RADIOGRAPHIC INTERPRETATION ACCURACY AND CONFIDENCE LEVEL IN CLINICAL CASES BETWEEN ORAL MAXILLOFACIAL RADIOLOGISTS AND NEURORADIOLOGISTS IN THE HEAD AND NECK REGIONS

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A thesis submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Science in the School of Dentistry (Oral and Maxillofacial Radiology).

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ABSTRACT

Erin Sujeong Hong: Radiographic Interpretation Accuracy and Confidence Level in Clinical Cases between Oral Maxillofacial Radiologists and Neuroradiologists in the Head and Neck Regions
(Under the direction of Shannon Wallet)

Objectives: 1. To Compare accuracy in diagnosing lesions or conditions in the head and neck regions between OMFR and NR. 2. To Compare confidence levels in responses between OMFR and NR. 3. To Correlate confidence and accuracy between OMFR and NR. 4. To Propose basic guidelines based on the predictions for primary care doctors and dentists who are in need of advanced imaging interpretation of the head and neck region. **Methods**: An electronic anonymous survey consisting of 18 clinical cases, was sent to recruit NR and OMFR. A total of 57 (27 NR and 30 OMFR) responses were analyzed for means in accuracy and confidence into three predictions. The predictions were formulated by grouping cases into three. The first prediction was that the NR group would perform better for non-odontogenic lesions and malignant cases. The second was that the OMFR group would perform better for odontogenic and TMJ cases. Lastly was that both groups would perform similarly in sinus cases, systemic and developmental anomalies. To test the null hypotheses: the same accuracy and confidence levels between NR and OMFR were computed. Pearson's (r) correlation was used to assess the relationship between accuracy and confidence based on predictions. **Results**: NR achieved higher means for accuracy (overall average at 60.08%, p-value <0.0001) in all three predictions but OMFR scored higher confidence levels for odontogenic, TMJ, sinus, systemic, and developmental cases while NR had a higher confidence level for the cases of non-odontogenic lesions and malignancies. **Conclusions**: Predictions for NR were supported by data. The null hypothesis was rejected for accuracy only. OMFR's overall accuracy scored 40%

with a confidence level of 3.18 (somewhat confident). NR scored 60.08% of overall mean accuracy with an average confidence level at 3.22 (somewhat confident). OMFR demonstrated a lower accuracy but insignificant difference in confidence level compared to NR. OMFR's total correlation was r= 0.1757, *p*-value: 0.3592 while NR's at r= 0.1030, *p*-value: 0.6092. No overall correlation was found regardless of each group's accuracy and its perceived confidence. A proposal for basic referral guidelines was not supported by the data although valuable information regarding the differences between two groups of radiologists is apparent.

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LIST OF ABBREVIATIONS

AAOMR	American Academy of Oral Maxillofacial Radiology
ABOMR	American Board of Oral Maxillofacial Radiology
ABR	American Board of Radiology
CBCT	Cone Beam Computed Tomography
CODA	Commission on Dental Education
DDS	Doctor of Dental Surgery
DMD	Doctor of Dental Medicine
IRB	Institutional Review Board
MD	Doctor of Medicine
MDCT	Multidetector Computed Tomography
MRI	Magnetic Resonance Imaging
NR	Neuroradiology
OMFR	Oral Maxillofacial Radiology
PET	Positron Emission Tomography
TMJ	Temporomandibular Joint

MANUSCRIPT

Introduction

Education and role

In the radiology world, two specialty groups diagnose in the head and neck regions. The groups are neuroradiologists (NR) and oral maxillofacial radiologists (OMFR). There are clear distinctions between the two groups as well as similarities. Neuroradiologists are medical radiologists with MD's who further their education in radiology through a hospital-based neuroradiology fellowship[1,3]. This means they graduate from medical schools; complete radiology residency, then specialize in neuroradiology fellowship and interpret abnormalities from the apex of a human skull to the hypo-larynx including the spine and brain. In contrast, OMFR's are dentists with DDS or DMD degrees who finish a residency in OMFR emphasizing the oral and maxillofacial complex, from the calvarium to cervical spine[4]. To be more specific, MRI is not a commonly used modality for OMFR, but a dental MRI is under reviews in feasibility and returns on investment by a few major imaging equipment manufacturers. As mentioned before, two highly specialized groups diagnose similar anatomical regions such as calvarium, brain, meninges, skull bases, sinuses, pharynx, nasal cavity, oral cavity, glottis, larynx, etc. When clinicians suspect lesions in the head and neck regions, they need to consider where they refer their patients so it can lead to an optimal prognosis. Clinicians should consider: the extent of the lesion (soft vs hard vs mixed tissue), expertise, availability, and affordability. Of primary interest in this study is validating which group has a higher accuracy and confidence level in interpreting abnormalities that can be manifested in the head and neck regions using computed tomography.

Overlapped regions but distinctive approaches

The American Society of Head and Neck Radiology (ASHNR) educates neuroradiologists to hone their interpretation skills in the head and neck regions, similar to the American Association of Oral Maxillofacial Radiology (AAOMR)[1,2]. However, compared to OMFR residents, NR fellows practice mainly diagnosing soft tissue, particularly cancers. In contrast, the main focus of the OMFR is to interpret lesions in hard tissue. Neuroradiologists also report abnormal but benign oral lesions to the patient's primary providers so they can deal with it later unless there is perineural spread or lymph node involvement, or the actual lesion of interest is in the oral cavity. The success level in rehabilitation and functionality heavily depends on early diagnosis and proper referral. This research will attempt to fill the gap regarding whether OMFR or NR is more efficient in interpreting the head and neck lesions. Each group's specific scope of practice introduces ambiguity and confusion regarding referral patterns as well as interpretation of the lesions. To clarify, primary providers who are either dental or medical could benefit from basic referral outlines to determine the patient's advanced imaging needs (location, soft tissue vs hard tissue, malignant vs benign). A referral can be complicated and requires a critical thought process. It is not solely based on the availability of radiologists but should be based on the expertise of radiologists.

Current referral routine

Most cancer patients are referred to a hospital setting not only for treatments but also for additional MRI scans or PET with CT to diagnose soft tissue involvement in cancer along with the multidetector CTs. Many oral lesions are detected often by chance in the dental setting while a patient is exposed with routine X-rays; periapical, bitewing radiographs, panoramic, and cephalometric radiographs for orthodontic and craniofacial patients. Then a patient is likely to be referred to an imaging center or a dental school for a CBCT scan. Many times, patients go through a biopsy to obtain a pathology specimen during an exploratory phase along with the CBCT. If the case is determined to be eradicated by an oral surgeon without chemo or radiation therapies, then surgery is performed with rehabilitation and reconstruction in mind. This survey is designed to compare the interpreting accuracy and confidence level between the two radiology groups and to aid in proposing patient referral guidelines for primary physicians and dentists. These guidelines can aid to ensure reliable radiographic diagnosis so that referring and treating doctors can collaborate in subsequent treatment options for better prognoses.

Previous studies

Currently, no articles compared these two groups of specialists. This is the first study to compare accuracy and confidence level in interpretation skills. Additionally, a proposal to set basic guidelines for primary providers will be discussed. Other studies compared diagnostic accuracy between modalities such as in a study by Lim and Tyndall as the investigators compared panoramic radiographs and CBCT to test diagnostic accuracy[5]. Additionally, previous investigations have explored how radiologists, otolaryngologists, and pathologists defined borders of cancer invasion in tongue extrinsic muscles. This study highlighted differences in disciplines: diagnostic science, surgical intervention, and pathology[6]. To our knowledge, this study is the first to compare two specialty groups in interpreting lesions in the head and neck regions. This study could aid in proposing basic guidelines for referring doctors who are in need of advanced imaging interpretation.

Research aims

1. To compare accuracy in diagnosing lesions or conditions in the head and neck regions between OMFR and NR.
2. To Compare confidence levels in responses within OMFR and NR.
3. To Correlate confidence and accuracy within OMFR and NR.
4. To Propose basic guidelines based on the predictions for primary care doctors and dentists who are in need of advanced imaging interpretation of the head and neck region.

Predictions

1. Neuroradiologists will score better than their OMFR counterparts diagnosing non-odontogenic lesions and malignancies (Group I cases, table 1).
2. OMFR radiologists will score better than NR counterparts diagnosing odontogenic lesions and TMJs (Group II cases, table 1).
3. Both radiologists will score similarly in sinuses, systemic, and developmental anomalies (Group III cases, table 1)

Null Hypotheses

1. OMFR and NR have the same accuracy to respond correctly in their diagnosis
2. OMFR and NR have the same confidence level in their diagnosis

Materials and Methods

An anonymous survey containing clinical cases of static computed tomographic images in the head and neck regions was distributed to OMFR and NR.

Recruitment

NR and OMFR specialists will be recruited by a list-serv or email invitation. For OMFR, an invitation email with an anonymous survey link was posted in a list-serv that is hosted by the University of California at Los Angeles OMFR program. An invitation email with the survey link was sent to NR fellowship directors.

Anonymous survey delivery

The participants were instructed to click on the anonymous link created by Qualtrics®. This will ensure an anonymous survey and no tracing of respondents to their scores is possible.

Question format

Anonymous respondents of the survey were asked to answer 18 cases in a single-answer multiple-choice format presenting mostly MDCT images (the common modality between two groups) in two of three planes; axial, coronal, and sagittal. Each question was timed for 30 seconds then the survey automatically prompts a respondent to the next question. It is timed so no respondent can utilize any external resources to answer the survey.

Categories

The cases can be divided into nine categories; TMJs, sinuses, developmental anomalies, odontogenic tumors and cysts, nonodontogenic tumors and cysts, systemic diseases. Each category contains two clinical cases. Categories, diagnosis, group number, and case number are organized in table 1 for readers.

Viewing conditions

Since each participant used their computers to view the images, inherent variations could be the display settings, ambient room lighting, and physical conditions of a respondent. These uncontrollable biases were not considered since they mimic real practice settings.

Deadline and conditions

The survey was sent or posted with a link and the recipients had a month to participate. Once respondents started the survey, they had to finish the survey in one sitting. All recorded surveys per specialty group were collected.

Case collection

The de-identified human scanned images used in this survey were from real patients who have been seen at or referred to the University of North Carolina hospital. The images were provided by a neuroradiology fellowship director and OMFR cases were excerpted from Radiopaedia by various doctors who donated their cases to be displayed (Radiopaedia.org) [7]. The images were acquired mostly using MDCT or CBCT. Any information about manufacturers and image acquisition parameters were not available. The images did not contain any identifiers (name and date of birth). Besides, the images were all static slices that mostly feature the key characteristics and prime locations. The age of the patient was not given to the responders. The quality of the images was less than ideal but still diagnostic. There was only one abnormality to identify and four answer choices were listed including the best answer choice or the top differential diagnosis. The slices were provided; each respondent was then asked to select the best answer. In addition, the respondent was asked to rate their confidence level on a 1 to 5 scale regarding the corresponding answer choice.

Excluded responses

The total number of responses recorded for data analysis was 79. 22 out of 79 responses were excluded due to incompleteness. This indicates 22 respondents recorded less than 9 cases. The OMFR group completed 30 responses while NR completed 27. Slightly higher responses from one group most likely do not affect the mean scores for accuracy and confidence nor other statistical analysis [8,18].

Statistics

Data were transferred to the Statistical Analysis System (SAS®) to obtain statistical analysis. Mean for confidence level and accuracy were computed as well as the *p*-value for each null hypothesis. Pearson's correlation was used to describe the relationship between each group's accuracy and confidence level of perceived accuracy[18]. For accuracy, the assigned number (0 or 1) for each response will be recorded as incorrect or correct for OMFR and NR. Accuracy was determined by the percentage of correct responses by the members of each group for each question. For the confidence level, it ranges from 1 to 5. 1 means totally not confident, 2: not very confident, 3: somewhat confident, 4: very confident, and 5: totally confident. The higher the number, the more confident the participant rates one's confidence level relative to the answer choice. The following null hypotheses were analyzed to either reject or not reject using *p* values.

Results

Accuracy

Pre-data predictions were presumed by each group's exposure level and familiarity of the disease categories, but predictions for OMFR were invalidated as below. 1) Neuroradiologists will score better than their OMFR counterparts diagnosing non-odontogenic lesions and malignancies. Case numbers correspond to non-odontogenic lesions and malignancies are listed as group I cases in table 1. Based on the overall score, the NR group performed significantly better with an overall score of 69.13 while OMFR scored 47.77 with $p < 0.001$ (figure 1 and table 2). 2) OMFR radiologists will score better than NR counterparts diagnosing odontogenic lesions and TMJ cases listed as group II cases in table 1. OMFR group performed with an overall score at 44.45 and NR scored at 50.62 with the same p-value as above (figure 2 and table 3). OMFR did not perform as well as NR. 3) Both radiologists will score similarly in sinus cases, systemic, and developmental anomalies listed as group III cases in table 1. NR scored an overall score at 60.49 in these 3 categories and the mean score for OMFR was 40.55 (figure 3 and table 4). NR performed better than OMFR in these categories. OMFR slightly over-performed NR in case 2, case 5, case 13, and case 16 but the difference was not significant (figure 4 and table 5).

Confidence level

Confidence level was not predicted but it is pertinent to share these results. For non-odontogenic and malignancies categories, NR had a confidence level at 3.69 while OMFR had a confidence level at 2.87 (figure 5 and table 6). OMFR yielded a 3.34 confidence level and NR a confidence level of 2.96 with a p-value at 0.025 for odontogenic and TMJ categories (figure 6 and table 7). Lastly, the confidence level was 3.01 for NR and 3.18 for OMFR for categories where a similar accuracy was predicted in both groups such as sinus cases, systemic, and developmental anomalies and the *p*-value was at 0.41 (figure 7 and table 8). Overall, NR demonstrated an insignificant higher confidence level with a *p*-value at 0.59 despite the fact that NR significantly over-performed OMFR for all the disease categories (figures 8 and table 9).

Null hypotheses

1) OMFR and NR have the same accuracy in their diagnosis. The corresponding *p*-value was less than 0.05 which is significant enough to reject the null hypothesis[18]. This rejected null hypothesis was supported by the mean accuracy scores (table 5). 2) OMFR and NR have the same confidence level in their diagnosis. The corresponding *p*-value was more than 0.05 which is not significant. Therefore, the null hypothesis was not rejected. This finding is also supported by the mean confidence level even though the NR group performed better than the OMFR group; however, the difference was not statistically different (table 9).

Correlation (Pearson's correlation, r)

The correlation between confidence level and accuracy was determined by calculating the Pearson's correlation (r) and *p*-value for each group and cumulatively[18]. Correlation with *p* values less than or equal to 0.05 was reported and interpreted as a larger magnitude of r value usually yields lower *p* value[18]. The correlation between the two groups using quantitative variables is summarized below for each set of categories. Within odontogenic and TMJ categories (group II cases), there was a positive correlation for both NR and OMFR in case 10 (TMJ case) and OMFR only in case 9 which is anotherTMJ case (table 11). Both groups showed a positive correlation in case 6 (group I) which is a non-odontogenic case (table 10). For sinus cases and systemic and developmental anomalies (group III cases), NR showed a positive correlation for case 12 (table 12). OMFR showed a positive correlation in case 11 and overall in Group III categories (table 12). A positive correlation was observed in case 16 for both groups (table 12). On average, there was no correlation except OMFR showed a positive correlation in sinus cases, systemic, and developmental anomalies (tables 12 and 13). Furthermore, no positive correlation was observed regardless of each group's accuracy and confidence level (table 13).

Discussion

Validity of cases in interpretation approach

There were 7 cases for which neither group scored more than 50% correctly. Since less than 50% of the respondents selected the answer correctly, it necessitates discussing the validity of the cases (table 14). For case 1, 70% of the respondents selected choice 2 (Ameloblastoma) which was not the correct answer choice. The sagittal slice shows the tooth is surrounded by the remnant apical bone. This hints to the respondents that there is no tooth resorption. The presence of scalloped borders likely eliminates Ameloblastoma from the top of the differential list. For case 4, 35% of respondents answered correctly by choosing choice 4 instead of choice 1 or 3. The choices 1 (Central Giant Cell Granuloma) or 3 (Odontogenic Myxoma) could be eliminated by describing the lesion as a corticated multilocular hypodense lesion with thick septae. Neighboring teeth show different stages of tooth resorption especially horizontally resorbed left mandibular molar. For case 5, the data showed that 85% of respondents answered incorrectly by choosing answer choice 3 (Lymphatic Malformation). A well-delineated hypodensity is noted on the floor of the mouth close to sublingal glands. This could lead one to the best differential as a simple ranula. For case 8, 50% of the respondents selected choice 4 (Fibrous Dysplasia). A homogeneous hyperdense mass near the right anterior skull is noted. In the same slice, it also features its superior bony spiculation encroaching to the brain region so one could eliminate Fibrous Dysplasia or Osteosarcoma. For case 13, 84% of responses favored incorrect answer choice 1 (Squamous Cell Carcinoma). This case 13 can be very confusing but the lesion is located at the anterior portion of the oropharyngeal pathway. This could help one to place squamous cell carcinoma as a second-best differential then likely to favor choice 4, Lymphoma instead. For case 17, the correct answer was Gardner's syndrome. Most of the respondents preferred choice 4 (Mandibular tori) at 73%. There are multiple osteomas identified in the right mandible and condylar head region; Besides, multiple osteomas on the contralateral condyle can also be appreciated. This could aid one to eliminate tori. For the last case 18, the respondents also demonstrated a poor score. 42% of respondents chose incorrect answer choice 3 (Cleidocranial Dysplasia). Midface deficiency, hypoplastic mandible, and lack of frontal bossing are the key features. The correct answer choice is Treacher Collins Syndrome. If respondents were to select the next best differential, then answer choice 2 (Crouzon Syndrome) could have been more logical[15-17]. This discussion led the authors to believe the questions were valid and the possible explanations for the poor performance of the above cases are unfamiliarity to diagnose with MDCT slices for OMFR, lack of knowledge or exposure in certain disease categories, or short response time (30 seconds).

Validity of cases in the statistical approach

The accuracy and confidence means were recalculated after removing 7 cases from the raw data set. The actual accuracy spread was higher, still favoring the NR group and OMFR's confidence factor was slightly lower with removal of the 7 cases. If the 7 cases were removed then a very low number of questions in the survey and consequently statistical validity could be questionable. This possible flaw was reflected in a table that shows there were 7 questions with a low percentage of accurate responses (table 14). To summarize mean accuracy and confidence without the 7 cases, there was a slight increase in overall accuracy (NR: 85.19, OMFR 66.14, and $p<0.001$) and a slight decrease in confidence level in the OMFR group from 3.13 to 3.11 but still did not differ significantly compared to NR from 3.22 to 3.34 with a p-value at 0.1833. These results were relatively similar to the original statistics. Pre-data predictions were not supported by the data and its analysis. Therefore, the focus of this study was shifted to advocate more interpretation training rather than ascertaining in-depth health and radiation physics and to propose a minor modification in the didactic curriculum to meet the accreditation requirement for OMFR specialty and hone interpretation accuracy in OMFR. According to the Commission of Dental Accreditation (CODA), an American Dental Association (ADA) accredited advanced dental education in OMFR must provide in-depth knowledge of radiation and imaging physics[12]. ABOMR is the governing board that certifies OMFR's who have passed part I and part II board examinations. Part I is entirely testing one's ability to master health physics and radiation physics including imaging technology[13]. On the contrary, the certification examination of NR does not test one's knowledge of physics; however, the general radiology certification examination does provide for physics examination[14]. Both of the board exams ascertain one's knowledge mainly on interpretation with little emphasis on radiation physics[14]. The discipline of medical physics tests one's mastery of radiation physics within the radiology specialties[14]. It is presumed that the degree of depth in knowledge in physics that is required by ABOMR is equivalent between medical physics and OMFR excluding nuclear physics[14].

Gaps in accuracy

What elements have contributed to the significant gap in the specialty groups' performances? In this section, four main factors that potentially have affected the outcome will be discussed. The first factor is the years of training. NR is a sub-specialty fellowship training that medical radiologists enter after the residency training. As a result, NR fellows spend 1 year in a neuroradiology fellowship after a 4 years long general radiology residency which provides NR with 3 additional years of training as compared to OMFR's[14]. Secondly, NR also focuses on clinical interpretation without multitasking with other responsibilities such as teaching or research. Thirdly, the images that the authors selected for the survey are slices from MDCT except "Cholesteatoma". MDCT is a common modality and it was chosen for its dual window function: Bone window vs soft tissue window[15,16]. NR reads MDCT on a regular basis while OMFR reads CBCT as the main modality. Lastly, NR does not focus its emphasis on physics. These factors will aid NR to be exposed more in interpretation even though NR has more modalities for which are required to master reading. The three main foci in OMFR training consist of in-depth physics training, 2D plane imaging, and CBCT interpretation. The CBCT is a heavily used modality for OMFR and by its design, CBCT features a better resolution contrast with many benefits for patients and radiologists[15,16]. The most critical weakness of CBCT is the lack of contrast resolution which enables a radiologist to differentiate soft tissue details[15,16]. One of the main tasks for OMFR is to educate dental students and interpret plane imaging such as full mouth X-rays, panoramic radiographs, cephalometric radiographs, periapical radiographs, and bitewing radiographs. Furthermore, OMFR acquires deep learning in MRI physics while reading an MRI as a primary or secondary modality is very limited. At a telehealth setting for TMJ management, the multidisciplinary team often consists of an NR reading MRI for oral surgeons and rheumatologists. Since oral surgeons perform the most invasive TMJ reconstruction surgeries, training OMFR in MRI interpretation potentially creates a more efficient way to provide for the needs of dental specialists, especially oral surgeons. The current referral system flows uninterrupted as long as each specialty places patients first but adopting basic guidelines for referring doctors will prevent any interruptions in continuous care and also increase collaboration level between OMFR and NR. With the emerging artificial intelligence industry and need for research and development in a feasible dental MRI, practice models for both OMFR and NR can be re-designed seamlessly and very quickly. The survey data did not support pre-data predictions; therefore, this study does not devote its result for a proposal to set basic guidelines for referring doctors. Instead, the study aids in understanding the gap in radiographic interpretation accuracy and the correlating confidence level for each specialty and correlation between accuracy and confidence.

Limitations

This survey type is intended to be an anonymous survey, not a confidential survey[9-11,18]. The survey did not include any other identifiers such as years in practice, work setting (hospital vs academia), workstation parameters, and electronic patient management software, etc. This survey has also introduced unintended biases despite the efforts to minimize the effects by formulating predictions. First, the timed response has favored NR since their workflow and practice pattern are more fast-paced than OMFR. The intended rationale behind the timing is to test one's diagnosis accuracy without consulting references. Second, NR programs greatly outnumber OMFR residency programs, plus neuroradiology has been a recognized specialty for a longer period of time. The fact that NR has a longer history than OMFR could have favored NR because the greater number of training programs with a longer history is likely to lead to greater uniformity and standardization within the profession of NR. These practice patterns and differences in uniformity and standardization between how the NR and OMFR groups are currently trained could have accentuated the observed differences in performances of the groups in this study.

Future directions

Data and analysis did not support predictions which shifted this study's focus to evaluate differences in training of each specialty, OMFR interpretation training, and OMFR curriculum. This study could potentially alert OMFR educators to seek a virtual education module and to consider standardizing OMFR training in an effort to reduce the gap in interpretation accuracy. Due to the unprecedented world-wide pandemic that human beings are facing in 2020, OMFR education is forced to transition into a virtual teaching module. Since OMFR is already equipped with virtual capabilities and expertise, OMFR can be a role model for many other specialty programs and disciplines. If each OMFR program will collaborate and learn from each other's resources and expertise, OMFR could merge in a standardized manner in the virtual world. The possible outcome of this pandemic, and future pandemics likely to occur, could provide the impetus for OMFR to become an innovative pioneer in the new virtual world of radiology education.

Conclusion

The mean score for accuracy was higher in NR compared to OMFR. While the confidence level demonstrated that both groups have a slightly higher than average confidence level of 3 (somewhat confident), there was no statistically significant difference. Null hypotheses were rejected for accuracy but not rejected for confidence level and these findings are consistent with overall mean accuracy and mean confidence. The correlation between the two groups can be summarized as follows. The OMFR group had a lower accuracy score but demonstrated a higher confidence level compared to its accuracy while the NR group scored higher in accuracy but with a lower confidence level compared to its accuracy. The difference in accuracy was significant but not in confidence level. There was a correlation in a few selected cases but no correlation in overall mean accuracy and mean confidence was observed for both NR and OMFR.

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Figures

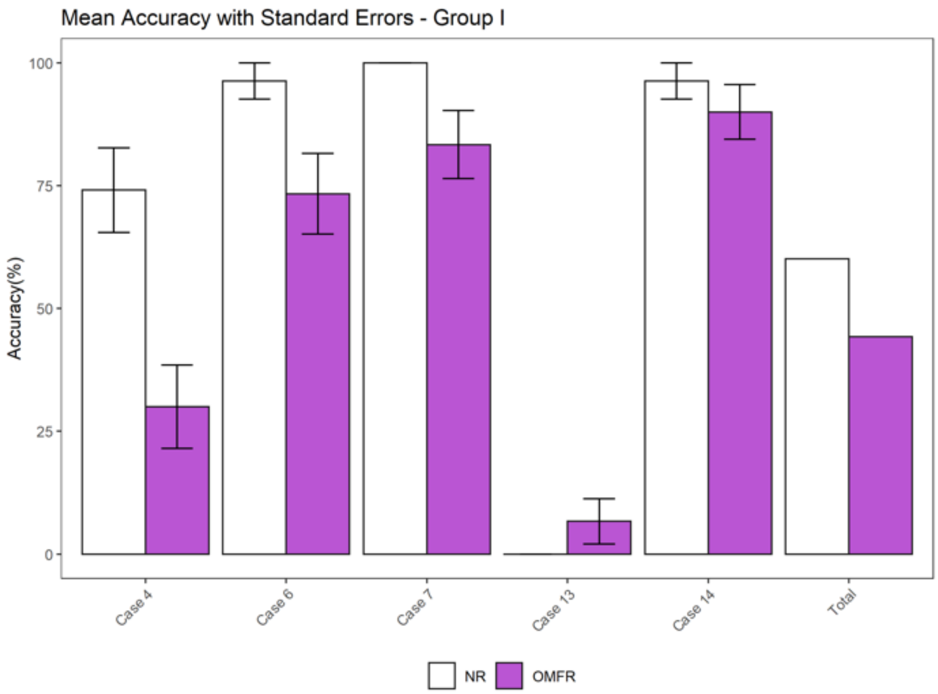

Figure 1: Bar graph of Mean Accuracy-Group I

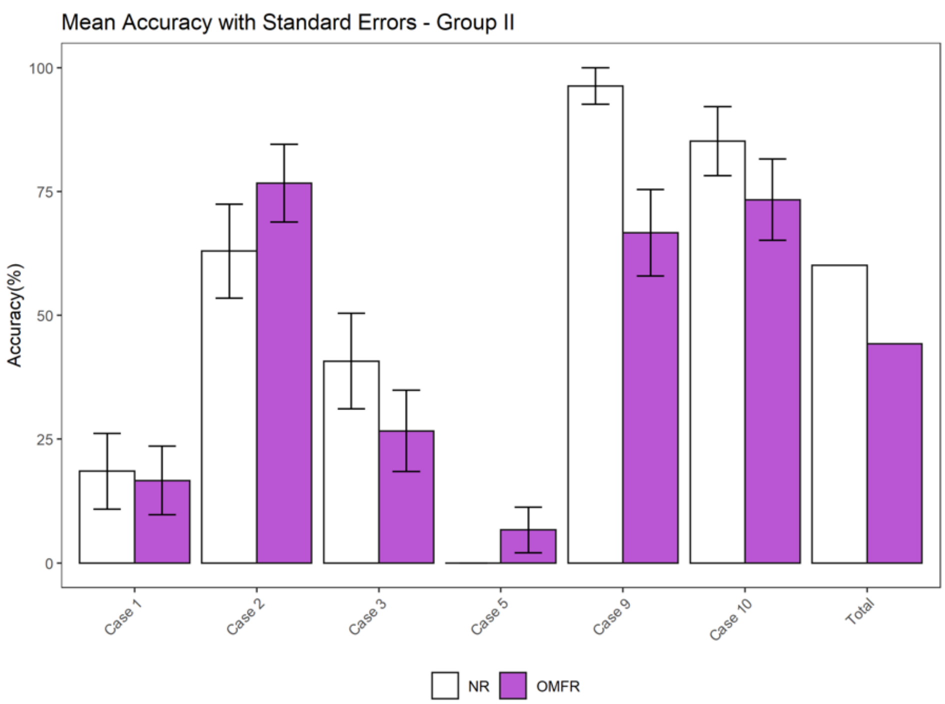

Figure 2: Bar graph of Mean Accuracy-Group II

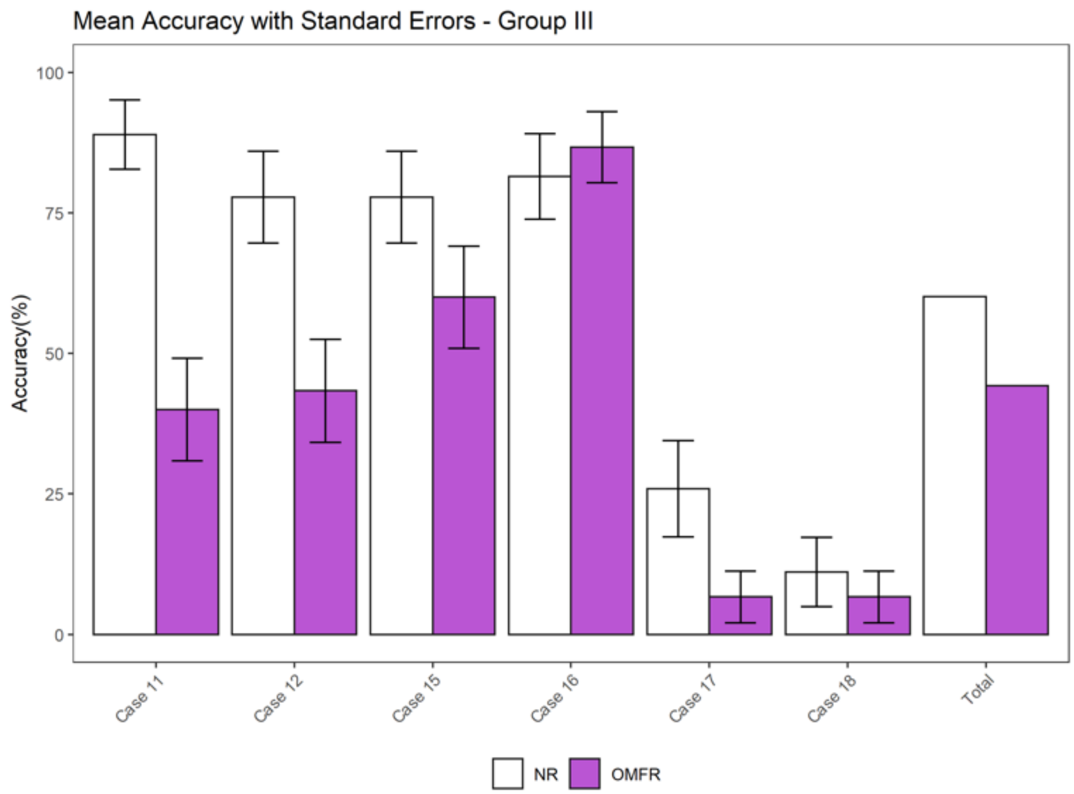

Figure 3: Bar graph of Mean Accuracy-Group III

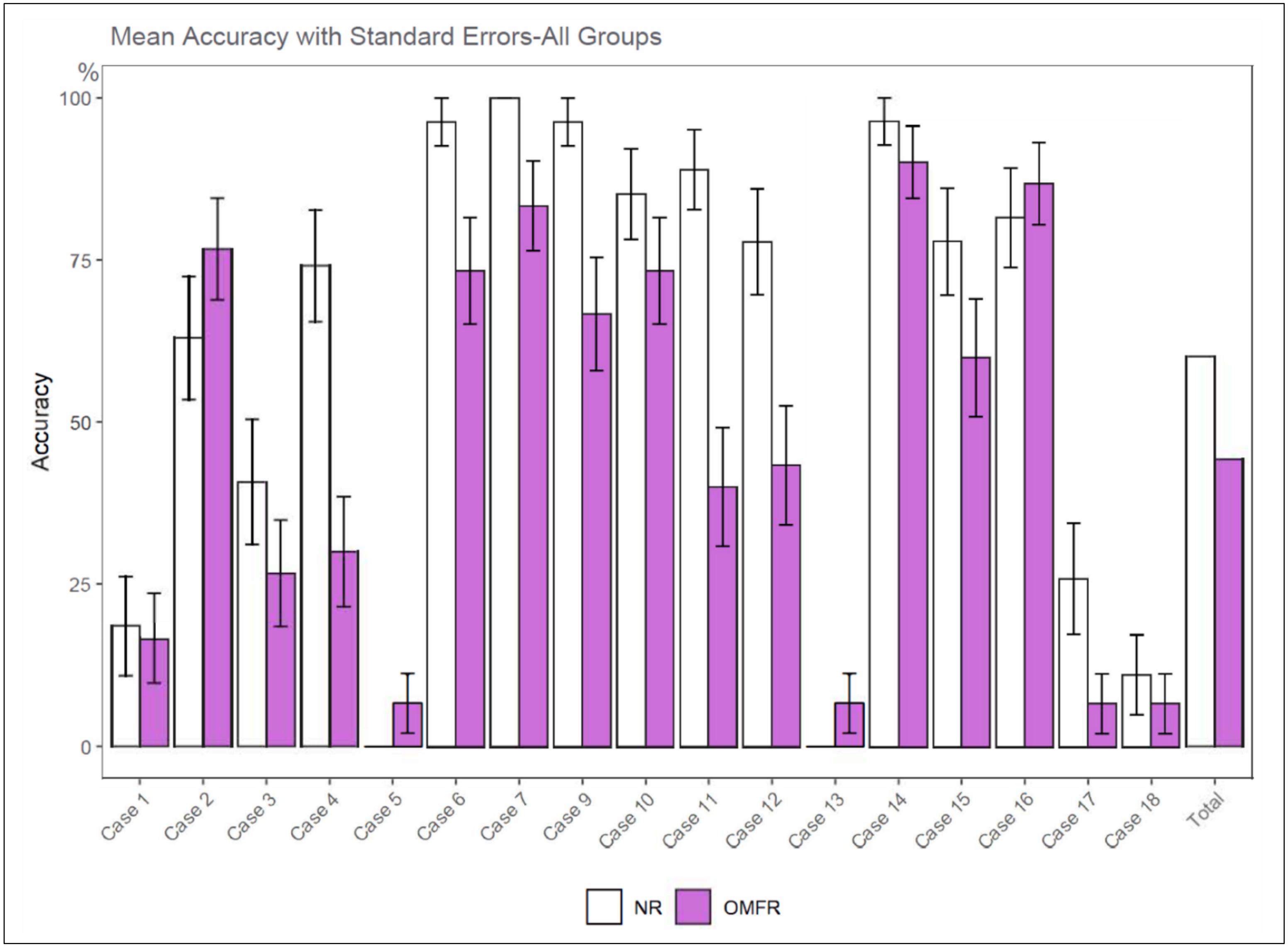

Figure 4 : Bar graph of Mean Confidence-All

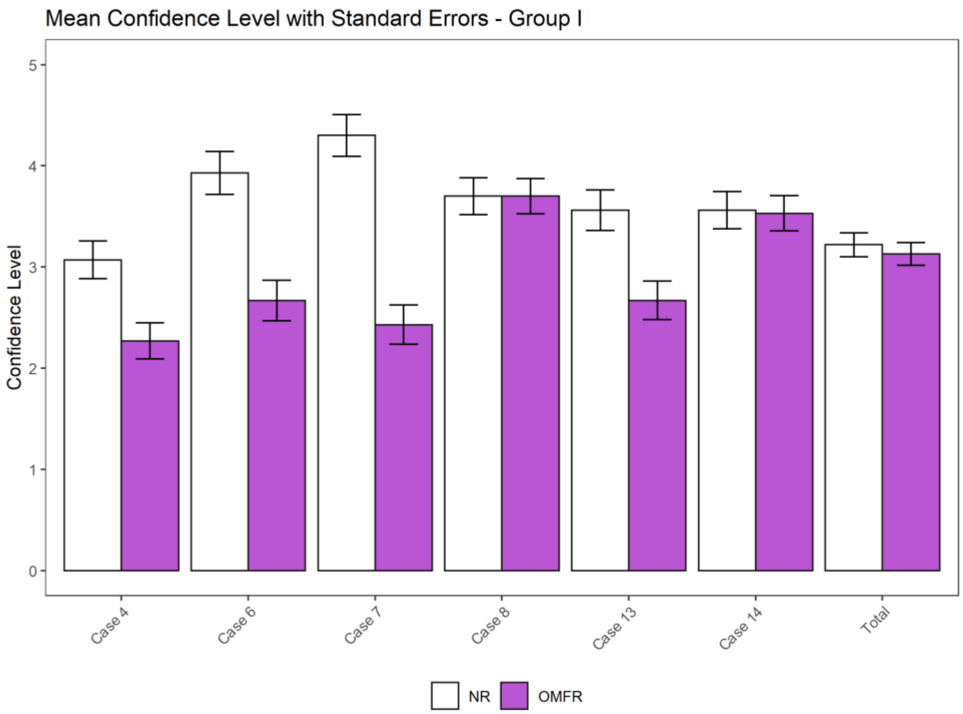

Figure 5: Bar graph of confidence level-Group I

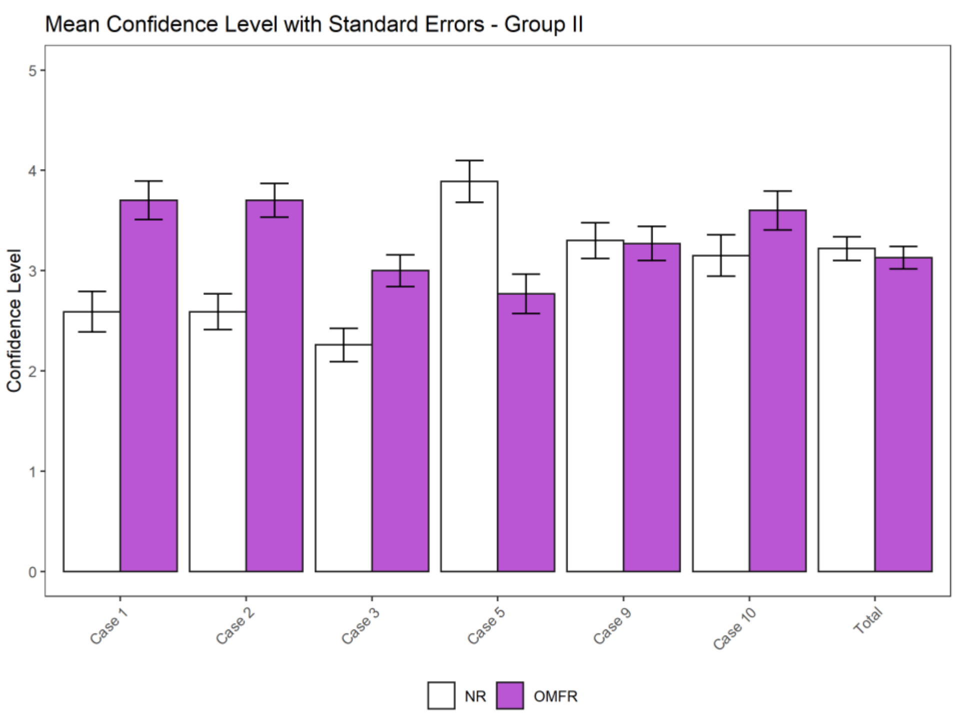

Figure 6: Bar graph of confidence level-Group II

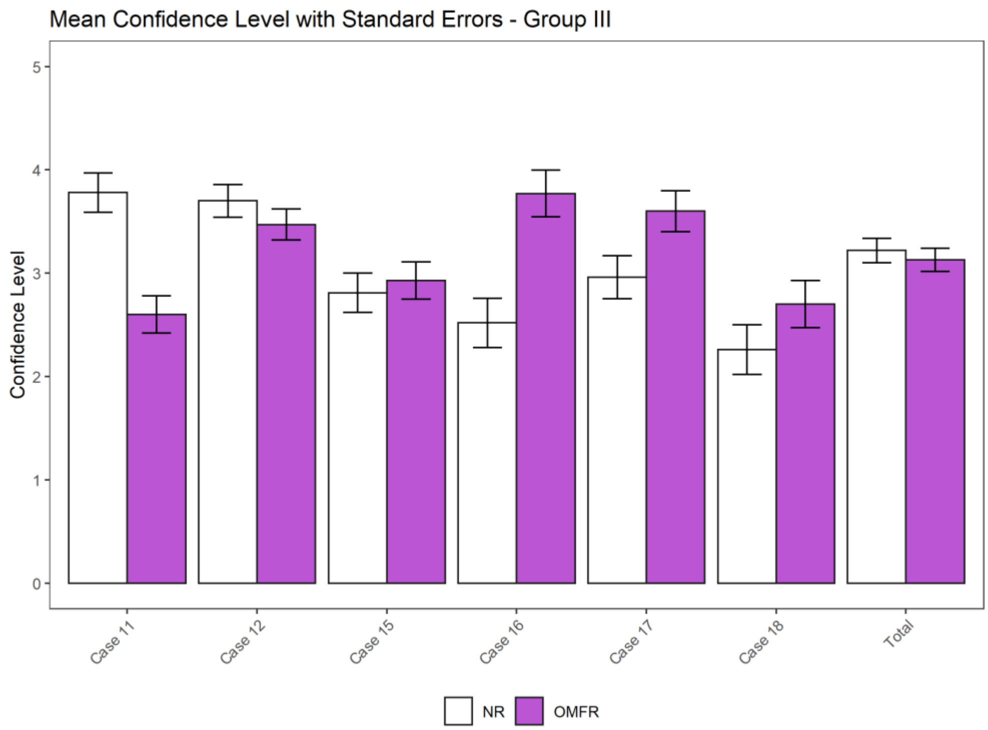

Figure 7: Bar graph of Mean Confidence Level-Group III

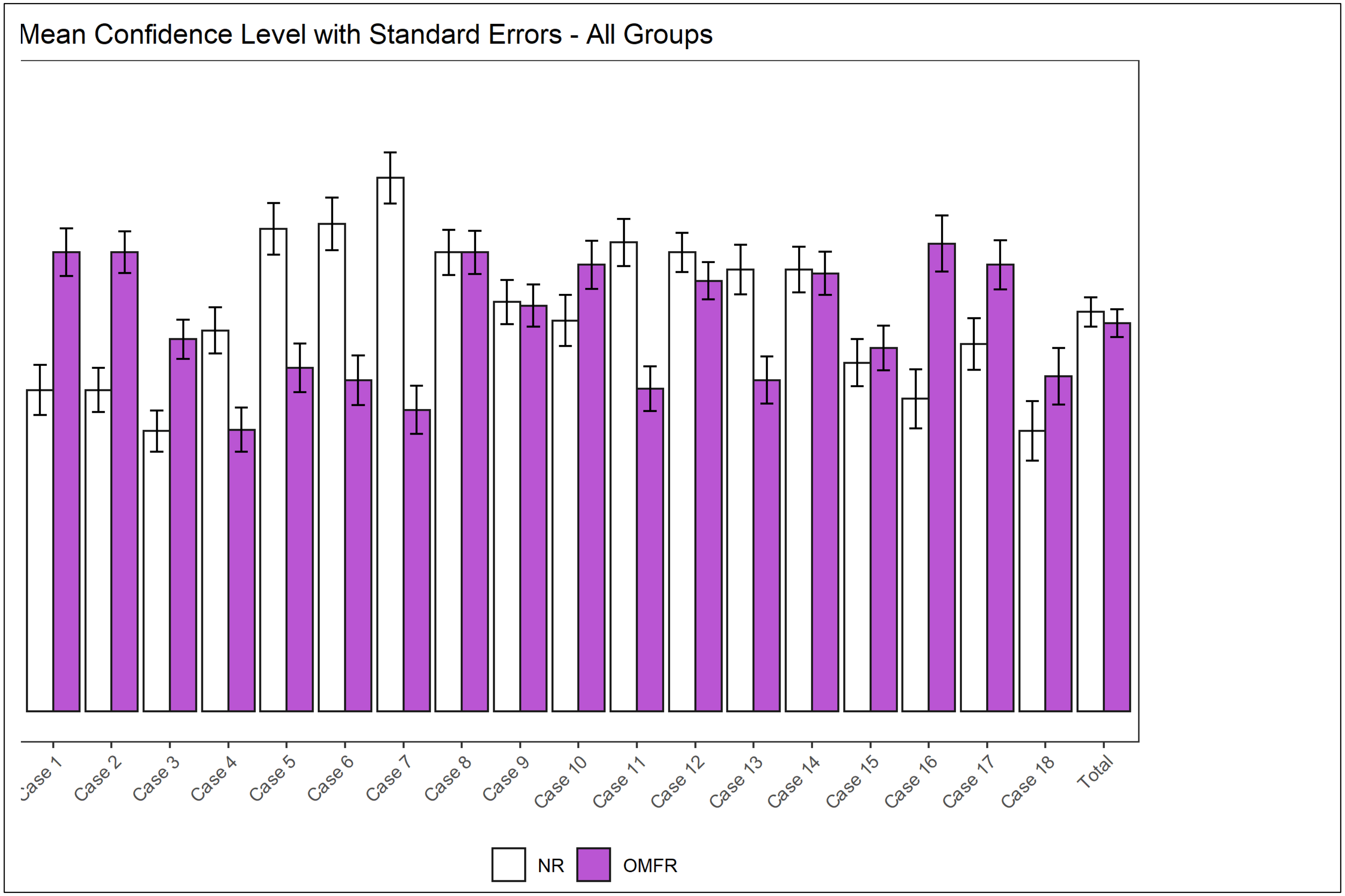

Figure 8: Bar graph of Mean Confidence Level-All Group

Tables

Table 1: Categories, Diagnosis, and Groups				
Case #	**Categories**	**Diagnosis**	**Group**	
Case 1	Odontogenic	Odontogenic Keratocyst	**II**	OMFR
Case 2	Odontogenic	Dentigerous Cyst	**II**	OMFR
Case 3	Odontogenic	Ameloblastoma	**II**	OMFR
Case 4	Non-odontogenic	Pleomorphic adenoma	**I**	NR
Case 5	Odontogenic	Ranula*	**II**	OMFR
Case 6	Non-odontogenic	Thyroglossal duct cyst	**I**	NR
Case 7	Non-odontogenic	Cholesteatoma	**I**	NR
Case 8	Non-odontogenic	Meningioma	**I**	NR
Case 9	TMJ	Synovial chondromatosis	**II**	OMFR
Case 10	TMJ	Osteoarthritis	**II**	OMFR
Case 11	Sinuses	Allergic fungal sinusitis	**III**	Both
Case 12	Sinuses	Antrochoanal polyp	**III**	Both
Case 13	Malignant	Non-Hodgkin's lymphoma	**I**	NR
Case 14	Malignant	Osteosarcoma	**I**	NR
Case 15	Systemic	Thalassemia	**III**	Both
Case 16	Systemic	Cherubism*	**III**	Both
Case 17	Developmental	Gardner Syndrome	**III**	Both
Case 18	Developmental	Treacher collins syndrome	**III**	Both

*Ranula and Cherubism can be categorized differently than listed

Table 2: Mean Accuracy Group I					
Case #	**NR**	**SE NR**	**OMFR**	**SE OMFR**	**p-Value**
Case 4	**74.074**	**8.59436**	**30**	**8.50963**	**0.0014**
Case 6	**96.296**	**3.7037**	**73.3333**	**8.21176**	**0.0271**
Case 7	**100**	**0**	**83.3333**	**6.92046**	**0.0533**
Case 8	**48.148**	**9.79908**	**3.3333**	**3.33333**	**<.0001**
Case 13	**0**	**0**	**6.6667**	**4.63206**	**0.4925**
Case 14	**96.296**	**3.7037**	**90**	**5.57086**	**0.6135**
Mean Total	**69.136**		**47.7778**		**<.0001**

Table 3: Mean Accuracy Group II					
Case #	NR	SE NR	OMFR	SE OMFR	p-Value
Case 1	18.5185	7.61809	16.6667	6.92046	1
Case 2	62.963	9.47052	76.6667	7.85403	0.3851
Case 3	40.7407	9.6362	26.6667	8.21176	0.2785
Case 5	0	0	6.6667	4.63206	0.4925
Case 9	96.2963	3.7037	66.6667	8.75376	0.0061
Case 10	85.1852	6.96696	73.3333	8.21176	0.3402
Mean total	50.6173		44.4444		0.1293

Table 4: Mean Accuracy Group III					
	NR	SE NR	OMFR	SE OMFR	p-Value
Case 11	88.8889	6.16334	40	9.09718	0.0002
Case 12	77.7778	8.15333	43.3333	9.20187	0.0143
Case 15	77.7778	8.15333	60	9.09718	0.168
Case 16	81.4815	7.61809	86.6667	6.31243	0.722
Case 17	25.9259	8.59436	6.6667	4.63206	0.07
Case 18	11.1111	6.16334	6.6667	4.63206	0.6597
Mean Total	60.4938		40.5556		<.0001

Table 5: Mean Accuracy All Groups					
	NR	SE NR	OMFR	SE OMFR	p-Value
Case 1	18.519	7.61809	16.6667	6.92046	1
Case 2	62.963	9.47052	76.6667	7.85403	0.3851
Case 3	40.741	9.6362	26.6667	8.21176	0.2785
Case 4	74.074	8.59436	30	8.50963	0.0014
Case 5	0	0	6.6667	4.63206	0.4925
Case 6	96.296	3.7037	73.3333	8.21176	0.0271
Case 7	100	0	83.3333	6.92046	0.0533
Case 9	96.296	3.7037	66.6667	8.75376	0.0061
Case 10	85.185	6.96696	73.3333	8.21176	0.3402
Case 11	88.889	6.16334	40	9.09718	0.0002
Case 12	77.778	8.15333	43.3333	9.20187	0.0143
Case 13	0	0	6.6667	4.63206	0.4925
Case 14	96.296	3.7037	90	5.57086	0.6135
Case 15	77.778	8.15333	60	9.09718	0.168
Case 16	81.481	7.61809	86.6667	6.31243	0.722
Case 17	25.926	8.59436	6.6667	4.63206	0.07
Case 18	11.111	6.16334	6.6667	4.63206	0.6597
Mean Total	60.082		44.2593		<.0001

Table 6: Mean confidence Group I					
	NR	SE NR	OMFR	SE OMFR	p-Value
Case 4	3.07	0.18662	2.27	0.17704	0.0027
Case 6	3.93	0.21165	2.67	0.20078	<.0001
Case 7	4.3	0.20597	2.43	0.1954	<.0001
Case 8	3.7	0.18336	3.7	0.17396	0.9884
Case 13	3.56	0.19989	2.67	0.18963	0.0021
Case 14	3.56	0.18374	3.53	0.17431	0.9304
Mean total	3.69	0.1346	2.87	0.12769	<.0001

Table 7: Mean confidence Group II					
	NR	SE NR	OMFR	SE OMFR	p-Value
Case 1	2.59	0.20237	3.7	0.19199	0.0002
Case 2	2.59	0.17756	3.7	0.16845	<.0001
Case 3	2.26	0.16654	3	0.15799	0.0021
Case 5	3.89	0.20765	2.77	0.197	0.0002
Case 9	3.3	0.17884	3.27	0.16966	0.9048
Case 10	3.15	0.20533	3.6	0.19479	0.1161
Mean total	2.96	0.11905	3.34	0.11294	0.0258

Table 8: Mean confidence Group III					
	NR	SE NR	OMFR	SE OMFR	p-Value
Case 11	3.78	0.19046	2.6	0.18068	<.0001
Case 12	3.7	0.15805	3.47	0.14994	0.2813
Case 15	2.81	0.19059	2.93	0.18081	0.6537
Case 16	2.52	0.23799	3.77	0.22577	0.0004
Case 17	2.96	0.20786	3.6	0.1972	0.0303
Case 18	2.26	0.23993	2.7	0.22762	0.1881
Mean total	3.01	0.15025	3.18	0.14254	0.4109

Table 9: Mean Confidence All Groups					
	NR	SE NR	OMFR	SE OMFR	p-Value
Case 1	2.59	0.20237	3.7	0.19199	0.0002
Case 2	2.59	0.17756	3.7	0.16845	<.0001
Case 3	2.26	0.16654	3	0.15799	0.0021
Case 4	3.07	0.18662	2.27	0.17704	0.0027
Case 5	3.89	0.20765	2.77	0.197	0.0002
Case 6	3.93	0.21165	2.67	0.20078	<.0001
Case 7	4.3	0.20597	2.43	0.1954	<.0001
Case 8	3.7	0.18336	3.7	0.17396	0.9884
Case 9	3.3	0.17884	3.27	0.16966	0.9048
Case 10	3.15	0.20533	3.6	0.19479	0.1161
Case 11	3.78	0.19046	2.6	0.18068	<.0001
Case 12	3.7	0.15805	3.47	0.14994	0.2813
Case 13	3.56	0.19989	2.67	0.18963	0.0021
Case 14	3.56	0.18374	3.53	0.17431	0.9304
Case 15	2.81	0.19059	2.93	0.18081	0.6537
Case 16	2.52	0.23799	3.77	0.22577	0.0004
Case 17	2.96	0.20786	3.6	0.1972	0.0303
Case 18	2.26	0.23993	2.7	0.22762	0.1881
Mean total	3.22	0.11784	3.13	0.11179	0.596

Table 10: Pearson's correlation-Group I				
	NR Correlation	p-Value	OMFR Correlation	p-Value
Case 4	-0.2798	0.1575	0.2215	0.2394
Case 6	0.5283	0.0046	0.374	0.0418
Case 7			0.0889	0.6405
Case 8	0.3349	0.0878	-0.1293	0.4957
Case 13			-0.1569	0.4075
Case 14	0.1245	0.536	0.1794	0.3429
Mean total	0.0712	0.7243	0.2606	0.1643

Table 11: Pearson's correlation-Group II				
	NR Correlation	p-Value	OMFR Correlation	p-Value
Case 1	-0.1821	0.3633	-0.3879	0.0342
Case 2	0.293	0.138	0.2926	0.1166
Case 3	0.1921	0.3371	-0.088	0.6437
Case 5			-0.2883	0.1224
Case 9	0.0596	0.7676	0.3865	0.0349
Case 10	0.6179	0.0006	0.4431	0.0142
Mean total	0.1314	0.5136	-0.1727	0.3615

Table 12: Pearson's correlation-Group III			
	NR Correlation	OMFR Correlation	p-Value
Case 11	0.2669	0.3563	0.0533
Case 12	0.5456	0.1704	0.3679
Case 15	-0.0881	0.1839	0.3305
Case 16	0.4996	0.4231	0.0198
Case 17	-0.142	-0.148	0.435
Case 18	-0.2588	-0.045	0.8133
Mean total	0.0497	0.4239	0.0196

Table 13: Pearson's correlation-All Groups			
	NR Correlation	OMFR Correlation	p-Value
Case 1	-0.1821	-0.3879	0.0342
Case 2	0.293	0.2926	0.1166
Case 3	0.1921	-0.088	0.6437
Case 4	-0.2798	0.2215	0.2394
Case 5		-0.2883	0.1224
Case 6	0.5283	0.374	0.0418
Case 7		0.0889	0.6405
Case 8	0.3349	-0.1293	0.4957
Case 9	0.0596	0.3865	0.0349
Case 10	0.6179	0.4431	0.0142
Case 11	0.2669	0.3563	0.0533
Case 12	0.5456	0.1704	0.3679
Case 13		-0.1569	0.4075
Case 14	0.1245	0.1794	0.3429
Case 15	-0.0881	0.1839	0.3305
Case 16	0.4996	0.4231	0.0198
Case 17	-0.142	-0.148	0.435
Case 18	-0.2588	-0.045	0.8133
Mean total	0.103	0.1757	0.3529

Table 14: Frequency and Percentage of cases with less than 50% accuracy														
Answer choice	***Case 1***		***Case 3***		***Case 5***		***Case 8***		***Case 13***		***Case 17***		***Case 18***	
	Frequency	*Percent*	*Frequency*	*Percent*	*Frequency*	*Percent*	*Frequency*	*Percent*	*Frequency*	*Percent*	*Frequency*	*Percent*	*Frequency*	Percent
Choice 1	4	8	13	25	3	5.45	13	23.21	47	83.93	2	3.57	21	38.89
Choice 2	35	70	8	15.38	4	7.27	14	25	5	8.93	4	7.14	5	9.26
Choice 3	1	2	12	23.08	46	83.64	1	1.79	2	3.57	9	16.07	23	42.59
Choice 4	10	20	19	36.54	2	3.64	28	50	2	3.57	41	73.21	5	9.26
Missing	7		5		2		1		1		1		3	