the mediastinum and can be life-threatening.^{2,4}

Signs of a deeply extending OI include a preceding toothache, fever, difficulties with swallowing or breathing, and especially restricted mouth opening along with facial and neck swelling.^{1,3,5} Infection can develop quickly, and the most important treatment is to interfere with the origin of the infection, e.g., extract the

causative tooth and drain the abscess. Antibiotics support surgical treatment but are secondary in the therapy.^{2,5–7}

Odontogenic abscesses of deep fascial planes are usually polymicrobial, consisting of both aerobic and anaerobic microbes. The most common genera of bacteria are Streptococci, Prevotella, and Fusobacterium.^{1,2,5} *Streptococcus anginosus* group (SAG) bacteria *S. anginosus*, *Staphylococcus intermedius*, and *Streptococcus constellatus* are often discovered in deep neck abscesses, and they are associated with a more severe course of infection.⁸ Antibiotics are usually administered empirically, penicillin-metronidazole being the most commonly used combination covering aerobic and anaerobic bacteria.⁹ Bacterial culture is still the standard method of analysis of microbial specimens, but the results may not be readily available. Having a tool to reliably predict the causative bacteria in odontogenic neck abscesses would be valuable in helping to choose appropriate management strategies and foresee patient outcomes.

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Statement of Clinical Relevance

Streptococcus anginosus group (SAG) bacteria cause severe odontogenic neck infections. Mediastinal edema as detected in MRI is highly suggestive of SAG in odontogenic neck abscesses. MRI can provide insights into the microbiological nature of these abscesses prior to bacterial culture.

Magnetic resonance imaging (MRI), with its outstanding soft tissue sensitivity, provides excellent diagnostic accuracy for imaging patients with DNI. Specifically, in emergency cases, MRI is highly feasible in hospital settings and has a strong technical success rate for acutely ill patients, with excellent diagnostic accuracy for infections and abscesses.¹⁰ MRI can reveal reactive edema patterns that have clinical and prognostic value.¹¹ Prior studies have shown that abscess diameter, retropharyngeal edema (RPE), and mediastinal edema (ME) are associated with a more severe course of the disease.^{10,12,13} In odontogenic neck infections, ME predicts the need for extraoral incision to establish abscess drainage. Furthermore, MRI can depict the causative tooth with high accuracy.¹² MRI therefore provides clinically meaningful information for diagnosing and treating patients with odontogenic neck infections.

Reactive MRI edema patterns (RPE, ME) and SAG positivity in an abscess have been shown to predict a more serious course of infection. However, it is unknown whether MRI findings can predict the presence of SAG before abscess drainage. Therefore, this study sought to explore whether odontogenic abscesses caused by SAG are associated with distinct MRI findings by examining imaging outcomes along with microbiological, demographic, clinical, laboratory, and surgical data. We hypothesize that diagnostic outcomes with MRI and the other data can meaningfully discriminate between SAG-positive and SAG-negative patients.

METHODS

This was a retrospective cohort study from a tertiary hospital that primarily uses MRI for acute neck infections. Procedures for patient selection, MR imaging and interpretation, and extraction of medical and surgical information have been previously published.^{10,12} Briefly, we obtained study permission from the hospital district board, and the requirement of patient consent was waived due to the retrospective nature of the research. The study was conducted according to the Helsinki Declaration. We included patients who had 1) MRI evidence of an acute odontogenic neck infection and an abscess, using previously established criteria (high signal on fat-suppressed T2-weighted images suggesting tissue edema, nonenhancing fluid collection with restricted diffusion suggesting an abscess, and a final clinical diagnosis of an odontogenic cause)¹²; 2) surgical confirmation of an abscess; and 3) microbiological cultures from intraoperative pus samples.

MR images were acquired between April 1, 2013, and August 31, 2021, with the Philips Ingenia 3T system using a dS HeadNeckSpine coil configuration and a gadolinium-based intravenous contrast agent

(Dotarem; Guerbet). In MRI, the tissue surrounding the abscess often enhances after injecting the contrast agent, but the abscess content does not enhance. From the MRI data, we recorded the maximal abscess diameter and five edema patterns: RPE, ME, submandibular space edema (SMSE), sublingual space edema (SLSE), and visceral space edema (VSE). Examples of these patterns are illustrated in Figure 1. Maximal abscess diameter was measured by a single radiologist (J. He), and edema patterns were agreed upon by two fellowship-trained neuroradiologists (J. Hi and J. He) with 13 and 12 years of experience in diagnostic radiology, respectively, as previously described.¹¹ We had previously established good interobserver agreement on detection of these MRI variables in blinded multireader settings.^{10,13}

Microbiological cultures were indexed as positive or negative for the presence of at least one of the SAG group pathogens. From the patients' medical records, we recorded age, biological sex, prior dental treatment (root canal treatment, intraoral incision, tooth extraction, or none), C-reactive protein (CRP) levels, white blood cell count (WBC), trismus (yes/no), the need for intensive care unit (ICU) treatment (yes/no), the need for transcervical (in addition to intraoral) incision (yes/no), and length of stay (LOS) in a hospital.

The effect of SAG status was assessed at the univariate level using the chi-squared test for nominal variables. Continuous variables were not normally distributed according to the Shapiro-Wilk test, with *P* values ranging from .035 to .001, and had comparable variances according to the Levene test (*P* = .181-.941). Therefore, the Mann-Whitney *U*-test was utilized to compare these results. At the multivariate level, we used the logistic regression model with SAG status as the dependent variable and data available at the time of imaging (maximal abscess diameter, MRI outcomes, age, biological sex, prior dental treatment, CRP, WBC, and trismus) as predictors. The impact of SAG status on later clinical variables (ICU treatment, transcervical incision, and LOS) was presented only at the univariate level. Statistical data were analyzed using IBM SPSS Statistics for Mac version 28. *P* values lower than .05 were considered statistically significant.

RESULTS

A total of 93 patients fulfilled the inclusion criteria (Table I). Among these patients, 46 (49%) had bacteria belonging to SAG growing in their cultures, whereas 47 (51%) did not. Regarding the MRI findings, the SAG-positive patients had a larger maximal abscess diameter (36.2 vs 31.7 mm, *P* = .036) and a significantly higher prevalence of ME (43% vs 15%, *P* = .003). The other imaging findings and clinical predictors (RPE, SMSE, SLSE, VSE, patient age, and

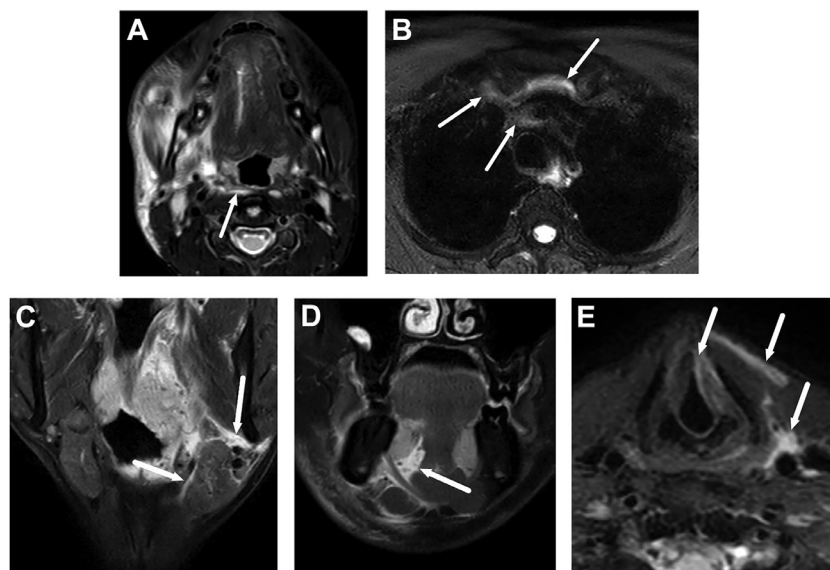


Fig. 1. Examples of edema patterns on T2-weighted fat-suppressed magnetic resonance (MR) images. (A) An axial MR image at the level of the oropharynx shows retropharyngeal edema (RPE, arrow) in the retropharyngeal space between the superior constrictor pharyngeal muscle and the prevertebral muscles. (B) An axial MR image at the level of the upper mediastinum shows mediastinal edema (ME, arrows) behind the sternum. (C) A coronal MR image at the level of the mandibular angle shows submandibular space edema (SMSE, arrows) superior and medial to the submandibular salivary gland. (D) A coronal MR image at the mid-level of the oral cavity shows sublingual space edema (SLSE, arrow) medial and inferior to the sublingual salivary gland. (E) An axial MR image at the level of the larynx shows visceral space edema (VSE, arrows) in the vocal cords, in the strap muscles outside the larynx, and anterior to the common carotid artery.

biological sex, prior dental treatment, CRP level, WBC, trismus, ICU treatment, and LOS) were not significantly different between SAG-positive and -negative patients ($P \geq .059$). In the multivariate model, ME was the only statistically significant predictor of SAG positivity (OR = 7.455, $P = .004$). An example of ME is shown in Figure 1.

Regarding surgical outcomes, SAG-positive patients required transcervical incisions more often than SAG-negative patients (61% vs 36%, $P = .004$). However, the need for ICU treatment was similar among SAG-positive and -negative patients (11% vs 19%, $P = .229$), as was LOS (mean 4.8 vs 4.0 days, $P = .219$).

DISCUSSION

When examining MRI and microbiological data from patients with odontogenic neck abscesses, we found that ME is highly suggestive of the involvement of SAG. Detection of SAG status before surgery might be beneficial because these pathogens are associated with a severe course of illness. These findings highlight the clinical utility of emergency MRI in patients with acute odontogenic neck infections.

Research has now shown that 1) SAG is a common finding in severe DNI, and these bacteria can cause more-severe infections^{8,14}; 2) SAG is associated with severe OI⁸; 3) SAG has a tendency to form abscesses^{8,14}; 4) patients with ME often need extraoral

incision¹²; and 5) ME is highly suggestive of SAG presence in microbial cultures, as revealed in the present study. Patients with SAG need to be recognized early and treated with appropriate surgery. MRI can indicate the ability of SAG to progress within deep structures of the neck, and it can be a good method for surgeons to assess the need for more aggressive surgery to avoid complications. The role of SAG bacteria in DNI abscesses is probably even more important than has yet been proven, even if the microbiology of odontogenic DNI has been studied mainly with culture. The entire microbiome and the possibility of biofilm in DNI abscesses need more research with novel techniques such as polymerase chain reaction (PCR) and next-generation sequencing (NGS).

It is well-known that *S. anginosus*, *S. intermedius*, and *S. constellatus* are pathogens of periapical abscesses.¹⁵ Periapical infection without adequate root canal treatment is the main reason for severe OI.¹⁶ In a retrospective study, the cause is usually determined based on the information given in the referral. Unfortunately, this information is often limited. It is sometimes not known without imaging whether OI originates from a periapical infection, periodontitis, or pericoronitis. Quite often, emergency physicians are not informed if the tooth has been extracted due to infection or if the infection has developed postoperatively. This can lead to the overdiagnosis of postoperative infections in the

Table 1. Radiological, demographic, clinical, laboratory, and surgical data from the study subjects stratified as SAG-positive or SAG-negative

| | Total n (% of all) or total mean (\pm SD) | SAG-positive (% of positive) or mean (\pm SD) | SAG-negative (% of negative) or mean (\pm SD) | Univariate statistic | Univariate P value | Multivariate OR | Multivariate P value | |
|--------------------------------------|--|--|--|----------------------|--------------------|-----------------|----------------------|------|
| Total | 93 (100) | 46 (49) | 47 (51) | | | | | |
| Maximal abscess diameter (mm) | 34 (\pm 16) | 36.2 (\pm 14.2) | 31.7 (\pm 17.9) | 1353.5 | .036 | 1.012 | .572 | |
| RPE | 33 (36) | 16 (35) | 17 (36) | 0.020 | .889 | 0.650 | .457 | |
| ME | 27 (29) | 20 (43) | 7 (15) | 9.124 | .003 | 7.455 | .004 | |
| SMSE | 93 (100) | 46 (100) | 47 (100) | | N.A. | | N.A. | |
| SLSE | 72 (77) | 36 (78) | 36 (77) | 0.037 | .848 | 1.187 | .804 | |
| VSE | 77 (83) | 39 (85) | 38 (81) | 0.252 | .615 | 0.464 | .335 | |
| Age (years) | 41 (\pm 15) | 39 (\pm 14) | 42 (\pm 16) | 962 | .360 | 0.966 | .060 | |
| Biological sex: male/female | 50/43 (54/46) | 25/21 (54/46) | 25/22(53/47) | 0.013 | .911 | 0.624 | .438 | |
| Prior dental treatment | | | | | | | | |
| | Total | 67 (72) | 32 (70) | 35 (74) | 7.430 | .059 | 0.619 | .461 |
| | Root canal treatment | 7 (8) | 0 (0) | 7 (15) | | | | |
| | Intraoral incision | 4 (4) | 2 (4) | 2 (4) | | | | |
| | Tooth extraction | 56 (60) | 30 (65) | 26 (55) | | | | |
| | None | 26 (28) | 14 (30) | 12 (26) | | | | |
| CRP | 114 (\pm 83) | 157 (\pm 80) | 132 (\pm 84) | 1263 | .069 | 1.004 | .331 | |
| WBC | 14 (\pm 5) | 13.8 (\pm 4.7) | 13.6 (\pm 5.4) | 1073.5 | .754 | 0.906 | .120 | |
| Trismus | 72 (77) | 35 (76) | 37 (79) | 0.518 | .472 | 0.345 | .142 | |
| ICU treatment | 14 (15) | 9 (19) | 5 (11) | 1.449 | .229 | | | |
| Transcervical incision | 45 (48) | 28 (61) | 17 (36) | 8.252 | .004 | | | |
| LOS (days) | 4 (\pm 4) | 4.8 (\pm 4.3) | 4.0 (\pm 3.2) | 1212 | .219 | | | |

CRP, C-reactive protein level; ICU, intensive care unit; LOS, length of stay; ME, mediastinal edema; N.A., not applicable; OR, odds ratio; RPE, retropharyngeal edema; SAG, *Streptococcus anginosus* group; SLSE, sublingual space edema; SMSE, submandibular space edema; VSE, visceral space edema; WBC, white blood cell count. P values in bold type indicate statistically significant results ($P < .05$).

dataset. In our study, the periapical infections had previously been analyzed with MRI,¹² making identification of the causative agents stronger than in most retrospective studies. Treating periapical infection endodontically is sound practice in its early stages, and the infection should never be treated with antibiotics alone.¹⁷ In severe cases, the causative tooth is usually extracted. Our findings should be of interest to all dentists: SAG is a common finding in OI and can cause severe infections, edema, and abscesses far from the original location. All OIs should be treated with subsequent surgery (tooth extraction, incision, and drainage in the oral cavity) in the early stages of the infection. Antibiotic treatment is secondary to surgery with OI. Broad-spectrum antibiotics should be avoided, and penicillin should be used in combination with metronidazole when streptococci are still susceptible.

Our sample size was limited, which may have been a factor in the discrepancy between our findings and previous investigations of the association between SAG and high CRP, WBC, the presence of trismus, and LOS. The SAG-positive patients in our study had a trend toward higher laboratory findings and longer hospital days, but these did not reach statistical significance and were therefore not clinically meaningful. Difficulty in swallowing has been reported to be an indicator of SAG, but in our material, this issue was only vaguely documented, and we were unable to obtain reliable data due to the retrospective nature of the study. Nevertheless, all factors mentioned above should be taken into account when determining the severity of the infection and making decisions about treatment. Given the limited sample size, our results should be considered preliminary. We did not attempt machine learning-based classification because of the risk of overfitting and poor generalizability due to the small sample size and the lack of external validation. These models should be the focus of future work on this topic.

MRI should not replace microbiological analysis. Rather, we suggest it as a tool for an emergency surgeon in situations where results of microbial samples are not yet available and imaging shows edema in the mediastinum. Until now, the surgeon has not been able to assess the involvement of SAG without culture results to inform the decision for more aggressive surgery if necessary. However, it should be noted that the availability of MRI or the time spent on MR imaging should never delay the care of the patient in need of immediate treatment. Thus, MR imaging studies do not replace clinical examination and computed tomography (CT) imaging for the most urgent patients.

Importantly, ME represents reactive edema that is seen in about 25% of patients with acute neck infections of various origins¹¹ and not a drainable

mediastinal abscess. Most ME cases represent faint edema reaching the upper parts of the mediastinum as a caudal continuation of either visceral space/anterior cervical space edema (anterior type of ME) or that of RPE (posterior type of ME), as shown in [Figure 1](#). Such faint tissue edema is unlikely to represent a precursor of actual descending mediastinitis, although such cases would likely be preceded or accompanied by widespread ME.

In clinical practice, CT is often used to image deep odontogenic neck infections in emergency departments.¹⁸ CT is widely available and characterized by fast scanning times, lower cost, and a good ability to depict bones and teeth. A limitation of CT is a variable diagnostic accuracy for neck abscesses, likely due to limited soft tissue discrimination.¹⁹ Although large abscesses may be detected and measured fairly accurately using CT, it is unknown whether edema patterns such as ME can be depicted with this imaging system. Future prospective studies comparing CT and MRI are needed to resolve this issue.

The strengths of this study include high-quality 3T MR images, the use of imaging variables that have been previously validated for good interobserver agreement, and a well-characterized patient cohort in terms of microbiological data as well as demographic, clinical, laboratory, and surgical parameters. Extraoral surgery was needed more often in the SAG group, which can be expected as SAG is associated with a more severe course of illness. Yet, our study is limited by the single-center retrospective setting: controlling for selection bias is difficult, clinical and surgical information may be inaccurate or missing, and MRI may not always be suitable or available for all patients in all institutions, limiting the generalizability of our findings.

CONCLUSIONS

SAG bacteria occur especially in the most severe OI extending to the lower neck and the mediastinum. ME observed on an emergency MRI is highly suggestive of the involvement of SAG in patients with acute odontogenic neck infections. These findings highlight the clinical utility of emergency MRI in these patients because detecting SAG status even before surgery might be beneficial due to the association of these pathogens with a severe course of illness. Further studies should clarify the radiological characteristics of different bacteria in OI in more detail so that the typical behavior of the infection can be predicted early.

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ETHICAL APPROVAL

The study was conducted in accordance with the Helsinki Declaration and was approved by institutional permission from the Turku Clinical Research Center. Written patient consent was waived due to the retrospective nature of the study.

DECLARATIONS OF INTEREST

None.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Meira Lääveri: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Jaakko Heikkinen:** Writing – review & editing, Investigation, Formal analysis, Data curation. **Tatu Happonen:** Writing – review & editing, Investigation, Formal analysis, Data curation. **Aapo Sirén:** Writing – review & editing, Investigation, Formal analysis, Data curation. **Janne Nurminen:** Writing – review & editing, Investigation, Formal analysis, Data curation. **Jari-Pekka Vierula:** Writing – review & editing, Investigation, Formal analysis, Data curation. **Jarno Velhonoja:** Writing – review & editing, Investigation, Data curation. **Heikki Irjala:** Writing – review & editing, Data curation, Conceptualization. **Tero Soukka:** Conceptualization, Data curation, Writing – review & editing. **Kimmo Mattila:** Writing – review & editing, Data curation, Conceptualization. **Marianne Gunell:** Writing – review & editing, Data curation, Conceptualization. **Johanna Snäll:** Writing – review & editing, Supervision, Conceptualization. **Jussi Hirvonen:** Writing – review & editing, Visualization, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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