Assessment of HLDI Scoring Methods and Their Effect on Orthodontic Medicaid Approval/Denial Rates.

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THESIS

Submitted as partial fulfillment of the requirements for
The Master of Science in Oral Sciences in the Graduate
College of the University of Illinois at Chicago, 2020

Chicago, Illinois

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This thesis is dedicated to my Father Soul and My Mother for their limitless love and support.

ACKNOWLEDGEMENTS

I would like to thank my thesis committee Dr. Budi Kusnoto, Dr. Mohammed H. Elnagar, Dr. Flavio Sanchez, Dr. Jennifer Caplin, Dr. Ales Obrez, and Maria Grace Costa Viana for their patience, support, and advice.

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LIST OF ABBREVIATIONS

ABO	American Board of Orthodontics
CAD	OrthoCAD software
DQ	DentaQuest
DI	Discrepancy Index
HLDI	Handicapping Labio-Lingual Deviation Index
MCO	Managed Care Organization
MCO-DQ	Managed Care Organization DentaQuest
OB	Overbite
OJ	Overjet
VI	Visual inspection

SUMMARY

The objective of this study was to determine the reliability of approval and/or denial decisions based on the Handicapping Labio-Lingual Deviation Index (HLDI) scored via visual inspection (VI) using intra oral photographs versus using digital models (CAD). Furthermore, the association between denial/approval decision by the Medicaid Managed Care Organization (MCO) such as DentaQuest (DQ) and the operator's approval/denial decision as determined by VI and CAD was assessed.

Digital records were obtained from 401 randomly selected subjects with varying degrees of malocclusion from the University of Illinois at Chicago, College of Dentistry, and Department of Orthodontics clinic. HLDI measurements were completed via VI from the intra oral photographs and using digital dental casts via OrthoCAD software (Cadent, Carlstadt, NJ). Final score results were compared to each other and to the decision made by the Managed Care Organization (MCO) DentaQuest (DQ). Total HLDI score and its target disorders were computed by visual inspection using the intra oral photographs as well as digitally measured using the corresponding digital dental cast.

Intra--rater reliability was assessed for 50 randomly selected subjects. Subjects were measured twice with a one-week interval. Reliability was calculated for Overjet, Overbite, Crossbite, and total HLDI score. The intra correlation coefficients (ICC) were determined for each of these study variables as an indicator of consistency of the visual inspection method and the CAD method.

The correlation coefficient for the variables was 0.80 and higher (p-value<0.05), indicating a good degree of intra-reliability for the visual inspection method and the CAD method. The inter-reliability measurements were assessed by two investigators (experienced and trained orthodontic faculty) of the same randomly selected 50 subjects on Overjet, Overbite, Cross bite, and HLDI. The inter correlation coefficients (ICC) were determined for each of these study variables as an indicator of the consistency of the VI and CAD method. The correlation coefficient for the variables was higher than 0.80 (P-value<0.05), indicating a very good degree of inter reliability between two investigators on the study VI and CAD method.

Statistically significant differences were found between the VI and CAD results, with CAD showing higher HLDI score acceptance rate and a moderate association between the VI and MCO-DQ result. Furthermore, weak associations were found between CAD and MCO-DQ results.

In conclusion, according to this study, the assessment result provided by MCO-DQ as scored using HLDI is inconsistent with CAD and VI results. Fair association and agreement of HLDI results were observed between MCO-DQ and CAD and VI. MCO-DQ showed inconsistency in their decision for Medicaid coverage based on HLDI scores.

I. INTRODUCTION

1.1. Background

The Handicapping Labio-Lingual Deviation Index (HLDI) is one of the methods commonly used by Medicaid providers and Medicaid Managed Care Organizations (MCO) to determine the severity of orthodontic treatment need. Many states have implemented the index in recent years (Cooke et al. 2010; Parker 1999; Theis et al. 2005). Many other indexes of orthodontic treatment need, including the Index of Orthodontic Treatment Need (IOTN), the Index of Complexity Outcome and Need (ICON), the Dental Aesthetic Index (DAI), the Peer Assessment Rating Index (PAR), and the American Board of Orthodontics' Discrepancy Index (DI) are also available for use by orthodontists when determining a patient's orthodontic treatment need (Borzabadi-Farahani and Borzabadi-Farahani 2011; Cangialosi et al. 2004; Jenny and Cons 1996; S Liu et al. 2017; Siqi Liu et al. 2018; Maumela and Hlongwa 2012; Onyeaso and Begole 2007; Siddiqui, Shaikh, and Fida 2014). Compared to these other indices, the HLD Index does not include some essential criteria, such as Angle Classification and detection of impacted teeth (DentaQuest of Illinois 2017). Another issue is that HLDI has a low sensitivity. Sensitivity relates to the proportion of patients with a disorder who have a positive test result; on the other hand, specificity relates to the proportion of patients without the disorder who have a negative test result. When an index has a tremendous sensitivity, adverse decision eliminates the diagnosis. On the other hand, when an index has a tremendous specificity, accurate result courses in the diagnosis. (Cooke et al. 2010)

It is possible that patients who have significant orthodontic need will not be properly categorized in their severity of treatment need based on the score produced by the HLDI. The HLDI was developed to provide a single score based on a series of measurements on dental plaster models to differentiate normal and abnormal alignment and occlusion. (Draker 1960; Theis et al. 2005)

The HLDI scoring method that is currently being used in the orthodontic clinical setting is calculated by visual inspection from intraoral photographs, even though the accuracy of the measurements is questionable when compared to direct measurements or measurements of the 3D dental cast. Also, the accuracy of intraoral photographic orthodontic records is likely to decrease significantly as camera angulation becomes less ideal. (Fleming, Marinho, and Johal 2011; Jackson et al. 2019)

Beginning in January 2017, the state of Illinois joined 35 other states and began utilizing the HLD Index to assess the orthodontic treatment need for all Medicaid patients and determine their Medicaid coverage eligibility (acceptance/rejection) for receiving orthodontic treatment (DentaQuest of Illinois 2017). Insurance claim submission process for Managed Care Organization DentaQuest (MCO-DQ) insurance company required patient records which includes intra and extra oral images in composite format; single shot of overjet, overbite photo, panoramic, cephalometric radiograph, and scored HLD index sheet by orthodontist (DentaQuest of Illinois 2017). A board of case assessors at MCO-DQ insurance company who are orthodontist or dentists, and or clinical review specialist will assess the cases via visual inspection method based on the documents submitted through the insurance portals and provide the result within 1-2 weeks (Anonymous. 2018. Interview with health care worker by author. March 22).

The approval rates decreased after the introduction of the HLD index (Caplin et al. 2019). The current study determines the reliability of measurements based on various HLDI scoring methods (visual inspection vs digital 3D measurements). Furthermore, the study also looked at the association between the decision made by the MCO-DQ to the one derived from the HLDI scoring methods (visual inspection via photographs (VI) and 3D digital measurements (CAD). The CAD method was used as the gold standard in this study.

Most previous studies regarding HLDI scoring methods used dental stone casts to determine the HLDI score (Parker 1999). In this study, however, we used digital dental casts.

1.2. Specific Aims

The aims of this study are to:

- Assess the reliability of two different scoring methods of HLDI
    - Visual Inspection (VI)
    - 3D Digital measurements (CAD).
- Determine the association between VI and MCO-DQ HLDI assessment and the association between the CAD and MCQ-DQ HLDI assessment.
- Find the parameters/components that most significantly influence the decision outcome based on HLDI total score.

1.3. Null Hypotheses

- There is no association between approval/denial determination via VI and digital casts CAD HLDI assessment.
- There is no association between approval/denial determination via VI and Medicaid MCO-DQ HLDI assessment.
- There is no association between approval/denial determination via CAD and Medicaid HLDI MCO-DQ assessment.

II. REVIEW OF THE LITERATURE

2.1. The History of Orthodontics under Medicaid

With the government's concern of the health of individuals continuously increasing, the subsequent expansion of health legislation has been witnessed. Various health insurance packages have also incorporated dental prepayment plans into their benefits. Data from the Division of Dental Health, United States Public Health Service states that less than 1.5 million persons, an equivalent of 1 percent of the total country's population, were enrolled for dental care under public coverage by 1964 (Grainger 1967). By 1970, the number of persons covered by prepaid dental plans was, however, was anticipated to rise to over 15 million which in turn would necessitate the introduction of a third party outside the patient-doctor relationship to handle fee payment issues (Grainger 1967). As such, even though the federally administered health insurance plan for people over sixty-five years of age provided under Title 18 of the Social Security Act does not directly concern orthodontists, they should be much concerned with Medicaid; the provision of Title 19. Both Title 18 and Title 19 were, however, included in the federal Social Security act as a result of the constantly elevating social benefits (Grainger 1967).

According to Title 19, all States were required to set up a healthcare program between 1st Jan 1966 and 1st July 1967 (Grainger 1967). The purpose of the program was to provide some institutional as well as some non-institutional care to all recipients. The Title additionally listed all specific medical service items payable by the states conjointly with the federal government, with licensed practitioners within the scope of such services

required to furnish them. Orthodontic treatment was on this list. Medicaid was passed by New York State on 1st April 1966 and is still enforceable today (Grainger 1967).

While awaiting action from the Ways and Means Committee, the Department of Health, Education, and Welfare (HEW) halted approval of New York's plan for federal aid. However, with Medicaid now fully operational in New York, $217,000,000 was contributed by the federal government in support of the program. On the other hand, HEW approved federal aid plans on 1st March 1966 in California, a State that equals New York in size, and subsequently recorded a $243,000,000 share from the federal government (Grainger 1967).

In 1966, the president of the American Dental Association's (ADA) House of Delegates named a committee to deliver a report to the House of Delegates. Recommendations of the report were that maintenance of spaces emanating from loss of early teeth should be conducted; normal occlusion should be maintained through the restoration of carious teeth, and harmful oral behaviors should be fought against. The report also stated that handicapping or disfiguring malocclusions should be tackled with interceptive services as a matter of high priority. Additionally, for public funds to be used to pay for orthodontic patients, the eligibility criteria should be based on the presence of a malocclusion proving detrimental to the wellbeing and dentition functionality and manifesting a harmful effect on the facial esthetics of such an individual (Grainger 1967).

Over the past several years, constant efforts were undertaken to define the criteria for recognition of handicapping malocclusions. The development of such criteria became more wanting after the passing of Medicaid. Before the American Association of Orthodontists'

(A.A.O) annual meeting held in April 1966, a conference was held in New York City to develop a common definition and criteria for handicapping malocclusion recognition. Subsequently, a proposal emerged in a second meeting which aimed at establishing weights for various criteria in the fall of 1966. In April 1966, the American Association of Orthodontists' Board of Directors authorized the conference (Grainger 1967).

On 27th Sept 1966, a meeting was held in Washington D.C with the main agenda of whether the National Center for Health Statistics and the United States Public Health Service would cooperate with the A.A.O and jointly establish common criteria for handicapping malocclusion. This was done while prioritizing both treatment and public health purposes. Additionally, the criteria would be used in identifying and selecting patients aimed for treatment by qualified specialists listed by the A.D.A. Council on Dental Health. In attendance at this meeting was the chairperson of the Council on Orthodontic Health Service, American Association of Orthodontists (Salzmann 1966).

A Treatment Priority Index developed during the Burlington Orthodontic Research Project by the University of Toronto was used for comparison in the discussion of the newly adopted criteria during the New York conference (Grainger 1967). Participants of the Washington Conference agreed that all the criteria agreed on during the New York conference were substantially present in the 'Treatment Priority Index.' As such, the need for treatment based on the severity of handicapping malocclusion could be differentiated using the Index upon the establishment of a "cut-off" point. 1400 dental models were selected randomly by the Dental Health by the Dental Health of the State of New York department to be judged by orthodontists from various parts of the country with the

primary aim of establishing a “cut-off.” Health, function, esthetics, and "Treatment Priority Index" were the primary considerations in a 1-2-minute cast judgments before an orthodontist could rule on the severity and priority of malocclusion handicapping (Grainger 1967).

2.2. Development of the Orthodontics Medicaid Program

Title 19 of the Federal Social Security Act marked the introduction of Medicaid in 1965 (Salzmann 1966). This Title offered a wide range of health benefits including comprehensive dental care for individuals in need irrespective of their age (Salzmann 1966). According to the A.D.A, various dental problems prevail among the low-income population. They include severe malocclusions requiring medical attention that is not affordable for such a population. A task force created by the A.D.A to evaluate juvenile national health programs suggested that priority in provisioning malocclusion treatment should be “for interceptive service for disfiguring or handicapping malocclusions” (Salzmann 1966).

To pinpoint persons in dire need of treatment, the constituents of handicapping malocclusion had to be defined. As such, the involvement of orthodontists in the definition and treatment of handicapping malocclusion was unavoidable (Salzmann 1967). Various indexes have been created to develop a standard and objective definition of handicapping malocclusion. Nevertheless, the definition is still unclear due to the numerous indexes that have resulted in scaling subjectivity (Parker 1998). Even with the frequency of this

situation, federal matching funds are still made available to the state for the treatment of malocclusions among other dental services. Although states are guided by federal laws in determining included services, their freedom of Medicaid health plans customization is subject to federal approval. This consequently leads to the occurrence of similar but different allocation of orthodontic care resources and rules among various states (Salzmann 1966).

Providers in a state commence provision of orthodontic care once the authorities have decided on resource allocation for the services. Nonetheless, processes and low levels of resource reimbursements have resulted in poor participation of providers in the Medicaid system, a situation that has led to dissatisfaction among the providers (Waldman and Perlman, n.d.; Damiano et al. 1990). This among other challenges has led to the argument that those in dire need of orthodontic care have been denied treatment. Patients, state Medicaid officers, and providers have however made efforts to increase accessibility to orthodontic care, though the progress seems stalled in many states (Salzmann 1966).

One of the primary goals of Medicaid at its inception was to integrate orthodontic care into the mainstream healthcare system rather than it being available in public health clinics alone (Damiano et al. 1990). Since its availability would increase the number of providers, it would be more accessible. There has, however, been limited access to care for patients funded by Medicaid primarily due to dentists and physicians being reluctant to offer care to these patients (Damiano et al. 1990). Some key reasons for their reluctance are high paperwork and bureaucracy, as well as extremely low fees given by Medicaid schedules (Venezie et al., n.d.; Damiano et al. 1990). Requirements for eligibility are compulsory due

to the limited nature of government funding for the Medicaid program. This is another hindrance to care access as the low reimbursements cannot cover the expenses of treatment of severe cases.

Eligibility for orthodontic care and treatment is determined using occlusal indexes which gives data related to treatment need and the severity of malocclusion through objective and quantitative evaluations (Draker 1960; Han and Davidson 2001; Firestone et al. 2002; Beglin et al. 2001; Shaw, Richmond, and O'Brien 1995; Parker 1998). There are numerous types of these indexes such as; the index of complexity, outcome, and need (ICON) (Daniels and Richmond 2000), the index of orthodontic treatment need (Beglin et al. 2001; Shaw, Richmond, and O'Brien 1995), and the handicapping labiolingual deviation (HLD) index (Draker 1960). Several states in the US utilize the HLD to determine the need for treatment as well as eligibility into the Medicaid program.

In some states, the determination of treatment needs and prioritization of treatment through the Medicaid program is done using variations of the HLD index (Han and Davidson 2001; Parker 1998). Its initial development was aimed at the identification of handicapping malocclusions based on the theory that the presence of a physical handicap emanating from a malocclusion should be the basis for providing funding. Nevertheless, the majority of states define handicapping malocclusion with an index as the criteria for qualification since funding decisions are a necessity during budgeting. However, due to the lack of standardized qualification requirements, as well as constant alterations of qualification criteria, there exists a disparity in approval of orthodontic Medicaid cases among various states. A recent increase in the required complexity for qualification in the

state of Iowa, for example, led to a decrease in the number of cases approved for funded care in yearly budgets (McKernan et al. 2013). Also, in the state of Illinois, the implementation of the HLD index led to decreased access to orthodontic care (Caplin et al. 2019). Consequently, such scenarios have raised concerns that low income patients are not eligible to receive funded treatment due to strained state budgets.

When reviewing cases for funding approval, reviewers may or may not consider the esthetic components of a malocclusion. Various indices used in some states combine the study cast analysis with the esthetic component. Such indices include; Dental Aesthetic Index (Cons 1986), Index of Complexity, Outcome and Need (Daniels and Richmond 2000), the Index of Treatment Need (Brook and Shaw 1989), and the Salzmann Index (Salzmann 1967). On the other hand, indices used by other states entirely rely on study cast analysis with no esthetic component. Such indices include; Peer Assessment Rating Index (Richmond et al. 1992), the Handicapping Labiolingual Deviation (HLD) Index (Draker 1960), as well as the HLD (CalMod) Index (Parker 1998). An existing visual deformity may not be identified by the sole use of study cast analysis and it may not indicate the need for orthodontic treatment which would be indicated by a visual assessment.

2.3. Occlusal Indices

Although there exist numerous types of occlusal indices, their mode of functionality is different; some of them look at esthetics, some look at case complexity, and some look at the severity of the malocclusion. Scores from occlusal traits form the foundation of these indices with the resulting objective information describing a malocclusion. In an orthodontic setting, numerous potential benefits emanate from occlusal indices. First, planning and allocation of resources are greatly facilitated by indices, for example, when determining the communal level of need and the subsequent distribution of finances to areas with high demands. Additionally, they are also applicable in monitoring and promotion of standards at the individual level as well as at multiple levels. Furthermore, in the context of clinical practice, potential orthodontic patients are easily identified and referred for further comprehensive treatment with the help of occlusal indices. In the determination of the complexity of an orthodontic case, orthodontists widely apply indices, which also enables them to estimate the treatment duration as well as the most appropriate charges (Shaw, Richmond, and O'Brien 1995). Below are the properties of an ideal occlusal index (DeGuzman et al. 1995; Otuyemi and Jones 1995; Richmond et al. 1992; Summers 1971):

1. Reliable: It should take consistent measurements whenever applied by any specialist.
2. Valid: It should measure what it claims it can measure.
3. Simple: it should not be complex to use among specialists.
4. Open to modification whenever the need arises.

5. Provides accurate quantitative data.

Quantifying malocclusion severity or orthodontic need to meet a specific purpose has been a critical focus area over time. Consequently, numerous indices have been proposed and developed in an attempt to achieve the objectives mentioned above. The general acceptable idea is that the complexity of the case at hand indicates the severity and need for treatment. Due to individual limitations of various indices, no single index represents the standard measure that is accepted globally. Summers (1971), whose main aim was to achieve objectivity in occlusion measurement, is acknowledged for the development of the occlusal index. The index's scoring was, however, thought to consume much time in addition to being burdening (Summers 1971). The Aesthetic Component (A.C) and the Dental Health Component (DHC) are both constituents of the Index of Treatment Need (IOTD) that utilizes occlusal trait rankings to prioritize orthodontic treatment. The A.C is, however, considered subjective (Brook and Shaw 1989). Driven by the need to identify cases suitable for the Board certifying examination, the American Board of Orthodontics (ABO) developed the Discrepancy Index (DI) as its own case complexity determination method (Cangialosi et al. 2004). Contrary to previously developed indices, time of patient evaluation, sex, or age has no impact on the DI (Cangialosi et al. 2004; Schafer et al. 2011).

Researchers have also suggested several more indices for use in the evaluation of treatment outcomes. To facilitate the assessment of occlusion complexity, treatment need as well as improvement of treatment and outcomes, scientists developed the Index of Complexity, Outcome, and Need (ICON) (Daniels and Richmond 2000). Later, results indicated high concurrence between experts' decisions with the Index of Complexity,

Outcome, and of need (Firestone et al. 2002), proper approval for outcome and complexity, and only good agreement for improvement (Savastano et al. 2003). The Peer Assessment Rating Index (PAR) uses the overall score deviation between pretreatment and post-treatment to measure clinical outcomes (Richmond et al. 1992).

Moreover, several ABO case reports claimed that the measuring system in PAR lacked the precision to distinguish between minor tooth position's inadequacies (Casko et al. 1998). Subsequently, an ABO committee was formed to conduct field tests on precise methods of objective evaluation for radiographs and post-treatment casts (Casko et al. 1998). ABO also developed a model analysis grading system known as the Occlusal Grading System (OGS) in 1999 to facilitate the evaluation of final occlusion (Casko et al. 1998).

2.4. HLD Index

Draker (1960) states that occlusion is not a stationary but rather a functional relationship that is attributed to some of the challenges encountered in classification. On the other hand, malocclusion refers to the combination of differential diagnosis and etiology (Draker 1960a). Since an orthodontic handicap has a disfiguring nature, its detection tends to be easier. With the author's primary aim being the identification of an orthodontic handicap, Draker draws from sentiments made at the White House Conference on Child Health and Protection but first states the need to deviate from the "norm." Draker then argued that for the Index to be applicable, it was imperative to determine the norm and then create a list of labio-lingual deviations from the norm. Based upon the two considerations, an HLD Index capable of unveiling the prevalence of handicap and its degree in an individual was brought into existence.

Draker states that the HLD Index presented in the article has successfully undergone several tests. A simplicity test revealed that three minutes are required on average to conduct measurements with the index. In a test to determine how measurements are reproducible between examiners, 517 measurements were evaluated with no case found to have less than 50% agreement. A blind check was run against the program’s clinical determinations of acceptability to test for validity. Among 272, the average correlation turned out to be approximately 80% (Draker 1960b).

In the last section of the article, Draker outlines the procedure for using the HLD Index., The index includes seven component conditions. The first condition relates to the presence or absence of cleft palate while the second condition relates to traumatic deviations; both

of which Draker defines as self-explanatory. He states that the presence of both warrants an individual's acceptance to the New York State Dental Rehabilitation Program even in the absence of any other conditions (Draker 1960c).

Overjet is the third condition. It should be measured while the patient is in a centric relationship. This measurement applies to the entire arch or a single protruding tooth. Upon reading a measurement, it is converted to the nearest millimeter (mm). The fourth condition is the overbite. Measuring this condition is made easier by marking the tooth with a pencil to indicate the extent of overlap. Mandibular protrusion is the fifth condition. The measurement is taken from the labial of the lower incisor to the labial of the upper incisor. The sixth condition is open bite, which Draker defined as a lack of occlusal contact in the anterior region. Measurements for this condition are taken from incisal edge to incisal edge; but cannot be taken when the open bite is associated with pronounced protrusion. The last condition is labio-lingual spread which is measured by determining the extent of deviation from the normal arch. The measurement is from the incisal edge of the deviated tooth to the standard arch line (Draker 1960d).

Extensive use of the HLD (CalMod) index had been adopted by Jan 1 1998 with qualified orthodontists examining 135, 655 patients (W. S. Parker 1998a). From this figure, 49,537 patients were involved in production of impressions and study models which were later on examined and scored by the Board of Qualified Orthodontists. Moreover, this index has proven essential in identification of various malocclusions as well as the destructive individual anterior cross-bites and deep destructive impinging bites. High dynamism has been found to prevail in the index problem in real practice with changes and adjustments

being triggered by the upcoming appeals at both the judicial and administrative levels (W. S. Parker 1998b).

In a study entailing 313 patients aimed at comparing the two main forms of malocclusion indexes in the USA (HLD-CalMod & HLD-Md), the two indexes did not display a strong correlation, an indicator that the HLD (CalMod) index could be modified (Han and Davidson

2001). of all the patients identified by the HLD (CalMod) index as orthodontically handicapped, 70 percent of them had an automatically qualifying exception trait. For patients with no qualifying exception overjet and crowding of anterior teeth were the most contributing factors for HLD (CalMod) and HLD (Md) indexes respectively. In another study, testing the HLD (CalMod) index under heavy load revealed than the index selects a wide array of malocclusions (W. S. Parker 1999).

When comparing the validity and reliability of three occlusal indexes of orthodontic treatment need namely; Index of Orthodontic Treatment Need, the Handicapping Labiolingual Deviation with the California Modification, and the Dental Aesthetic Index, the three indexes were found to be valid and reliable (Beglin, et al. 2001a). While attempting to distinguish patients with indicated treatment from those for whom it is not, the overall accuracy is not very high. While trying to establish the optimum cut off point, the results indicates the need for the indexes' users to be aware of the cut-off point location on the ROC curve and the consequent implications on availability of services (Beglin, et al. 2001b).

In conclusion, developing malocclusions are effectively treated in phase I treatment and thus significantly reducing eligibility for Medicaid-Funded treatment (Theis, Huang and Omnell 2005a). this in turn reduces Medicaid funding cost per patient and consequently

increasing the number of needy patients who can be covered by the funds. HLD index plays a vital role in identifying the patients eligible for Medicaid funding as the index has the capacity for independent modifications for both qualifying conditions and cutoff scores (Theis, Huang and Omnell 2005b).

2.5. Digital Models

In the past, completing a model analysis has predominantly relied on the use of plaster casts as the gold standard. The commercial introduction of digital models is traceable to OrthoCAD (Cadent, Carlstadt, NJ, USA) in 1999. The Journal of Clinical Orthodontics recently surveyed orthodontists to evaluate the use of digital models in pre-treatment diagnosis and treatment. The results of this study indicated a significant steady increase from 6.6% in 2002 to 18.0% in 2008 (Keim et al. 2008). In the current world, plaster models are being replaced by digital models that are offered by various companies. It is possible to obtain digital models indirectly by pouring a dental impression into a stone or plaster. The process is succeeded by image processing, which could be of either a destructive or non-destructive nature.

For the destructive imaging process, removal of a thin layer of material alternates with image capturing, giving rise to a stack of 3D images. On the other hand, non-destructive imaging entails the application of a laser-based system with a multi-axis robot scanning several perspectives whose combination renders the 3D model. An impression is not required in the direct production of 3D models. It, however, entails several non-optical technologies that post-processes single images that emanate from a single perspective to reconstruct a virtual model (Mah and Hatcher 2003). Destructive scanning entailing scanning plaster equivalent in thin slices multiple times is used in OrthoCAD (Stevens et al. 2006). The Ortho Insight 3D Scanner and Software that was introduced by Motion View Software (Hixson, TN, USA) produced 3D renderings of impressions or plaster models by

utilizing a robotic scanner. This software is considered highly advantageous because of its flexibility and ability to create files with an open format.

2.6. Accuracy and Reliability of Digital Model Analysis

Verification of 3D digital models' linear measurement accuracy with the use of various software has prevailed in the literature, even though the verification results have been divergent. Recently, studies were evaluated using a systematic review to gauge the validity of seven digital model systems. The assessed systems were; Cecile, Easy3D Scan, OrthoCAD, ConoProbe, C3D-builder, Digimodels, and Emodel (Fleming, Marinho, and Johal 2011). The reviewers concluded that there existed a low mean discrepancy between the digital model and plaster measurements in most studies. Based on the findings of the review, the researchers also revealed that digital models could replace plaster models. They, however, stated that evidence to support the revelation above is of variable quality (Fleming, Marinho, and Johal 2011).

Numerous studies compare measurements taken from OrthoCAD digital models against those made from plaster models. In OrthoCAD digital models, tooth size measurements have been found to be smaller or slightly smaller (Bootvong et al. 2010; Leifert et al. 2009a; Quimby et al. 2004; Santoro et al. 2003; Tomassetti et al. 2001; Zilberman, Huggare, and Parikakis 2003). Significant variations have also been recorded by comparing the arch width of plaster models with that of OrthoCAD digital models (Bootvong et al. 2010; Quimby et al. 2004; Zilberman, Huggare, and Parikakis 2003). In some studies, no significant difference was recorded in overjet measurements between OrthoCAD digital

Models and plaster models (Bootvong et al. 2010; Santoro et al. 2003). However, a study conducted by Quimby et al., (2004) indicates that a relatively smaller overjet measurement was obtained from OrthoCAD digital models. The plaster model demonstrated higher overbite measurements compared to those from OrthoCAD digital models (Santoro et al. 2003; Quimby et al. 2004). Crowding measurements taken by determining the arch length or the space available and the mesio-distal width of teeth demonstrated a significant difference between plaster models and OrthoCAD digital models. These discrepancies ranged from 0.4mm to 2.88mm (Leifert et al. 2009a; Quimby et al. 2004). Also, The OrthoCAD has also been demonstrated to be a clinically acceptable replacement to the hand-operated estimation of the discrepancy index (Dragstrem et al. 2015).

Regarding occlusal indices, the Index of Complexity, Outcome, and Need (ICON), Index of Complexity and Peer Assessment Rating Index (PAR) demonstrated high levels of digital and manual agreements (Mayers et al. 2005; Stevens et al. 2006; Veenema et al. 2009).

III. MATERIALS AND METHODS

3.1. Approval

This research was approved by the University of Illinois at Chicago Institutional Review Board, and it was determined that this research does not involve human subjects (Research Protocol #2018-1184). Approval is found in Appendix.

3.2. Sample

The study assessed 401 randomly selected subjects whose records were submitted by the University of Illinois at Chicago, (UIC), College of Dentistry orthodontic clinic to the Managed Care Organization (MCO) DentaQuest (DQ) of the state of Illinois for orthodontic Medicaid coverage, and who received an approval or denial of coverage in the years 2017 and 2018. All subjects were patients or potential patients at the University of Illinois at Chicago College of Dentistry, Department of Orthodontics, and records were taken for the purposes of orthodontic treatment. No records were taken solely for research purposes.

Initially, subjects for the study were selected randomly from the 802 charts of UIC's Department of Orthodontics' log of Medicaid submissions. Randomized selection was performed by Microsoft Office 365 Excel for windows 2018 (Version 365, Microsoft Corporation, Redmond, WA) from the list of all patients submitted MCO-DQ from the UIC orthodontics clinic in 2017 and 2018.

The following inclusion and exclusion criteria were applied to all subjects:

Inclusion criteria:

- Subjects whose records were submitted to MCO-DQ in the state of Illinois for orthodontic Medicaid coverage in the years 2017 and 2018.
- All necessary records for each subject including all required intraoral photographs, digital dental models in OrthoCAD format, panoramic radiograph, and cephalometric radiograph

Exclusion Criteria:

- Subjects who were not submitted to the state of Illinois for orthodontic Medicaid coverage in the years 2017 and 2018.
- Lack or inadequate quality of any necessary records

The records collected for each subject consisted of:

- Intraoral photos
    - Upper arch occlusal
    - Lower arch occlusal
    - Right lateral
    - Left lateral
    - Frontal
    - Overjet
    - Overbite
- Cephalometric radiograph

- Panoramic radiograph
- Digital dental models
    - OrthoCAD (™) (Cadent, Carlstadt, NJ) in 3DM format
- Approval or denial decision by the MCO

The intraoral photos were taken by a digital camera that produces high quality photographs suitable for orthodontic records and journal publications. Digital panoramic and cephalometric radiograph images were generated by a Planmeca ProMax® X-ray unit (ProMax 2D S3, PLANMECA USA, Hoffman Estates, IL).

Dolphin imaging (™) software (version 11.7; Dolphin Imaging & Management Solutions, Chatsworth, California) was used to arrange and export the intraoral photos in a composite format that included all intraoral photos and the panoramic and cephalometric radiograph images in single files. All the files were exported in JPEG at resolution 96 DPI (dots per inch).

The digital dental models for each subject were obtained by taking alginate impressions (Kromopan 100, Kromopan USA, Des Plaines, Ill) and a wax bite registration of each subject using plastic trays. The impressions were then wrapped in moist towels, sealed in plastic bags, and stored in individual boxes at 37 degrees Fahrenheit overnight until they were sent the next day to Align Technology (™) for digitization. Align returned the digital 3D models 1 week later to be viewed and manipulated using the proprietary OrthoCAD software Version 5.9.0.36 (Cadent, Carlstadt, NJ). Models were visually verified for accuracy of occlusion and if necessary were manipulated using the jaw alignment function to mimic the original subject's occlusion.

After applying the inclusion/exclusion criteria, 480 subjects remained. 79 subjects were found to have inadequate or damaged records. 401 subjects remained in the final sample.

3.3. De-Identifying

MCO-DQ approval/denial decision information were extracted from the Department of Orthodontics' log of Medicaid submissions for the subjects of this study. No protected health information was collected. All the intraoral photographs and digital dental models were de-identified by removing subjects' names, extraoral photographs, chart ID numbers, and any other protected health information during collection. All subjects were assigned a random number by Microsoft Office 365 Excel for windows 2018 (Version 365, Microsoft Corporation, Redmond, WA). This information and data were the sole source of data for this study.

3.4. Methodology

The current study was designed to assess HLDI scoring according to the criteria listed on the HLD scoring sheet (Table I) by 2 different methods. From each subject, 13 target disorders were evaluated via VI and via CAD. Seven of these target disorders, including the overjet, overbite, anterior crossbite, anterior upper arch crowding, anterior lower arch crowding, anterior open bite and labio-lingual spread were quantified in millimeters. These target disorders were measured via sight for VI from intraoral photographs and cephalometric radiographs viewed in Photo viewer software for

Windows 10 (Microsoft Corporation, Redmond, WA), and via digital measurements for CAD using the OrthoCAD software Version 5.9.0.36.(Cadent, Carlstadt, NJ). For the CAD measurements, the 3D models were manipulated through zoom or rotation at the examiner's discretion. When determining tooth widths for measurements of crowding, the mesio-distal, occlusal-gingival, and buccal-lingual planes were all verified.

The other five qualitative target disorders, which included cleft palate, palatal tissue impingement, gingival recession of the lower anterior teeth as a result of an anterior cross bite, and the number of ectopic teeth were evaluated via VI using intraoral photographs with aids of cephalometric and panoramic radiographs viewed in Photo viewer software for Windows 10 (Microsoft Corporation, Redmond, WA).

Once all target disorders were quantified, HLDI score was calculated for all subjects using both VI and CAD methods. Approval or denial for each subject was determined based on the final HLDI score. The cutoff for approval was an HLDI score of 28 or greater, the minimum cutoff score for approval in Illinois (DentaQuest of Illinois 2017). In the case of an automatic qualifier, the subject was accepted regardless of HLDI score (Table I).

The final HLDI score for the VI and CAD methods were compared to each other along with the final approval/denial decision of HLDI. The final approval/denial decisions of the CAD and VI methods were compared to the MCO DQ approval/denial decision respectively (Figure 1).

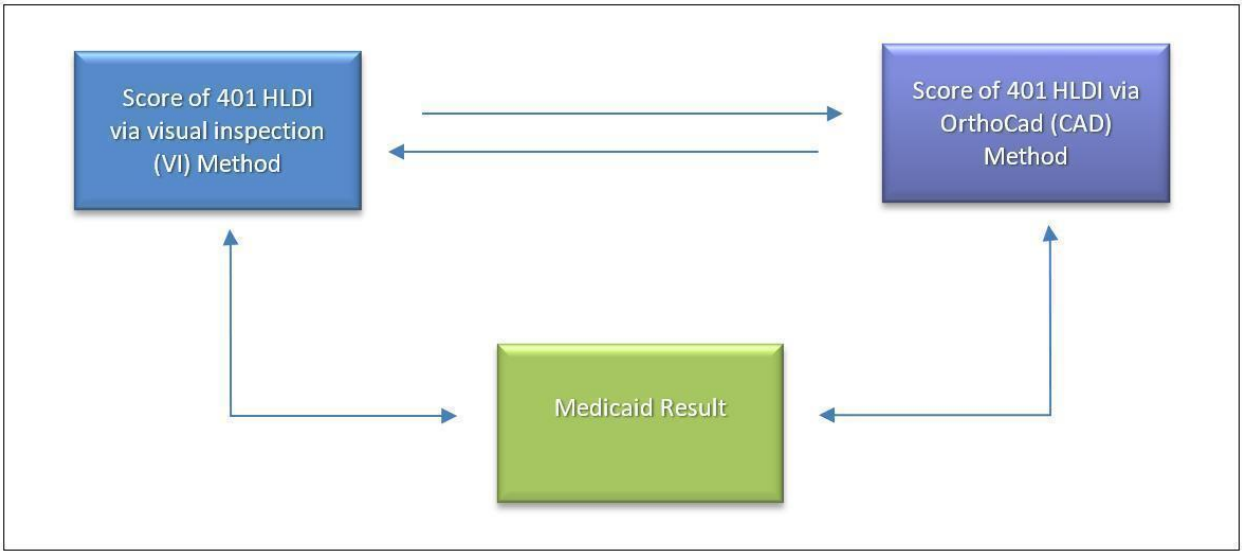

Figure 1. Method of comparison

3.5. Data Measurements

Table I describes the seven quantitative criteria, five qualitative criteria (target disorders), and methods of evaluation according to HLDI DentaQuest guide (DentaQuest of Illinois 2017). All raw data measurements were entered into Microsoft Office 365 Excel for windows 2018 (Version 365, Microsoft Corporation, Redmond, WA).

Overjet, overbite, anterior crossbite, anterior upper arch crowding, anterior lower arch crowding, anterior open bite, and labio-lingual spread were recorded in millimeters. Fractional values were rounded to the nearest 0.1mm for OrthoCAD measurements only; no fractional value were noted in visual inspection measurements. For all qualitative disorders, presence or absence was noted.

TABLE I

DEFINITIONS AND SCORING OF HLD INDEX TARGET DISORDERS

TARGET DISORDERS	Definition
Cleft palate	Cleft palate must be present in the study model. Presence of this disorder is an automatic qualifier.
Deep impinging overbite	Tissue damage of the palate must be visible on study models. The lower teeth must be touching the palate; soft tissue damage must be visible. Presence of this disorder is an automatic qualifier.
Anterior crossbite	Gingival recession must be at least 1.5 mm more than the adjacent teeth. It also must be visible intraorally and on the study models. Presence of this disorder is an automatic qualifier.
Traumatic deviations	Loss of a premaxillary segment by traumas, or pathology lesion such as osteomyelitis. Presence of this disorder is an automatic qualifier.
Overjet	Measured in mm from the labial surface of a lower incisor to the labial surface of an upper central incisor. Teeth must be in centric occlusion.
Overbite	Measurement in mm from the incisal edge of the upper central incisor to the incisal edge of the adjacent lower incisor. Teeth must be in centric occlusion.
Reverse overjet/Mandibular protrusion	Measurement from the labial surface of a lower incisor tooth to the labial surface of an upper central incisor. Score is the number of mm measured x5. Teeth must be in centric occlusion.
Open bite	Measurement from the incisal edge of an upper central incisor to the incisal edge of an adjacent lower incisor. Score is the number of mm measured x4. Teeth must be in centric occlusion.
Ectopic tooth/teeth	Number of ectopic teeth Score is the number of teeth x3.
Maxillary anterior crowding	If the anterior crowding of the maxillary arch is more than 3.5 mm, score 5 points.

TABLE I (continued)

DEFINITIONS AND SCORING OF HLD INDEX TARGET DISORDERS

TARGET DISORDERS	Definition
Mandibular anterior crowding	If the anterior crowding of the mandibular arch is more than 3.5 mm, score 5 points.
Labio-lingual spread	The measurement in mm from the incisal edge of the most severely displaced anterior tooth to a line representing the normal arch. Canines cannot be measured.
Posterior crossbite	First or second molar in palatal crossbite or fully buccal crossbite. If present, score 4 points. Teeth must be in centric occlusion.

***** Points will only be awarded for ectopic teeth or crowding within an arch. Points may not be scored for both conditions.

3.6. Reliability

Fifty cases were selected randomly for tests of reliability. Two investigators measured and scored each case via visual inspection (VI) and digital dental cast measurement (CAD) twice for all target disorders and total HLDI scores. Measurements were separated by one week. Both examiners have HLDI calculation experience. The HLDI clinical examination guide was provided to each examiner.

The intra and intercorrelation coefficients (ICC) were determined for each of these study variables as an indicator of consistency for the VI and CAD methods.

3.7. Statistical Analysis

Statistical analysis was conducted with SPSS v25 (Chicago, IL). Descriptive statistics with frequencies were calculated. Cross-tabulations were calculated using Chi-Square tests and symmetric measures by Cramer's V were performed to investigate the relationship between the variables with proportions and odds ratios and the strength of the association between CAD, VI, and DQ. A Kappa test was performed to investigate the agreement of the association between CAD, VI, and DQ. A non-parametric Mann-Whitney U test was performed to test the mean rank of the scale variables between DQ levels. Statistically significant was set at 0.05 for all tests.

IV. RESULTS

4.1. Reliability Test Results

4.1.1. Intra-Reliability - Visual Inspection

The correlation coefficient for all variables was 0.80 or higher (p-value<0.05), indicating a good degree of intra-reliability for the visual inspection method (Table II).

4.1.2. Inter Reliability - Visual Inspection

The correlation coefficient for all variables was 0.80 or higher (p-value<0.05), indicating a good degree of inter reliability between the two investigators for the visual inspection method (Table III).

4.1.3. Intra Reliability - CAD

The correlation coefficient for all variables except overbite was 0.80 and higher (p-value<0.05), indicating a good degree of intra-reliability for the CAD method (Table IV). The correlation coefficient for overbite was >0.75, indicating an acceptable degree of intra-reliability (Table IV).

4.1.4. Inter Reliability - CAD

The correlation coefficient for all variables was higher than 0.80 (p-value<0.05), indicating good degree of inter reliability for the CAD method (Table V).

TABLE II - INTRA CLASS RELIABILITY – (ICC)

Variables	ICC	95% CI (lower bound, upper bound)	Degrees of freedom	P-value
Overjet	0.883	0.794, 0.934	49	<0.001
Overbite	0.864	0.761, 0.923	49	<0.001
Cross bite	0.988	0.979, 0.993	49	<0.001
HLD	0.942	0.893, 0.969	42	<0.001

TABLE III - INTER CLASS RELIABILITY – (ICC)

Variables	ICC	95% CI (lower bound, upper bound)	Degrees of freedom	P-value
Overjet	0.862	0.770, 0.926	49	<0.001
Overbite	0.821	0.685, 0.898	49	<0.001
Cross bite	0.980	0.965, 0.993	49	<0.001
HLD	0.906	0.827, 0.949	42	<0.001

TABLE IV - INTRA CLASS RELIABILITY – (ICC)

Variables	ICC	95% CI (lower bound, upper bound)	Degrees of freedom	P-value
Overjet	0.973	0.953, 0.985	49	<0.001
Overbite	0.751	0.561, 0.859	49	<0.001
Cross bite	0.997	0.995, 0.998	49	<0.001
HLD	0.880	0.778, 0.935	42	<0.001

TABLE V - INTER CLASS RELIABILITY – (ICC)

Variables	ICC	95% CI (lower bound, upper bound)	Degrees of freedom	P-value
Overjet	0.877	0.783, 0.930	49	<0.001
Overbite	0.870	0.771, 0.926	49	<0.001
Cross bite	0.982	0.968, 0.990	49	<0.001
HLD	0.954	0.916, 0.975	43	<0.001

4.2. Descriptive Statistics

Descriptive statistics with frequencies were calculated (Table VI). Cross-tabulations tables with Chi-Square and symmetric measures by Cramer's V were used to investigate the relationship between the variables. Statistical significant was set at 0.05.

Absence of cleft palate, deep bite, anterior crossbite, severe traumatic deviation, anterior crowding, maxilla and mandible, and posterior cross bite were the dominant events among those variables, whereas overjet, overbite, cross bite, open bite, ectopic teeth, labiolingual spread were the events most common among those variables.

Ectopic teeth, cross bite (negative overjet), and overjet target disorders are the most affected value that determined the acceptance or denial decision on HLDI as reported in Table I. Values in Table I are reported as the number of points contributed to the final HLDI score.

TABLE VI

DESCRIPTIVE STATISTICS

	CAD		VI	
Target Disorder	**Mean**	**STD**	**Mean**	**STD**
Overjet	2.68	2.703	2.13	2.252
Overbite	1.71	1.824	1.69	1.629
Cross bite	3.34	8.475	2.77	7.058
Open Bite	1.49	4.658	1.21	4.166
Labiolingual Spread	0.56	1.707	0.36	1.263

4.3. Differences between VI and CAD

Cross-tabulations tables with Chi-Square test were used to investigate the relationship between the variables with proportions and odds ratio. Statistical significance was set at 0.05. The proportion of VI DENIED (222/227 or 97%) for CAD DENIED was statistically different from the proportion of VI PASS for CAD PASS (33/174 or 18%) based on Chi-square statistics (p-value < 0.001). The corresponding odds ratio was 189.7, 95% (CI 72.3 -497.43). As reported in Table VII.

Cramer's V test was (0.845) and Kappa test was (0.803), indicating strong association and agreement.

TABLE VII

CROSS-TABULATIONS VI AND CAD

	VI DENIED	**VI ACCEPTED**	**Total**
CAD DENIED	222	5	227
% of Total	55.4%	1.2%	56.6%
CAD ACCEPTED	33	141	174
% of Total	8.2%	35.1%	43.4%
Total	255	146	401
% of Total	63.6%	36.4%	100.0%

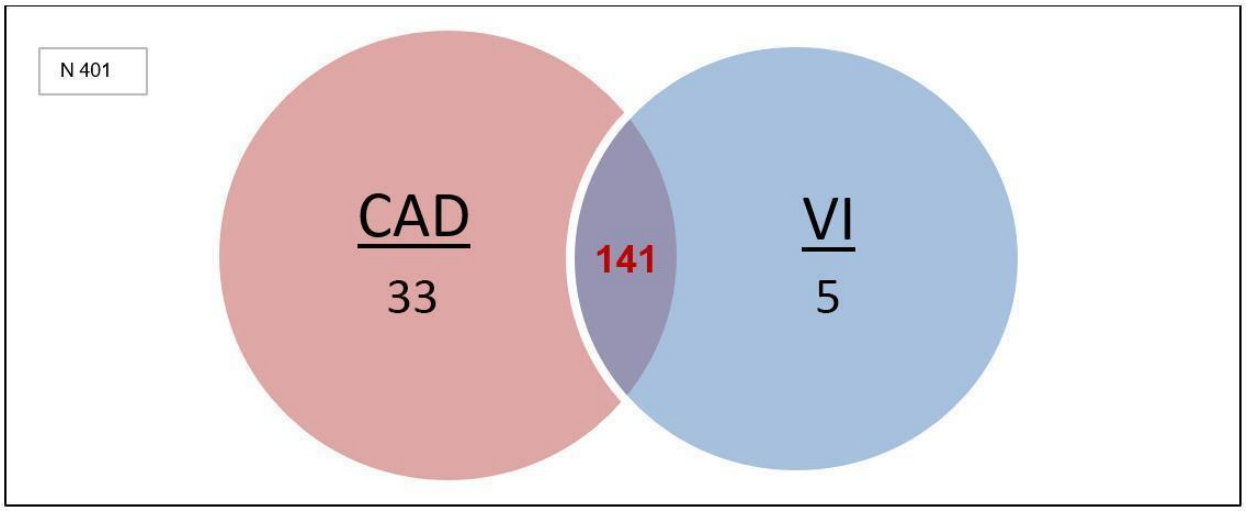

Figure 2. CAD VS. VI. mutual accepted cases

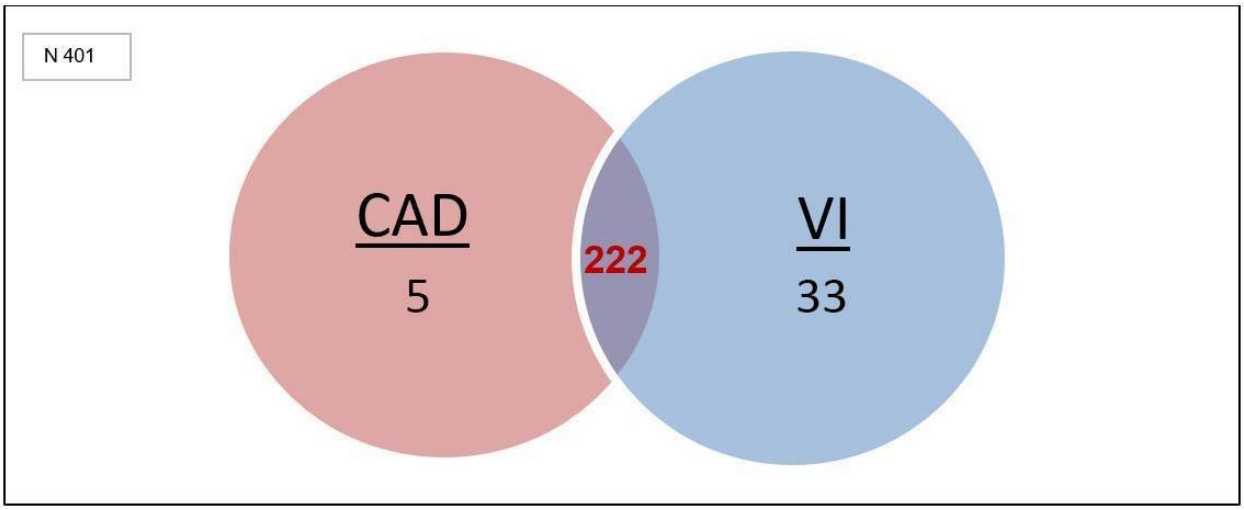

Figure 3. CAD VS. VI. mutual denied cases

4.4. Differences between MCO-DQ and CAD

The proportion of MCO-DQ DENIED (138/227 or 61%) for CAD DENIED was statistically different from the proportion of MCO-DQ ACCEPTED for CAD ACCEPTED (50/174 or 29%) based on Chi-square statistics (p-value < 0.001). The corresponding odds ratio was 3.845, 95% (CI 2.519 - 5.869). As reported in Table VIII.

Cramer's V test was (0.318) and Kappa test was (0.312), indicating low association and agreement.

TABLE VIII

CROSS-TABULATIONS MCO-DQ AND CAD

	MCO-DQ ACCEPTED	**MCO-DQ DENIED**	**Total**
CAD DENIED	89	138	227
% of Total	22.2%	34.4%	56.6%
CAD ACCEPTED	124	50	174
% of Total	31.0%	12.4%	43.4%
Total	213	188	401
% of Total	53.1%	46.9%	100.0%

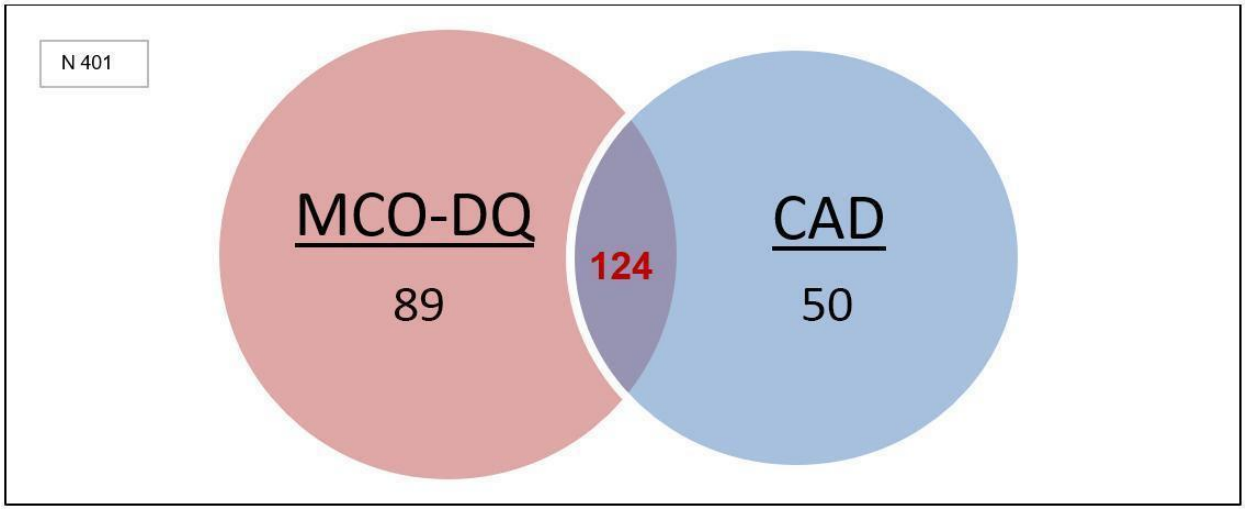

Figure 4. MCO-DQ VS. CAD. mutual accepted cases

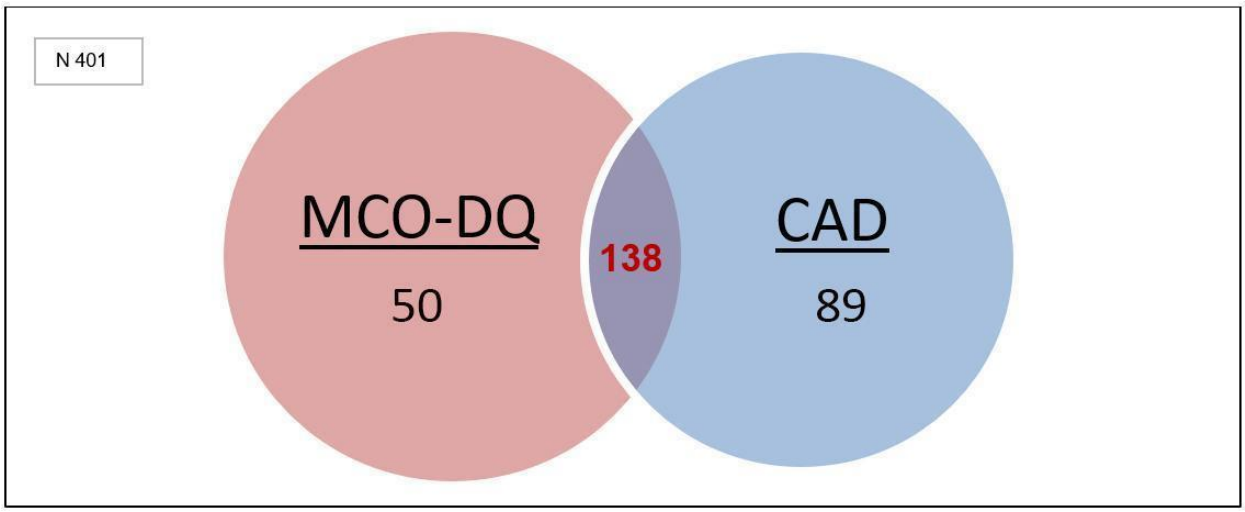

Figure 5. MCO-DQ VS. CAD. mutual denied cases

4.5. Differences between MCO-DQ and VI

The proportion of MCO-DQ DENIED (152/255 or 60%) for VI DENIED was statistically different from the proportion of MCO-DQ PASS for VI PASS (36/146 or 25%) based on Chi-square statistics (p-value < 0.001). The corresponding odds ratio was 4.509, 95% (CI 2.870 – 7.085). As reported in Table IX.

Cramer's V test was (0.341) and Kappa test was (0.318), indicating low association and agreement.

TABLE IX

CROSS-TABULATIONS MCO-DQ AND VI

	MCO-DQ ACCEPTED	**MCO-DQ DENIED**	**Total**
VI DENIED	103	152	255
% of Total	25.7%	37.9%	63.6%
VI ACCEPTED	110	36	146
% of Total	27.5%	8.9%	36.4%
Total	213	188	401
% of Total	53.1%	46.9%	100.0%

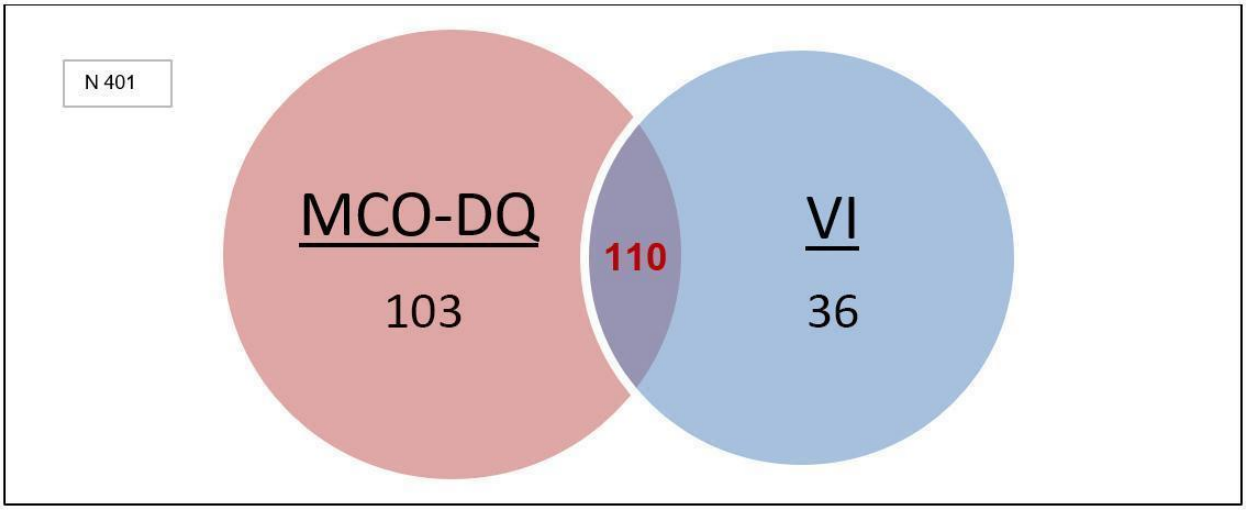

Figure 6. MCO-DQ VS. VI. mutual accepted cases

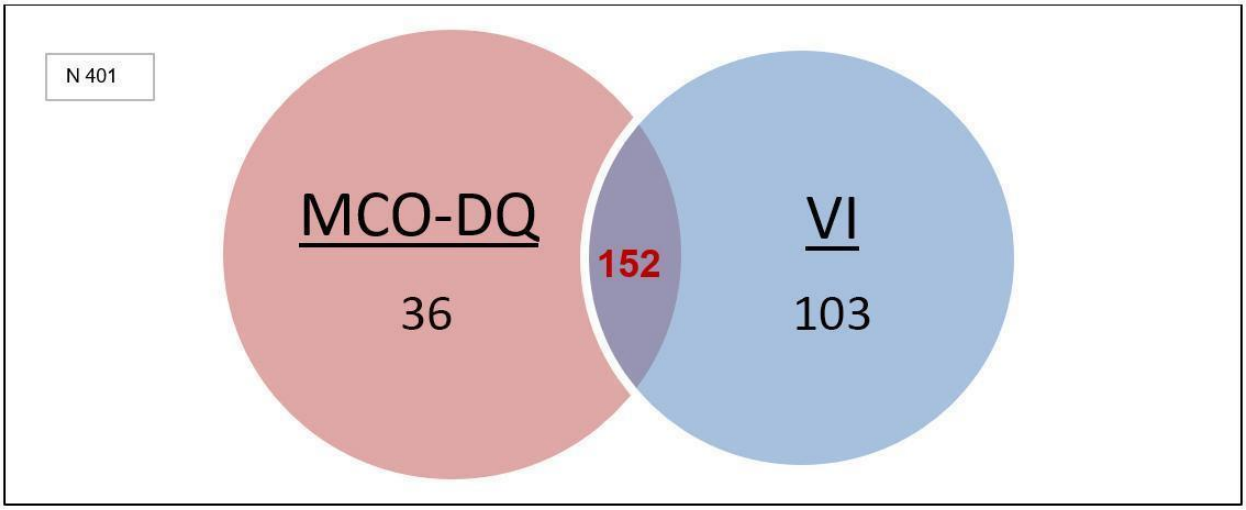

Figure 7. MCO-DQ VS. VI. mutual denied cases

V. DISCUSSION

5.1. Comparison with the Literature

This study aimed to assess the reliability of decisions based on the result of the HLDI score calculated using two different methods (visual inspection from intraoral photographs - (VI) and 3D measurements from digital casts (CAD). The study was conducted to evaluate the association and agreement level of the acceptance rates based on the decision by MCO-DQ compared to the HLDI scoring results produced by both VI and CAD methods. Orthodontic indices are a tool to analyze the prevalence and severity of various kinds of malocclusion. Over the years, a series of indicators has been developed to assist specialists in classifying malocclusion according to the degree of treatment required (Uğur et al. 1998). However, it is the social authorities that set the standards for an acceptable, healthy, and attractive physical appearance.

The lifestyle impact of malocclusion is attributed to a rise in usual life expectancy, which has led to an increase in the number of patients receiving orthodontic treatment. The main reasons behind this change in cognition are the improved ability to treat problems and the desire to maintain a patient's natural teeth and improve function and appearance (Scott, Fleming, and DiBiase 2007).

Many studies on the harmful effects of malocclusion presented proof of possible injury by characteristics found in Class II malocclusion. For instance, traumatic deep bits were found to be associated with enhanced rates of periodontal diseases. (Nasry and Barclay 2006). Also, prominent incisors are prone to accidental trauma in patients with 6mm or more of

overjet (Järvinen 1978). Facial aesthetics strongly influence personal and professional relationships, especially in school and professional settings, from childhood to adulthood. Patients with severe malocclusion are often dissatisfied with their physical appearance, especially their faces. Although the demand for orthodontic treatment is strongly linked to the patient's chief complaint about his/her appearance, as well as issues of psychological and social interaction, the assessment of the need for treatment places little emphasis on the patient's perception and how much treatment can improve his/her quality of health-related life.

Malocclusion characteristics can affect the time required for orthodontic treatment and the treatment methods. Various methods can assess malocclusion severity. The ABO Discrepancy Index (DI) has been revealed to have a significant positive association with the length of orthodontic treatment. Patients with DI greater than fifteen have longer orthodontics treatment time than subjects with DI equal or less than fifteen. (Skidmore et al. 2006).

In the healthcare system, particularly oral healthcare, there has been a trend to convert to electronic health records for patient information and data. Orthodontics is no exception (Westerlund et al. 2015). In the orthodontic world, records are required to quantify and diagnose malocclusion, which includes intra and extra photographs, panoramic, cephalometric radiograph images, and dental study models. Study models are essential to orthodontic diagnosis, management of disease, and assessment of varying degrees of malocclusion (Westerlund et al. 2015). Globally, digital dental cast models are produced by both direct and indirect procedures. Intraoral scanners are an example of the direct

procedure, and laser scanning or computed tomography imaging of the intraoral impressions or gypsum models are examples of the indirect procedure (Palo 2006).

Diagnosis and treatment planning are essential to orthodontic treatment. The need to preserve dental models for future use has caused storage problems. Digital models have become popular because of the benefits of storing, recovering, and exchanging data. Various cast systems have been assessed concerning reliability and validity of digital models: Cecile (Watanabe-Kanno et al., n.d.), e-models (Horton et al. 2010), Orametrix (Torassian et al. 2010), OrthoCAD (Leifert et al. 2009b), DigiModel (Veenema et al. 2009), O3DM (Sjögren, Lindgren, and Huggare 2010), and OrthoAnalyzer (Sousa et al. 2012).

The application of CAD in the dental profession has developed as a significant aspect of diagnosis and treatment planning oral diseases (Kumar et al. 2015). In recent years, the use of CAD systems has become popular in dentistry (Davidowitz and Kotick 2011).

In this study, we used tha CAD method as the control because CAD method is reliable and reproducible. The accuracy, precision, and reliability of CAD have been established in other studies that looked at the usability of this software program (Westerlund et al. 2015). One of the advantages of digital study models is that they offer a reliable result in the diagnosis and treatment plan orthodontic cases (Rheude et al. 2005). Additionally, the CAD method has also demonstrated to be a clinically acceptable replacement to the hand-operated estimation of the discrepancy index (Dragstrem et al. 2015).

- **Intra-Examiner, and interrater reliability analyses**

In order to determine the consistency of the visual inspection method, as well as the CAD method, intra-correlation coefficients (ICC) reliability test used in this study which is supported by the argument that intraclass correlation coefficient (ICC) is a generally accepted reliability index for intra/interrater reliability analyses. (Koo and Li 2016). Additionally, the high reliability of the VI method found in this study supports the use of the VI method by MCO-DQ.

- **Impact of each target disorder on the calculation of HLD INDEX**

From close observation of 401 intraoral photos and digital dental models, it is apparent that the HLD DQ Index is non-forgiving in embracing a broad spectrum of malocclusions from mild to moderate. Several examples are given below to illustrate this.

Tissue damage of the palate as a result of deep impinging overbite is one of the auto-qualifiers for approval. However, it must be visible (DentaQuest of Illinois 2017).Signs of palatal damage occur in different locations, which sometimes cannot be detected from the intraoral photographs due to camera angulation and or lighting effects, especially when the damage is located at the most anterior part of the rugae. On the other hand, we detected these signs of palatal tissue damage on the CAD.

A posterior bilateral or unilateral crossbite has a value of 4 points, which could affect the approval decision if it was missing from the diagnosis. According to the HLDI manual, the first molar needs to be involved in the posterior crossbite (DentaQuest of Illinois 2017). In

some cases, we were not able to detect the first molar in crossbite from the intraoral photographs via VI, whereas it was easy to identify using the CAD method.

In this study, we noticed that ectopic teeth points may have the greatest effect on the final HLDI approval/denial decision with a mean score of 4.5 on both CAD and VI methods. There is no exact definition of this criteria in the HLDI MCO-DQ scoring sheet nor in the reference manual (DentaQuest of Illinois 2017). Ectopic eruptions, described as a situation in which the permanent teeth find a path of eruption that intercepts a primary tooth due to insufficient growth of the jaw, can lead to premature loss of the primary tooth and malposition of the permanent tooth (Hafiz 2018). Diagnosis of ectopic teeth using the CAD method is more accessible than the VI method for the same subject, especially for first and second molars due to the full orientation control of OrthoCAD software and the 3D feature of the digital model. Meanwhile, lack of these features in 2D intraoral photos makes posterior ectopic teeth hard to diagnose.

Negative and positive overjet target disorders have a significant impact on the final approval/denial decision. The mean negative overjet using in the CAD method was 3.34 compared to 2.77 using VI, and the mean positive overjet using the CAD method was 2.68 versus 2.13 using VI. On the other hand, labio-lingual spread may have the least effect on approval/denial decision (CAD mean = 0.56, VI mean = 0.36). This mean value is low because duplicate points cannot be scored for crowding, ectopic teeth, and labiolingual spread. Only the worst condition may be scored. (DentaQuest of Illinois 2017). A better choice might be to allow scoring of overlapping conditions.

- **Association of HLDI results among MCO-DQ, CAD, and VI.**

In the current study, 174 cases were accepted by CAD compared to 146 by VI out of 401. The total number of mutually accepted cases between CAD and VI is 141.

- 174 – 141 = 33 cases accepted by CAD but were not accepted by VI
- 146 – 141 = 5 cases accepted by VI were not accepted by CAD

As illustrated in Figure 2.

Also, 227 cases were denied by CAD compared to 255 by VI out of 401. Total numbers of mutual denied cases between CAD and VI are 222.

- 227 – 222 = 5 cases denied by CAD but were not denied by VI
- 255 – 222 = 33 cases accepted by VI but were not accepted by CAD. As illustrated in Figure 3.

Based on Cramer's V test and Kappa test, the association and the agreement between CAD and VI methods are substantial.

Malocclusion, when quantified by an index, yields a value that can describe a variety of conditions. Reality shows that two people with the same index score may vary in their need for treatment (Beglin et al. 2001). Essential considerations are the outcomes of missing disease (false-negative results) and the outcomes of inaccurately recognizing the disease as a present (false-positive results). (Metz 1978; McNeil, Keller, and Adelstein 1975).

In this study, by comparing the acceptance and denial decisions between CAD method and HLDI MCO-DQ, the result showed that many subjects approved to receive orthodontic

treatment by MCO-DQ (false-positive) were not approved by the CAD method based on HLDI. Many subjects denied from receiving orthodontic treatment by MCO-DQ that were not approved by the CAD method based on HLDI.

For instance, 213 cases were accepted by MCO-DQ compared to 174 by VI out of 401; the total numbers of mutually accepted cases between MCO-DQ and CAD are 124.

- 213 – 124 = 89 cases accepted by MCO-DQ, which are not supposed to be qualified for treatment according to the HLDI result assessed by CAD.
- 174 – 124 = 50 cases denied by MCO-DQ, which are supposed to be qualified according to the HLDI result assessed by CAD. As illustrated in Figure 4.

Also, 188 cases denied by MCO-DQ compared to 227 by CAD out of 401, the total numbers of mutual denied cases between MCO-DQ and VI are 138.

- 188 – 138 = 50 cases denied by MCO-DQ, which are supposed to be qualified for treatment according to the HLDI result assessed by the CAD method.
- 227 – 138 = 89 cases accepted by MCO-DQ, which are not supposed to be qualified according to the HLDI result assessed by CAD. As illustrated in Figure 5.

Based on Cramer's V test and Kappa test, the association and the agreement between CAD and MCO-DQ methods are fair.

In contrast, this picture 213 cases were accepted by MCO-DQ compared to 146 by VI out of 401; total numbers of mutually accepted cases between MCO-DQ and VI are 110.

- 213 – 110 = 103 cases accepted by MCO-DQ, which were not supposed to be qualified for treatment according to the HLDI result assessed by VI.
- 146 – 110 = 36 cases denied by MCO-DQ, which were supposed to be qualified according to HLDI assessed by VI. As illustrated in Figure 6.

On the other hand, 188 cases denied by MCO-DQ compared to 255 by VI out of 401, total numbers of mutual denied cases between MCO-DQ and VI are 150.

- 188 – 152 = 36 cases denied by MCO-DQ, which were supposed to be qualified for treatment according to HLDI assessed by VI.
- 255 – 152 = 103 cases accepted by MCO-DQ, which were not supposed to be qualified according to HLDI assessed by VI. As illustrated in Figure 7.

Based on Cramer's V test and Kappa test, the association and the agreement between VI and MCO-DQ methods are fair.

- **Potential reasons for errors**

One potential reason for error is the unclear definition of some qualitative and quantitative criteria of HLDI as it is defined in the DentaQuest manual (DentaQuest of Illinois 2017). Ectopic tooth/teeth definitions and severe traumatic deviations are among some of the unclear descriptions that could cause an inconsistency of the final approval/denial decision at MCO-DQ.

Another potential reason for inconsistency in MCO DQ approval/Denial decisions is that the case assessors at MCO-DQ insurance company who are orthodontists or dentists and or clinical review specialists will assess the cases via visual inspection method based on the documents submitted through the insurance portals (Anonymous. 2018. Interview with health care worker by author. March 22). They may not have proper calibration training among each other to evaluate the submitted cases, which may lead to inconsistency in approval/denial decisions.

5.2. Limitations

The limitation of the present study is the lack of a detailed score reported of all 13 target disorders of HLDI assessed by MCO-DQ.

5.3. Recommendations

HLDI subscales should be compared with other orthodontic indices. The current study design should be conducted in different states in the USA to evaluate the reliability of their MCOs. The agreement, acceptance, and denial rate of the investigated subscales here should be evaluated in a graded and stage-dependent manner of dental malocclusion cases (Beglin et al. 2001).

A future project could be to develop and generate an effective artificial intelligence (AI) algorithm that could help to ensure consistency in assessing HLDI. AI algorithms can learn how to perform tasks that typically require human intelligence to complete, such as pattern and speech recognition, image analysis, and decision making. The accuracy of an AI algorithm must be assessed to ensure that patients fully benefit from these new advances.

VI. CONCLUSION

Based on the extent and limitations of this study, the following conclusions obtained concerning VI and CAD assessment methods of HLD Index:

- There is substantial association between approval/denial determination via VI and digital casts CAD HLDI assessment.
- There is a low level of association between approval/denial determination via VI and Medicaid MCO-DQ HLDI assessment.
- There is a low level of association between approval/denial determination via CAD and Medicaid HLDI MCO-DQ assessment.

CITED LITERATURE

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APPENDICES

APPENDIX A

Institutional Review Board Approval

Exemption Granted

November 26, 2018

Ayas Makki
Orthodontics

RE: Research Protocol # 2018-1184
"Reliability of HLD Index and its Correlation with Approval Denial rate of Orthodontics treated cases under Medicaid"

Sponsor(s): None

Dear Ayas Makki:

Your Claim of Exemption was reviewed on November 26, 2018 and it was determined that your research meets the criteria for exemption. You may now begin your research.

Exemption Period:	**November 26, 2018 – November 25, 2021**
Performance Site:	UIC
Subject Population:	De-identified medical records initially collected for clinical purposes from January 4, 2017 through February 1, 2018.
Number of Subjects:	1000

The specific exemption category under 45 CFR 46.101(b) is: 4

HIPAA Waiver:
The Board determined that this research meets the regulatory requirements for waiver of authorization as permitted at 45CFR164.512(i)(1)(i)(A). Specifically, that the use or disclosure of protected health information (PHI) meets the waiver criteria under 45CFR164.512(i)(2)(ii); the research involves no more than a minimal risk to the privacy of the individuals; the research could not practicably be conducted without the waiver; and the research could not practicably be conducted without access to and use of the PHI.

The type of protected health information (PHI) to be used in the research includes:
All collected information will be de-identified by removing any subject identifiers, including name and medical record number. No PHI will remain with the data collected for

APPENDIX A (continued)

research purposes. The subjects will be identified with a code that will be used strictly for organization purposes. The code will not link back to the patient chart or the log of patient Medicaid submissions, and will therefore not tie back to any PHI.

You are reminded that investigators whose research involving human subjects is determined to be exempt from the federal regulations for the protection of human subjects still have responsibilities for the ethical conduct of the research under state law and UIC policy. Please be aware of the following UIC policies and responsibilities for investigators:

1. Amendments You are responsible for reporting any amendments to your research protocol that may affect the determination of the exemption and may result in your research no longer being eligible for the exemption that has been granted.

2. Record Keeping You are responsible for maintaining a copy all research related records in a secure location in the event future verification is necessary, at a minimum these documents include: the research protocol, the claim of exemption application, all questionnaires, survey instruments, interview questions and/or data collection instruments associated with this research protocol, recruiting or advertising materials, any consent forms or information sheets given to subjects, or any other pertinent documents.

3. Final Report When you have completed work on your research protocol, you should submit a final report to the Office for Protection of Research Subjects (OPRS).

Please be sure to use your research protocol number (2018-1184) on any documents or correspondence with the IRB concerning your research protocol.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact the OPRS office at (312) 996-1711 or me at (312) 355-2908.

Sincerely,
Charles W. Hoehne, B.S., C.I.P.
Assistant Director, IRB #7
Office for the Protection of Research Subjects

cc: Budi Kusnoto

APPENDIX B

Statistics

Descriptive Statistics Scale Variables

	N	Mean	Std. Deviation	Minimum	Maximum
CAD Overjet	401	2.68	2.703	0	13
CAD Overbite	401	1.71	1.824	0	10
CAD Crossbite	401	3.34	8.475	0	55
CAD Open Bite	401	1.49	4.658	0	48
CAD Ectopic Teeth	401	4.50	5.752	0	27
CAD Labiolingual Spread	401	.56	1.707	0	9
Visual Overjet	401	2.13	2.252	0	10
Visual Overbite	401	1.69	1.629	0	7
Visual Crossbite	401	2.77	7.058	0	35
Visual Open Bite	401	1.21	4.166	0	32
Visual Ectopic Teeth	401	4.41	5.536	0	24
Visual Labiolingual Spread	401	.36	1.263	0	7
Visual DentalQuest	401	1.47	.500	1	2

APPENDIX B (continued)

Non Parametric Tests Mann-Whitney Test Ranks

	Visual DentalQuest	N	Mean Rank	Sum of Ranks
CAD Overjet	1	213	165.87	35331.00
	2	188	240.80	45270.00
	Total	401		
CAD Overbite	1	213	182.75	38926.50
	2	188	221.67	41674.50
	Total	401		
CAD Crossbite	1	213	221.38	47153.50
	2	188	177.91	33447.50
	Total	401		
CAD Open Bite	1	213	210.23	44778.00
	2	188	190.55	35823.00
	Total	401		
CAD Ectopic Teeth	1	213	197.54	42077.00
	2	188	204.91	38524.00
	Total	401		
CAD Labiolingual Spread	1	213	207.28	44150.50
	2	188	193.89	36450.50
	Total	401		

APPENDIX B (continued)

Non Parametric Tests Mann-Whitney Test Ranks

Visual Overjet	1	213	164.54	35046.00
	2	188	242.31	45555.00
	Total	401		
Visual Overbite	1	213	176.81	37659.50
	2	188	228.41	42941.50
	Total	401		
Visual Crossbite	1	213	221.28	47132.50
	2	188	178.02	33468.50
	Total	401		
Visual Open Bite	1	213	208.51	44413.50
	2	188	192.49	36187.50
	Total	401		
Visual Ectopic Teeth	1	213	196.67	41890.00
	2	188	205.91	38711.00
	Total	401		
Visual Labiolingual Spread	1	213	203.00	43239.00
	2	188	198.73	37362.00
	Total	401		

APPENDIX B (continued)

Test Statistics[a]

	CAD Overjet	CAD Overbite	CAD Crossbite	CAD Open Bite	CAD Ectopic Teeth
Mann-Whitney U	12540.000	16135.500	15681.500	18057.000	19286.000
Wilcoxon W	35331.000	38926.500	33447.500	35823.000	42077.000
Z	-6.665	-3.486	-5.769	-2.883	-.683
Asymp. Sig. (2-tailed)	.000	.000	.000	.004	.494

Test Statistics[a]

	CAD Labiolingual Spread	Visual Overjet	Visual Overbite	Visual Crossbite	Visual Open Bite
Mann-Whitney U	18684.500	12255.000	14868.500	15702.500	18421.500
Wilcoxon W	36450.500	35046.000	37659.500	33468.500	36187.500
Z	-2.087	-6.938	-4.610	-5.889	-2.474
Asymp. Sig. (2-tailed)	.037	.000	.000	.000	.013

Test Statistics[a]

	Visual Ectopic Teeth	Visual Labiolingual Spread
Mann-Whitney U	19099.000	19596.000
Wilcoxon W	41890.000	37362.000
Z	-.853	-.742
Asymp. Sig. (2-tailed)	.393	.458

a. Grouping Variable: Visual Inspection

APPENDIX B (continued)

Descriptive Frequency Table Nominal Variables

CAD Cleft Palate

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	400	99.8	99.8	99.8
	Yes	1	.2	.2	100.0
	Total	401	100.0	100.0	

Visual Cleft Palate

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	400	99.8	99.8	99.8
	Yes	1	.2	.2	100.0
	Total	401	100.0	100.0	

CAD Deep Bite

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	349	87.0	87.0	87.0
	Yes	52	13.0	13.0	100.0
	Total	401	100.0	100.0	

APPENDIX B (continued)

Visual Deep Bite

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	346	86.3	86.3	86.3
	Yes	55	13.7	13.7	100.0
	Total	401	100.0	100.0	

CAD Anterior Cross bite

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	372	92.8	92.8	92.8
	Yes	29	7.2	7.2	100.0
	Total	401	100.0	100.0	

Visual Anterior Cross bite

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	371	92.5	92.5	92.5
	Yes	30	7.5	7.5	100.0
	Total	401	100.0	100.0	

APPENDIX B (continued)

CAD * Visual Inspection Cross Tabulation

			Visual Inspection			Total
			0	1	2	
CAD	0	Count	222	3	2	227
		% of Total	55.4%	0.7%	0.5%	56.6%
	1	Count	1	84	0	85
		% of Total	0.2%	20.9%	0.0%	21.2%
	2	Count	32	2	55	89
		% of Total	8.0%	0.5%	13.7%	22.2%
Total		Count	255	89	57	401
		% of Total	63.6%	22.2%	14.2%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	572.166[a]	4	.000
Likelihood Ratio	521.989	4	.000
Linear-by-Linear Association	212.616	1	.000
N of Valid Cases	401		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.08.

APPENDIX B (continued)

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.195	.000
	Cramer's V	.845	.000
N of Valid Cases		401	

CAD * DentaQuest Cross Tabulation

			DentaQuest		Total
			1	2	
CAD	0	Count	89	138	227
		% of Total	22.2%	34.4%	56.6%
	1	Count	60	25	85
		% of Total	15.0%	6.2%	21.2%
	2	Count	64	25	89
		% of Total	16.0%	6.2%	22.2%
Total		Count	213	188	401
		% of Total	53.1%	46.9%	100.0%

APPENDIX B (continued)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	40.678a	2	.000
Likelihood Ratio	41.634	2	.000
Linear-by-Linear Association	34.804	1	.000
N of Valid Cases	401		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 39.85.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.318	.000
	Cramer's V	.318	.000
N of Valid Cases		401	

APPENDIX B (continued)

Visual Inspection * DentaQuest Cross Tabulation

			DentaQuest		Total
			1	2	
Visual	0	Count	103	152	255
		% of Total	25.7%	37.9%	63.6%
	1	Count	64	25	89
		% of Total	16.0%	6.2%	22.2%
	2	Count	46	11	57
		% of Total	11.5%	2.7%	14.2%
Total		Count	213	188	401
		% of Total	53.1%	46.9%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	46.619[a]	2	.000
Likelihood Ratio	48.698	2	.000
Linear-by-Linear Association	43.388	1	.000
N of Valid Cases	401		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 26.72.

APPENDIX B (continued)

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.341	.000
	Cramer's V	.341	.000
N of Valid Cases		401	

APPENDIX C

Raw Data

CAD-ID	1-Cleft Palate	2-Deep Bite	3-Anterior crossbite	4-Severe Traumatic	5-Overjet	6-Overbite	7-Crossbite	8-Open Bite	9-Ectopic Teeth	10-Anterior Crowding Maxilla	11-Anterior Crowding Mandible	12-Labiolingual	13-Posterior Crossbite	HLD Score	Qualify	DentaQuest Decision
3	0	0	0	0	0	5	15	0	9	0	0	0	4	33	Pass	APPROVED
8	0	0	0	0	0	2	35	0	0	0	0	0	4	41	Pass	DENIED
9	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
10	0	0	0	0	5	2	0	0	0	5	5	0	0	17	Fail	DENIED
11	0	0	0	0	5	4	0	0	0	0	0	2	0	11	Fail	DENIED
12	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
15	0	0	0	0	5	2	0	0	6	5	0	0	0	18	Fail	DENIED
16	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
17	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
21	0	0	0	0	3	2	0	0	0	0	0	0	0	5	Fail	APPROVED
23	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
30	0	0	0	0	7	4	0	0	21	0	0	3	0	35	Pass	APPROVED
31	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
32	0	0	0	0	5	0	0	20	6	0	0	0	0	31	Pass	APPROVED
33	0	0	0	0	3	4	0	0	6	0	0	0	0	13	Fail	DENIED
34	0	0	0	0	4	4	0	0	0	0	5	0	4	17	Fail	DENIED
36	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
37	0	0	0	0	4	3	0	0	3	0	0	2	0	12	Fail	DENIED
39	0	0	0	0	12	3	0	0	6	5	0	0	0	26	Fail	APPROVED
40	0	0	0	0	2	2	0	0	0	5	5	0	4	18	Fail	DENIED
41	0	0	0	0	5	2	0	0	6	5	5	0	0	23	Fail	APPROVED
42	0	0	0	0	0	3	20	0	3	0	0	2	0	28	Pass	APPROVED
43	0	0	0	0	2	3	0	0	3	5	5	3	0	21	Fail	APPROVED
44	0	0	0	0	3	1	0	0	0	0	0	3	0	7	Fail	DENIED
46	0	0	0	0	3	0	0	12	6	0	0	3	0	24	Fail	APPROVED
47	0	0	0	0	3	2	0	0	0	5	0	2	0	12	Fail	APPROVED
48	0	0	0	0	3	2	0	0	9	0	0	6	0	20	Fail	DENIED
50	0	0	0	0	1	0	0	0	0	5	0	0	0	6	Fail	DENIED
51	0	0	0	0	0	6	25	0	6	0	0	4	4	45	Pass	APPROVED
53	0	0	0	0	7	3	0	0	6	0	0	6	0	22	Fail	APPROVED
54	0	0	0	0	3	2	0	0	0	0	5	0	0	10	Fail	DENIED
56	0	0	0	0	7	5	0	0	6	0	0	0	0	18	Fail	APPROVED
57	0	0	0	0	3	2	0	0	0	0	0	0	0	5	Fail	DENIED
59	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
60	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
61	0	0	0	0	3	2	0	0	6	0	5	9	4	29	Pass	APPROVED
62	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
63	0	0	0	0	5	4	0	0	6	0	0	0	0	15	Fail	DENIED
64	0	0	0	0	3	2	0	0	12	0	0	6	4	27	Fail	APPROVED
66	0	0	0	0	3	0	0	12	0	5	0	0	0	20	Fail	DENIED
68	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
71	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
77	0	0	0	0	3	3	0	0	12	0	0	0	0	18	Fail	DENIED
78	0	0	0	0	4	0	0	12	0	5	0	2	0	23	Fail	APPROVED
79	0	0	0	0	4	4	0	0	3	0	0	0	0	11	Fail	DENIED
82	0	0	0	0	7	3	0	0	0	5	5	0	0	20	Fail	DENIED
86	0	0	0	0	4	5	0	0	0	0	5	0	0	14	Fail	DENIED
88	0	0	0	0	0	0	20	12	0	5	5	0	4	46	Pass	APPROVED
89	0	0	0	0	6	3	0	0	0	0	0	0	0	9	Fail	DENIED
90	0	0	0	0	0	4	35	0	0	5	5	0	4	53	Pass	APPROVED
91	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
92	0	0	0	0	8	0	0	4	3	0	5	8	0	28	Pass	DENIED
97	0	0	0	0	0	4	30	0	0	0	0	0	4	38	Pass	APPROVED
99	0	0	0	0	0	5	20	0	0	0	0	0	0	25	Fail	APPROVED
102	0	0	0	0	0	0	5	0	0	0	0	0	0	5	Fail	DENIED
103	0	0	0	0	5	4	0	0	9	5	5	0	0	28	Pass	DENIED
104	0	0	0	0	7	4	0	0	0	5	5	0	0	21	Fail	APPROVED
105	0	0	0	0	1	0	5	0	0	5	5	0	0	16	Fail	DENIED

APPENDIX C (continued)

106	0	0	0	0	0	4	15	0	12	0	0	0	0	31	Pass	APPROVED
108	0	0	0	0	4	10	0	0	0	0	0	0	0	14	Fail	DENIED
109	0	0	0	0	3	2	0	0	3	0	0	0	0	8	Fail	DENIED
111	0	0	0	0	3	2	0	0	0	5	5	0	0	15	Fail	DENIED
112	0	0	0	0	4	3	0	0	6	0	5	0	0	18	Fail	DENIED
113	0	0	0	0	0	4	35	0	0	5	0	0	0	44	Pass	APPROVED
116	0	0	0	0	4	2	0	0	0	5	5	0	0	16	Fail	DENIED
117	0	0	0	0	3	2	0	0	6	5	5	0	0	21	Fail	DENIED
120	0	0	0	0	3	2	0	0	0	5	5	0	0	15	Fail	DENIED
121	0	0	0	0	2	0	20	0	3	0	0	7	0	32	Pass	APPROVED
123	0	0	0	0	7	1	0	0	3	0	0	7	0	18	Fail	APPROVED
127	0	0	0	0	8	2	0	0	0	0	5	8	0	23	Fail	APPROVED
128	0	0	0	0	4	0	0	0	6	5	5	0	0	20	Fail	DENIED
129	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
130	0	0	0	0	10	1	0	0	9	0	5	0	0	25	Fail	APPROVED
131	0	0	0	0	0	3	20	0	0	0	0	0	4	27	Fail	APPROVED
133	0	0	0	0	4	2	0	0	0	5	5	0	0	16	Fail	DENIED
135	0	0	0	0	5	0	0	12	3	5	5	0	0	30	Pass	DENIED
136	0	0	0	0	0	0	30	12	0	5	5	0	0	52	Pass	DENIED
137	0	0	0	0	7	5	0	0	3	0	5	0	0	20	Fail	APPROVED
138	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
139	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
140	0	0	0	0	2	2	0	0	0	5	5	0	0	14	Fail	APPROVED
141	0	0	0	0	5	0	0	12	0	5	5	0	0	27	Fail	DENIED
142	0	0	0	0	5	2	0	0	12	5	5	0	0	29	Pass	DENIED
143	0	0	0	1	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
144	0	0	0	0	2	0	0	0	0	0	5	0	0	7	Fail	APPROVED
145	0	0	0	0	2	1	0	0	0	5	5	0	0	13	Fail	DENIED
146	0	0	0	0	5	5	0	0	3	0	5	0	0	18	Fail	DENIED
147	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
149	0	0	0	0	4	1	0	0	3	5	5	0	0	18	Fail	DENIED
151	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
152	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
155	0	0	0	0	5	3	0	0	15	0	0	0	0	23	Fail	DENIED
157	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
158	0	0	0	0	0	3	15	0	6	0	0	0	0	24	Fail	APPROVED
159	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
160	0	0	0	0	5	1	0	0	18	0	5	0	0	29	Pass	APPROVED
162	0	0	0	0	3	1	0	0	9	0	0	0	0	13	Fail	APPROVED
163	0	0	0	0	4	1	0	0	15	0	0	0	0	20	Fail	DENIED
164	0	0	0	0	0	0	20	16	0	0	0	0	0	36	Pass	APPROVED
165	0	0	0	0	8	0	0	12	0	0	5	6	4	35	Pass	APPROVED
166	0	0	0	0	5	1	0	0	0	0	5	0	0	11	Fail	DENIED
168	0	0	0	0	0	3	10	0	6	0	0	0	0	19	Fail	APPROVED
169	0	0	0	0	9	0	0	12	0	5	5	0	0	31	Pass	APPROVED
173	0	0	0	0	0	0	0	0	6	5	0	3	0	14	Fail	APPROVED
174	0	0	0	0	5	2	0	0	3	5	5	0	0	20	Fail	DENIED
178	0	0	0	0	2	0	0	12	9	0	0	0	0	23	Fail	APPROVED
181	0	0	0	0	3	2	0	0	6	5	5	0	0	21	Fail	APPROVED
183	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
185	0	0	0	0	1	1	0	0	6	5	5	0	0	18	Fail	DENIED
186	0	0	0	0	0	0	15	12	12	0	5	0	4	48	Pass	APPROVED
188	0	0	0	0	0	4	20	0	6	0	0	0	4	34	Pass	APPROVED
189	0	0	0	0	0	1	15	0	0	5	0	0	0	21	Fail	APPROVED
190	0	0	0	0	2	0	0	0	12	0	0	0	0	14	Fail	DENIED
191	0	0	0	0	5	0	0	8	12	0	0	5	4	34	Pass	DENIED
193	0	0	0	0	5	4	0	0	12	0	0	0	0	21	Fail	DENIED
195	0	0	0	0	3	0	0	4	0	5	0	0	0	12	Fail	DENIED
198	0	0	0	0	4	0	0	0	3	0	0	0	0	7	Fail	DENIED
199	0	0	0	0	3	0	0	6	15	0	5	6	4	39	Pass	APPROVED
200	0	0	0	0	6	6	0	0	0	5	5	0	0	22	Fail	DENIED
201	0	0	0	0	4	4	0	0	6	5	0	1	0	20	Fail	APPROVED
202	0	0	0	0	0	2	15	0	0	5	0	0	4	26	Fail	APPROVED
205	0	0	0	0	4	3	0	0	6	5	5	0	0	23	Fail	DENIED
206	0	0	0	0	0	5	20	0	0	0	0	0	0	25	Fail	APPROVED
208	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
209	0	0	0	0	3	3	0	0	9	5	0	0	0	20	Fail	APPROVED
210	0	0	0	0	2	0	0	0	0	0	0	0	0	2	Fail	APPROVED
211	0	0	0	0	5	2	0	0	6	0	0	0	0	13	Fail	DENIED
212	0	0	0	0	5	0	0	12	0	5	5	0	0	27	Fail	APPROVED

APPENDIX C (continued)

213	0	0	0	0	1	0	0	8	18	0	0	0	4	31	Pass	APPROVED
215	0	0	0	0	3	4	0	0	6	0	0	0	0	13	Fail	DENIED
216	0	0	0	0	8	1	0	0	9	0	5	0	0	23	Fail	DENIED
217	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
218	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
220	0	0	0	0	2	1	0	0	12	0	0	0	4	19	Fail	APPROVED
221	0	0	0	0	4	4	0	0	15	0	0	6	0	29	Pass	DENIED
223	0	0	0	0	3	0	0	0	12	0	0	0	0	15	Fail	DENIED
225	0	0	0	0	2	2	0	0	18	0	0	0	0	22	Fail	APPROVED
226	0	0	0	0	5	0	0	12	18	0	0	0	0	35	Pass	DENIED
227	0	0	0	0	10	1	0	0	18	0	0	0	0	29	Pass	DENIED
228	0	0	0	0	4	2	0	0	18	0	5	0	0	29	Pass	APPROVED
229	0	0	0	0	9	3	0	0	12	0	5	0	0	29	Pass	APPROVED
230	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
231	0	0	0	0	0	1	20	0	21	0	0	0	4	46	Pass	APPROVED
232	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
233	0	0	0	0	0	0	15	12	9	0	0	0	4	40	Pass	APPROVED
234	0	0	0	0	4	2	0	0	12	0	5	0	0	23	Fail	DENIED
237	0	0	0	0	0	2	15	0	15	0	0	0	4	36	Pass	APPROVED
241	0	0	0	0	5	1	0	0	12	5	0	0	0	23	Fail	APPROVED
242	0	0	0	0	4	3	0	0	12	0	0	0	0	19	Fail	DENIED
243	0	0	0	0	2	1	0	0	6	0	0	0	0	9	Fail	DENIED
244	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
246	0	0	0	0	1	0	0	20	0	0	0	0	0	21	Fail	APPROVED
247	0	0	0	0	4	4	0	0	18	0	0	0	4	30	Pass	APPROVED
248	0	0	0	0	5	2	0	0	15	0	0	0	0	22	Fail	DENIED
249	0	0	0	0	4	2	0	0	0	5	5	0	0	16	Fail	DENIED
250	0	0	0	0	4	4	0	0	12	0	5	0	4	29	Pass	DENIED
251	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
252	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
255	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
256	0	0	0	0	5	0	0	12	9	0	0	0	0	26	Fail	APPROVED
258	0	0	0	0	4	2	0	0	0	5	0	0	4	15	Fail	DENIED
260	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
264	0	0	0	0	6	4	0	0	0	5	5	0	0	20	Fail	DENIED
267	0	0	0	0	6	3	0	0	27	0	0	0	0	36	Pass	APPROVED
268	0	0	0	0	5	0	0	4	0	0	0	0	0	9	Fail	DENIED
270	0	0	0	0	1	0	0	8	12	0	0	0	4	25	Fail	APPROVED
271	0	0	0	0	0	1	30	0	12	0	0	0	0	43	Pass	APPROVED
274	0	0	0	0	4	2	0	0	6	5	0	0	0	17	Fail	DENIED
275	0	0	0	0	3	2	0	0	3	0	0	0	0	8	Fail	DENIED
276	0	0	0	0	3	0	0	20	0	0	0	0	0	23	Fail	APPROVED
277	0	0	0	0	4	3	0	0	6	0	0	0	0	13	Fail	DENIED
280	0	0	0	0	0	7	30	0	3	5	0	0	4	49	Pass	APPROVED
281	0	0	0	0	0	3	15	0	12	0	0	0	0	30	Pass	APPROVED
282	0	0	0	0	4	1	0	0	12	0	0	0	0	17	Fail	DENIED
283	0	0	0	0	0	0	10	4	0	0	0	0	0	14	Fail	APPROVED
285	0	0	0	0	5	3	0	0	9	5	0	0	0	22	Fail	DENIED
286	0	0	0	0	0	6	20	0	6	0	0	0	0	32	Pass	DENIED
287	0	0	0	0	4	5	0	0	12	0	5	0	0	26	Fail	APPROVED
288	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
289	0	0	0	0	6	1	0	0	6	0	5	0	0	18	Fail	DENIED
291	0	0	0	0	5	2	0	0	18	0	0	0	0	25	Fail	DENIED
297	0	0	0	0	0	3	15	0	9	0	0	0	0	27	Fail	APPROVED
298	0	0	0	0	2	3	0	0	6	5	0	0	0	16	Fail	DENIED
300	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
302	0	0	0	0	3	2	0	0	9	0	0	0	0	14	Fail	DENIED
303	0	0	0	0	4	3	0	0	6	0	0	0	0	13	Fail	DENIED
304	0	0	0	0	12	5	0	0	0	0	0	0	0	17	Fail	APPROVED
305	0	0	0	0	4	3	0	0	6	0	0	0	0	13	Fail	APPROVED
306	0	0	0	0	5	2	0	0	12	5	0	0	0	24	Fail	DENIED
307	0	0	0	0	2	3	0	0	12	0	0	0	0	17	Fail	DENIED
308	0	0	0	0	9	3	0	0	9	0	5	0	4	30	Pass	APPROVED
310	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
312	0	0	0	0	10	4	0	0	0	0	0	5	0	19	Fail	APPROVED
313	0	0	0	0	0	0	10	4	18	0	0	0	0	32	Pass	APPROVED
315	0	0	0	0	8	4	0	0	9	0	0	7	0	28	Pass	APPROVED
316	0	0	0	0	3	3	0	0	9	0	0	0	0	15	Fail	DENIED
317	0	0	0	0	3	1	0	0	9	0	5	0	0	18	Fail	DENIED
318	0	0	0	0	4	4	0	0	6	0	0	7	0	21	Fail	APPROVED

APPENDIX C (continued)

319	0	0	0	0	4	1	0	0	12	0	0	0	0	17	Fail	DENIED
320	0	0	0	0	7	3	0	0	6	0	0	0	0	16	Fail	DENIED
322	0	0	0	0	6	3	0	0	0	0	0	0	0	9	Fail	APPROVED
325	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
327	0	0	0	0	3	3	0	0	3	0	0	0	0	9	Fail	DENIED
328	0	0	0	0	2	2	0	0	6	0	0	7	0	17	Fail	DENIED
332	0	0	0	0	3	0	0	8	12	0	0	0	0	23	Fail	APPROVED
333	0	0	0	0	1	1	0	0	6	0	0	0	0	8	Fail	APPROVED
334	0	0	0	0	4	5	0	0	18	0	0	0	0	27	Fail	DENIED
335	0	0	0	0	1	2	0	0	18	0	0	0	0	21	Fail	DENIED
338	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
339	0	0	0	0	2	0	0	20	9	0	0	0	0	31	Pass	APPROVED
340	0	0	0	0	3	5	0	0	15	0	0	6	0	29	Pass	APPROVED
341	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
342	0	0	0	0	0	2	10	0	0	0	0	0	0	12	Fail	APPROVED
343	0	0	0	0	7	6	0	0	0	5	0	0	0	18	Fail	DENIED
344	0	0	0	0	4	4	0	0	3	5	5	0	0	21	Fail	DENIED
345	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
347	0	0	0	0	6	4	0	0	3	5	5	0	0	23	Fail	DENIED
348	0	0	0	1	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
351	0	0	0	0	6	6	0	0	12	0	5	0	0	29	Pass	DENIED
353	0	0	0	0	0	0	10	0	15	0	5	0	4	34	Pass	APPROVED
354	0	0	0	0	3	3	0	0	12	0	0	0	0	18	Fail	DENIED
355	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
356	0	0	0	0	4	3	0	0	3	0	0	0	0	10	Fail	DENIED
357	0	0	0	0	3	0	0	8	0	0	0	0	0	11	Fail	APPROVED
358	0	0	0	0	3	1	0	0	0	0	0	6	0	10	Fail	DENIED
359	0	0	0	0	0	2	15	0	0	0	0	0	0	17	Fail	APPROVED
362	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
363	0	0	0	0	3	3	0	0	3	0	0	0	0	9	Fail	DENIED
364	0	0	0	0	6	3	0	0	0	0	0	0	0	9	Fail	DENIED
369	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
370	0	0	0	0	0	4	30	0	0	5	0	0	0	39	Pass	APPROVED
371	0	0	0	0	0	5	25	0	0	0	0	0	0	30	Pass	APPROVED
374	0	0	0	0	3	2	0	0	6	5	0	0	0	16	Fail	DENIED
375	0	0	0	0	0	1	10	0	0	5	0	3	4	23	Fail	DENIED
379	0	0	0	0	7	5	0	0	0	5	0	0	0	17	Fail	DENIED
380	0	0	0	0	7	3	0	0	0	0	0	0	0	10	Fail	DENIED
381	0	0	0	0	0	0	5	4	0	0	0	0	4	13	Fail	APPROVED
383	0	0	0	0	7	4	0	0	3	0	0	0	0	14	Fail	APPROVED
384	0	0	0	0	4	4	0	0	9	5	0	0	0	22	Fail	DENIED
385	0	0	0	0	1	1	0	0	9	0	5	0	0	16	Fail	DENIED
386	0	0	0	0	4	2	0	0	12	0	0	7	4	29	Pass	APPROVED
387	0	0	0	0	3	4	0	0	15	0	0	0	0	22	Fail	APPROVED
388	0	0	0	0	6	3	0	0	6	5	0	5	0	25	Fail	DENIED
389	0	0	0	0	0	0	25	4	0	0	0	3	0	32	Pass	APPROVED
390	0	0	0	0	5	2	0	0	12	0	0	0	0	19	Fail	DENIED
391	0	0	0	0	4	3	0	0	6	0	0	0	0	13	Fail	DENIED
392	0	0	0	0	4	2	0	0	9	0	0	0	0	15	Fail	APPROVED
393	0	0	0	0	5	6	0	0	12	5	0	5	0	33	Pass	DENIED
396	0	0	0	0	3	1	0	0	0	5	5	0	0	14	Fail	DENIED
397	0	0	0	0	6	0	0	0	24	0	0	0	0	30	Pass	DENIED
399	0	0	0	0	0	0	5	4	0	5	0	0	4	18	Fail	APPROVED
400	0	0	0	0	0	0	55	24	3	5	0	0	0	87	Pass	DENIED
401	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
404	0	0	0	0	0	0	20	12	0	5	0	0	0	37	Pass	APPROVED
406	0	0	0	0	4	0	0	20	6	0	0	0	0	30	Pass	DENIED
408	0	0	0	0	4	3	0	0	3	0	5	0	4	19	Fail	DENIED
409	0	0	0	0	3	2	0	0	3	0	5	0	0	13	Fail	DENIED
410	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
411	0	0	0	0	6	3	0	0	15	0	0	6	0	30	Pass	APPROVED
412	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
413	0	0	0	0	7	4	0	0	0	0	0	0	0	11	Fail	DENIED
415	0	0	0	0	5	4	0	0	0	0	5	0	0	14	Fail	APPROVED
418	0	0	0	0	3	5	0	0	0	0	5	6	0	19	Fail	DENIED
420	0	0	0	0	5	2	0	0	6	0	0	0	0	13	Fail	DENIED
424	0	0	0	0	6	0	0	8	3	0	5	6	0	28	Pass	APPROVED
428	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
435	0	0	0	0	3	1	0	0	0	0	0	0	0	4	Fail	DENIED
436	0	0	0	0	0	2	15	0	0	5	5	0	4	31	Pass	APPROVED

APPENDIX C (continued)

439	0	0	0	0	6	4	0	0	3	0	0	6	0	19	Fail	DENIED
441	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
443	0	0	0	0	0	1	10	0	0	0	0	0	0	11	Fail	APPROVED
445	0	0	0	0	1	1	0	0	0	5	0	0	0	7	Fail	APPROVED
446	0	0	0	0	5	2	0	0	0	0	0	0	0	7	Fail	DENIED
447	0	0	0	0	1	1	0	0	6	0	5	6	0	19	Fail	APPROVED
449	0	0	0	0	4	2	0	0	6	5	0	2	0	19	Fail	APPROVED
450	0	0	0	0	5	3	0	0	0	0	0	0	0	8	Fail	DENIED
452	0	0	0	0	2	3	0	0	3	0	5	6	0	19	Fail	APPROVED
453	0	0	0	0	2	0	0	8	12	0	5	5	4	36	Pass	APPROVED
454	0	0	0	0	5	1	0	0	12	0	0	0	0	18	Fail	APPROVED
456	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
457	0	0	0	0	5	4	0	0	6	0	5	0	0	20	Fail	DENIED
460	0	0	0	0	5	3	0	0	0	0	0	0	0	8	Fail	DENIED
463	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
465	0	0	0	0	0	0	20	4	15	0	0	0	4	43	Pass	APPROVED
467	0	0	0	0	6	2	0	0	6	0	0	0	0	14	Fail	DENIED
469	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
473	0	0	0	0	3	2	0	0	15	0	0	0	0	20	Fail	APPROVED
474	0	0	0	0	5	1	0	0	0	0	5	0	0	11	Fail	DENIED
475	0	0	0	0	1	2	0	0	3	0	0	0	0	6	Fail	DENIED
476	0	0	0	0	2	0	25	0	0	0	0	0	0	27	Fail	APPROVED
479	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
480	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
483	0	0	0	0	6	1	0	0	6	5	0	0	0	18	Fail	APPROVED
485	0	0	0	0	2	1	0	0	3	0	0	0	0	6	Fail	APPROVED
490	0	0	0	1	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
492	0	0	0	0	5	3	0	0	0	5	5	0	0	18	Fail	DENIED
493	0	0	0	0	3	3	0	0	0	5	5	0	0	16	Fail	DENIED
497	0	0	0	0	3	1	0	0	6	0	5	0	0	15	Fail	DENIED
499	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
501	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
504	0	0	0	0	1	2	0	0	18	0	0	0	0	21	Fail	APPROVED
506	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
507	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
510	0	0	0	0	3	3	0	0	6	0	0	0	0	12	Fail	DENIED
511	0	0	0	0	0	5	35	0	6	0	0	0	0	46	Pass	APPROVED
512	0	0	0	0	13	3	0	0	12	0	0	7	0	35	Pass	APPROVED
514	0	0	0	0	0	1	15	0	0	0	0	0	0	16	Fail	APPROVED
515	0	0	0	0	0	5	20	0	0	5	0	0	0	30	Pass	APPROVED
518	0	0	0	0	3	1	0	0	24	0	0	0	0	28	Pass	DENIED
524	0	0	0	0	1	0	0	0	6	5	5	0	4	21	Fail	DENIED
525	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
528	0	0	0	0	4	3	0	0	12	5	0	0	4	28	Pass	DENIED
529	0	0	0	0	6	4	0	0	18	0	0	0	0	28	Pass	DENIED
530	0	0	0	0	8	2	0	0	18	0	0	0	0	28	Pass	DENIED
531	0	0	0	0	5	4	0	0	0	0	5	0	0	14	Fail	DENIED
532	0	0	0	0	3	0	0	0	3	5	0	0	0	11	Fail	APPROVED
533	0	0	0	0	1	0	0	8	6	0	0	0	4	19	Fail	APPROVED
536	0	0	0	0	5	0	0	8	12	0	0	0	0	25	Fail	APPROVED
537	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
538	0	0	0	0	2	2	0	0	0	0	0	1	0	5	Fail	DENIED
541	0	0	0	0	2	1	0	0	0	5	0	0	4	12	Fail	APPROVED
542	0	0	0	0	0	8	35	0	0	5	0	0	0	48	Pass	APPROVED
544	0	0	0	0	0	0	25	8	9	0	5	0	4	51	Pass	APPROVED
545	0	0	0	0	7	2	0	0	12	0	5	0	4	30	Pass	APPROVED
546	0	0	0	0	0	2	30	0	6	0	0	2	0	40	Pass	APPROVED
547	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
549	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
554	0	0	0	0	5	4	0	0	6	0	5	0	0	20	Fail	APPROVED
555	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
556	0	0	0	0	1	0	0	12	0	0	0	0	4	17	Fail	APPROVED
557	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
565	0	0	0	0	3	1	0	0	0	0	0	0	4	8	Fail	DENIED
568	0	0	0	0	7	5	0	0	0	5	0	0	0	17	Fail	APPROVED
569	0	0	0	0	3	1	0	0	3	0	0	0	0	7	Fail	DENIED
570	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
572	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
573	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
574	0	0	0	0	0	3	24	0	0	0	0	0	4	31	Pass	APPROVED

APPENDIX C (continued)

575	0	0	0	0	3	0	0	4	15	0	5	0	4	31	Pass	APPROVED
577	0	0	0	0	6	3	0	0	0	5	5	0	4	23	Fail	DENIED
578	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
579	0	0	0	0	9	2	0	0	6	5	0	0	0	22	Fail	DENIED
581	0	0	0	0	0	4	15	0	0	5	5	0	4	33	Pass	APPROVED
584	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
585	0	0	0	0	5	4	0	0	6	5	0	0	0	20	Fail	APPROVED
586	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
588	0	0	0	0	5	5	0	0	0	5	5	0	0	20	Fail	DENIED
597	0	0	0	0	0	0	15	12	9	0	5	0	0	41	Pass	APPROVED
598	0	0	0	0	0	0	0	0	6	0	5	0	0	11	Fail	APPROVED
600	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
602	0	0	0	0	0	2	20	0	0	0	5	0	0	27	Fail	APPROVED
608	0	0	0	0	0	1	10	0	0	5	5	0	0	21	Fail	DENIED
610	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
618	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
619	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
621	0	0	0	0	0	0	20	24	0	0	5	0	0	49	Pass	APPROVED
623	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
624	0	0	0	0	4	1	0	0	0	0	0	0	0	5	Fail	DENIED
625	0	0	0	0	3	2	0	0	0	0	0	0	0	5	Fail	DENIED
626	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
628	0	0	0	0	8	0	0	12	9	0	0	0	0	29	Pass	DENIED
632	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
633	0	0	0	0	0	4	50	0	6	0	0	0	4	64	Pass	APPROVED
634	0	0	0	0	7	3	0	0	9	5	0	0	0	24	Fail	APPROVED
635	0	0	0	0	3	1	0	0	0	5	0	0	0	9	Fail	DENIED
636	0	0	0	0	1	0	0	0	0	0	0	0	4	5	Fail	DENIED
637	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
638	0	0	0	0	0	0	5	12	0	0	0	0	0	17	Fail	DENIED
640	0	0	0	0	0	0	0	0	15	0	5	0	0	20	Fail	DENIED
643	0	0	0	0	3	2	0	0	6	0	0	0	0	11	Fail	DENIED
644	0	0	0	0	4	1	0	0	9	0	0	0	0	14	Fail	DENIED
645	0	0	0	0	3	2	0	0	3	5	0	0	0	13	Fail	APPROVED
646	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
648	0	0	0	0	0	0	25	0	9	0	0	0	4	38	Pass	APPROVED
650	0	0	0	0	2	0	0	4	9	0	5	0	4	24	Fail	APPROVED
651	1	0	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
654	0	0	0	0	4	6	0	0	0	0	0	0	4	14	Fail	DENIED
655	0	0	0	0	7	3	0	0	12	5	0	0	4	31	Pass	DENIED
661	0	0	0	0	0	8	25	0	3	0	0	0	0	36	Pass	APPROVED
663	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
664	0	0	0	0	7	0	0	48	12	0	5	0	4	76	Pass	APPROVED
665	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
666	0	0	0	0	0	0	10	0	6	0	5	0	4	25	Fail	APPROVED
667	0	0	0	0	0	2	20	0	0	5	5	0	0	32	Pass	DENIED
670	0	0	0	0	3	2	0	0	0	5	5	0	0	15	Fail	DENIED
699	0	0	0	0	7	3	0	0	0	5	5	0	4	24	Fail	APPROVED
708	0	0	0	0	9	4	0	0	15	0	5	0	0	33	Pass	APPROVED
711	0	0	0	0	2	0	0	0	15	0	0	0	0	17	Fail	APPROVED
712	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
714	0	0	0	0	0	4	20	0	0	0	0	0	4	28	Pass	APPROVED
717	0	0	0	0	6	3	0	0	0	5	0	0	0	14	Fail	DENIED
718	0	0	0	0	5	1	0	0	6	0	5	0	0	17	Fail	DENIED
719	0	0	0	0	1	2	0	0	0	0	5	0	0	8	Fail	APPROVED
720	0	0	0	0	2	2	0	0	3	0	0	0	0	7	Fail	DENIED
721	0	0	0	0	8	0	0	8	12	0	0	0	0	28	Pass	DENIED
722	0	0	0	0	4	1	0	0	9	0	0	0	0	14	Fail	DENIED
723	0	0	0	0	4	5	0	0	0	0	0	0	0	9	Fail	DENIED
736	0	0	0	0	2	1	0	0	12	0	5	0	4	24	Fail	APPROVED
737	0	0	0	0	6	6	0	0	0	5	5	0	0	22	Fail	APPROVED
738	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
739	0	0	0	0	4	0	0	8	0	0	0	0	0	12	Fail	DENIED

APPENDIX C (continued)

VI-ID	1-Cleft Palate	2-Deep Bite	3-Anterior crossbite	4-Severe Traumatic Deviation	5-OverJet	6-OverBite	7-Crossbite	8-Open Bite	9-Ectopic Teeth	10-Anterior Crowding Maxilla	11-Anterior Crowding Mandible	12-Labiolingual Spread	13-Posterior Crossbite	HLD Score	Qualify	DentaQuest Decision
3	0	0	0	0	0	4	20	0	9	0	0	0	4	37	Pass	APPROVED
8	0	0	0	0	0	2	30	0	0	0	0	0	4	36	Pass	DENIED
9	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
10	0	0	0	0	3	2	0	0	0	5	5	0	0	15	Fail	DENIED
11	0	0	0	0	5	4	0	0	3	0	0	0	0	12	Fail	DENIED
12	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
15	0	0	0	0	2	2	0	0	6	0	0	0	0	10	Fail	DENIED
16	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
17	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
21	0	0	0	0	3	2	0	0	0	0	0	0	0	5	Fail	APPROVED
23	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
30	0	0	0	0	2	2	0	0	15	5	5	0	0	29	Pass	APPROVED
31	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
32	0	0	0	0	2	0	0	20	6	0	0	0	0	28	Pass	APPROVED
33	0	0	0	0	3	5	0	0	6	0	0	0	0	14	Fail	DENIED
34	0	0	0	0	2	4	0	0	0	0	0	0	4	10	Fail	DENIED
36	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
37	0	0	0	0	4	3	0	0	3	0	0	2	0	12	Fail	DENIED
39	0	0	0	0	8	4	0	0	6	5	0	0	0	23	Fail	APPROVED
40	0	0	0	0	2	2	0	0	0	5	0	0	4	13	Fail	DENIED
41	0	0	0	0	4	5	0	0	6	5	5	0	0	25	Fail	APPROVED
42	0	0	0	0	0	3	20	0	3	0	0	1	0	27	Fail	APPROVED
43	0	0	0	0	2	2	0	0	3	0	0	5	0	12	Fail	APPROVED
44	0	0	0	0	4	2	0	0	0	0	5	3	0	14	Fail	DENIED
46	0	0	0	0	2	0	0	12	6	0	0	0	0	20	Fail	APPROVED
47	0	0	0	0	2	2	0	0	0	0	0	3	0	7	Fail	APPROVED
48	0	0	0	0	2	2	0	0	9	0	0	2	0	15	Fail	DENIED
50	0	0	0	0	2	2	0	0	0	5	0	0	0	9	Fail	DENIED
51	0	0	0	0	3	0	15	0	6	0	5	6	4	39	Pass	APPROVED
53	0	0	0	0	7	3	0	0	6	0	5	5	0	26	Fail	APPROVED
54	0	0	0	0	2	3	0	0	0	0	5	0	0	10	Fail	DENIED
56	0	0	0	0	7	5	0	0	6	0	0	0	0	18	Fail	APPROVED
57	0	0	0	0	2	2	0	0	0	0	0	0	0	4	Fail	DENIED
59	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
60	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
61	0	0	0	0	2	2	0	0	6	0	5	5	4	24	Fail	APPROVED
62	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
63	0	0	0	0	5	4	0	0	6	0	0	0	0	15	Fail	DENIED
64	0	0	0	0	2	2	0	0	12	0	0	7	4	27	Fail	APPROVED
66	0	0	0	0	1	0	0	5	0	5	0	0	0	11	Fail	DENIED
68	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
71	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
77	0	0	0	0	4	4	0	0	12	0	0	0	0	20	Fail	DENIED
78	0	0	0	0	1	0	0	5	0	5	0	2	0	13	Fail	APPROVED
79	0	0	0	0	4	3	0	0	3	0	0	0	0	10	Fail	DENIED
82	0	0	0	0	5	4	0	0	0	0	5	3	0	17	Fail	DENIED
86	0	0	0	0	4	4	0	0	0	5	5	0	0	18	Fail	DENIED
88	0	0	0	0	0	0	25	8	0	0	0	0	0	33	Pass	APPROVED
89	0	0	0	0	5	4	0	0	0	0	0	0	0	9	Fail	DENIED
90	0	0	0	0	0	3	30	0	0	0	5	3	4	45	Pass	APPROVED
91	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
92	0	0	0	0	8	0	0	4	3	0	5	7	0	27	Fail	DENIED
97	0	0	0	0	0	3	25	0	0	0	0	0	4	32	Pass	APPROVED
99	0	0	0	0	0	4	20	0	0	0	0	0	0	24	Fail	APPROVED
102	0	0	0	0	0	1	5	0	0	5	0	0	0	11	Fail	DENIED
103	0	0	0	0	3	3	0	9	0	0	5	0	0	20	Fail	DENIED
104	0	0	0	0	6	5	0	0	0	5	0	0	0	16	Fail	APPROVED
105	0	0	0	0	0	0	0	0	0	5	5	0	0	10	Fail	DENIED
106	0	0	0	0	0	3	15	0	12	0	0	0	0	30	Pass	APPROVED
108	0	0	0	0	2	0	0	15	0	0	5	0	0	22	Fail	DENIED
109	0	0	0	0	2	2	0	0	3	0	0	0	0	7	Fail	DENIED
111	0	0	0	0	3	3	0	0	0	5	5	0	0	16	Fail	DENIED

APPENDIX C (continued)

112	0	0	0	0	2	3	0	0	6	0	5	0	0	16	Fail	DENIED
113	0	0	0	0	0	4	35	0	0	5	0	0	0	44	Pass	APPROVED
116	0	0	0	0	5	2	0	0	0	0	0	2	0	9	Fail	DENIED
117	0	0	0	0	5	2	0	0	6	5	5	0	0	23	Fail	DENIED
120	0	0	0	0	2	2	0	0	0	5	0	0	0	9	Fail	DENIED
121	0	0	0	0	2	0	15	0	3	0	0	7	0	27	Fail	APPROVED
123	0	0	0	0	5	2	0	0	3	0	0	4	0	14	Fail	APPROVED
127	0	0	0	0	7	4	0	0	0	5	5	0	0	21	Fail	APPROVED
128	0	0	0	0	4	2	0	0	6	5	5	0	0	22	Fail	DENIED
129	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
130	0	0	0	0	7	1	0	0	9	0	5	0	0	22	Fail	APPROVED
131	0	0	0	0	0	4	25	0	0	0	0	0	4	33	Pass	APPROVED
133	0	0	0	0	5	2	0	0	0	5	5	0	0	17	Fail	DENIED
135	0	0	0	0	5	2	0	0	3	5	5	0	0	20	Fail	DENIED
136	0	0	0	0	0	0	25	12	0	0	0	0	0	37	Pass	DENIED
137	0	0	0	0	4	4	0	0	3	0	5	0	0	16	Fail	APPROVED
138	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
139	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
140	0	0	0	0	3	3	0	0	0	5	5	0	0	16	Fail	APPROVED
141	0	0	0	0	4	0	0	4	0	5	5	0	0	18	Fail	DENIED
142	0	0	0	0	3	3	0	0	12	5	5	0	0	28	Pass	DENIED
143	0	0	0	1	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
144	0	0	0	0	1	1	0	0	0	0	5	0	0	7	Fail	APPROVED
145	0	0	0	0	1	1	0	0	0	5	5	0	0	12	Fail	DENIED
146	0	0	0	0	4	3	0	0	3	0	0	0	0	10	Fail	DENIED
147	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
149	0	0	0	0	2	2	0	0	3	5	5	0	0	17	Fail	DENIED
151	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
152	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
155	0	0	0	0	4	5	0	0	15	0	0	0	0	24	Fail	DENIED
157	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
158	0	0	0	0	0	2	15	0	6	0	0	0	0	23	Fail	APPROVED
159	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
160	0	0	0	0	3	2	0	0	18	0	5	0	0	28	Pass	APPROVED
162	0	0	0	0	2	1	0	0	9	0	0	0	0	12	Fail	APPROVED
163	0	0	0	0	4	2	0	0	15	0	0	0	0	21	Fail	DENIED
164	0	0	0	0	0	0	15	16	0	0	0	0	0	31	Pass	APPROVED
165	0	0	0	0	7	0	0	4	0	5	5	0	4	25	Fail	APPROVED
166	0	0	0	0	4	2	0	0	0	0	0	0	0	6	Fail	DENIED
168	0	0	0	0	0	2	10	0	6	0	0	0	0	18	Fail	APPROVED
169	0	0	0	0	7	0	0	12	0	5	5	0	0	29	Pass	APPROVED
173	0	0	0	0	1	0	0	0	6	5	0	2	0	14	Fail	APPROVED
174	0	0	0	0	4	3	0	0	3	5	5	0	0	20	Fail	DENIED
178	0	0	0	0	2	0	0	16	9	0	0	0	0	27	Fail	APPROVED
181	0	0	0	0	4	2	0	0	6	0	5	0	0	17	Fail	APPROVED
183	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
185	0	0	0	0	2	2	0	0	6	0	5	0	0	15	Fail	DENIED
186	0	0	0	0	0	0	15	12	12	0	5	0	4	48	Pass	APPROVED
188	0	0	0	0	0	6	15	0	6	0	0	0	4	31	Pass	APPROVED
189	0	0	0	0	0	2	10	0	0	0	0	0	0	12	Fail	APPROVED
190	0	0	0	0	1	0	0	0	12	0	0	0	0	13	Fail	DENIED
191	0	0	0	0	7	0	0	4	15	0	0	3	4	33	Pass	DENIED
193	0	0	0	0	3	5	0	0	12	0	0	0	0	20	Fail	DENIED
195	0	0	0	0	2	0	0	8	0	0	0	0	0	10	Fail	DENIED
198	0	0	0	0	6	1	0	0	3	0	0	0	0	10	Fail	DENIED
199	0	0	0	0	3	0	0	4	15	0	5	3	0	30	Pass	APPROVED
200	0	0	0	0	3	5	0	0	0	5	5	2	0	20	Fail	DENIED
201	0	0	0	0	4	5	0	0	6	5	0	0	0	20	Fail	APPROVED
202	0	0	0	0	0	2	10	0	0	5	0	0	4	21	Fail	APPROVED
205	0	0	0	0	3	3	0	0	6	5	5	0	0	22	Fail	DENIED
206	0	0	0	0	0	3	25	0	0	0	0	0	0	28	Pass	APPROVED
208	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
209	0	0	0	0	2	3	0	0	12	0	0	0	0	17	Fail	APPROVED
210	0	0	0	0	1	1	0	0	0	0	0	0	0	2	Fail	APPROVED
211	0	0	0	0	4	3	0	0	6	0	0	0	0	13	Fail	DENIED
212	0	0	0	0	5	0	0	8	0	5	5	0	0	23	Fail	APPROVED
213	0	0	0	0	2	0	0	12	18	0	0	0	4	36	Pass	APPROVED
215	0	0	0	0	2	4	0	0	0	0	0	0	0	6	Fail	DENIED

APPENDIX C (continued)

216	0	0	0	0	4	2	0	0	9	0	5	0	0	20	Fail	DENIED
217	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
218	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
220	0	0	0	0	1	1	0	0	12	0	0	0	0	14	Fail	APPROVED
221	0	0	0	0	2	3	0	0	15	0	0	7	0	27	Fail	DENIED
223	0	0	0	0	2	1	0	0	12	0	0	0	0	15	Fail	DENIED
225	0	0	0	0	2	2	0	0	18	0	0	0	0	22	Fail	APPROVED
226	0	0	0	0	1	0	0	8	18	0	0	0	0	27	Fail	DENIED
227	0	0	0	0	7	2	0	0	18	0	0	0	0	27	Fail	DENIED
228	0	0	0	0	2	2	0	0	18	0	5	0	0	27	Fail	APPROVED
229	0	0	0	0	8	4	0	0	9	5	0	0	0	26	Fail	APPROVED
230	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
231	0	0	0	0	0	2	15	0	21	0	0	0	4	42	Pass	APPROVED
232	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
233	0	0	0	0	0	0	10	4	6	0	5	0	4	29	Pass	APPROVED
234	0	0	0	0	3	2	0	0	12	0	5	0	0	22	Fail	DENIED
237	0	0	0	0	0	1	10	0	15	0	0	0	4	30	Pass	APPROVED
241	0	0	0	0	3	2	0	0	12	5	0	0	0	22	Fail	APPROVED
242	0	0	0	0	2	2	0	0	12	0	0	0	0	16	Fail	DENIED
243	0	0	0	0	2	2	0	0	6	0	0	0	0	10	Fail	DENIED
244	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
246	0	0	0	0	1	0	0	24	0	0	0	0	0	25	Fail	APPROVED
247	0	0	0	0	3	4	0	0	18	0	0	0	4	29	Pass	APPROVED
248	0	0	0	0	4	3	0	0	15	0	0	0	0	22	Fail	DENIED
249	0	0	0	0	3	3	0	0	0	5	5	0	0	16	Fail	DENIED
250	0	0	0	0	2	2	0	0	12	0	5	0	0	21	Fail	DENIED
251	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
252	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
255	0	0	0	0	3	5	0	0	15	0	0	0	0	23	Fail	APPROVED
256	0	0	0	0	5	0	0	8	9	0	0	0	0	22	Fail	APPROVED
258	0	0	0	0	3	2	0	0	0	5	0	0	4	14	Fail	DENIED
260	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
264	0	0	0	0	2	3	0	0	3	0	5	0	0	13	Fail	DENIED
267	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
268	0	0	0	0	5	1	0	0	6	0	0	0	0	12	Fail	DENIED
270	0	0	0	0	1	0	0	4	12	0	0	0	4	21	Fail	APPROVED
271	0	0	0	0	0	1	25	0	9	0	5	0	4	44	Pass	APPROVED
274	0	0	0	0	2	2	0	0	6	0	0	0	0	10	Fail	DENIED
275	0	0	0	0	2	2	0	0	3	5	0	0	0	12	Fail	DENIED
276	0	0	0	0	3	0	0	24	0	0	0	0	0	27	Fail	APPROVED
277	0	0	0	0	3	2	0	0	6	0	0	0	0	11	Fail	DENIED
280	0	0	0	0	0	5	25	0	3	5	5	0	4	47	Pass	APPROVED
281	0	0	0	0	0	4	20	0	9	0	0	0	0	33	Pass	APPROVED
282	0	0	0	0	3	2	0	0	12	0	0	0	0	17	Fail	DENIED
283	0	0	0	0	0	0	5	8	3	0	0	0	0	16	Fail	APPROVED
285	0	0	0	0	5	2	0	0	9	5	0	0	0	21	Fail	DENIED
286	0	0	0	0	0	5	20	0	6	0	0	0	0	31	Pass	DENIED
287	0	0	0	0	2	5	0	0	12	0	5	0	0	24	Fail	APPROVED
288	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
289	0	0	0	0	6	2	0	0	9	0	0	0	0	17	Fail	DENIED
291	0	0	0	0	5	3	0	0	18	0	0	0	0	26	Fail	DENIED
297	0	0	0	0	3	0	15	0	9	0	0	0	0	27	Fail	APPROVED
298	0	0	0	0	3	4	0	0	6	0	0	0	0	13	Fail	DENIED
300	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
302	0	0	0	0	4	2	0	0	9	0	0	0	0	15	Fail	DENIED
303	0	0	0	0	2	2	0	0	6	0	0	0	0	10	Fail	DENIED
304	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
305	0	0	0	0	3	4	0	0	6	0	0	0	0	13	Fail	APPROVED
306	0	0	0	0	4	2	0	0	12	5	0	0	0	23	Fail	DENIED
307	0	0	0	0	2	2	0	0	12	0	0	0	0	16	Fail	DENIED
308	0	0	0	0	8	4	0	0	9	0	5	0	4	30	Pass	APPROVED
310	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
312	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
313	0	0	0	0	0	0	5	4	12	0	0	0	0	21	Fail	APPROVED
315	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
316	0	0	0	0	2	3	0	0	9	0	0	0	0	14	Fail	DENIED
317	0	0	0	0	2	1	0	0	6	0	5	0	0	14	Fail	DENIED
318	0	0	0	0	2	3	0	0	6	5	0	0	0	16	Fail	APPROVED

APPENDIX C (continued)

319	0	0	0	0	2	1	0	0	9	5	0	0	0	17	Fail	DENIED
320	0	0	0	0	4	2	0	0	6	0	0	0	0	12	Fail	DENIED
322	0	0	0	0	7	4	0	0	0	0	5	0	0	16	Fail	APPROVED
325	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
327	0	0	0	0	2	4	0	0	3	0	0	0	0	9	Fail	DENIED
328	0	0	0	0	2	2	0	0	9	0	0	0	0	13	Fail	DENIED
332	0	0	0	0	4	0	0	8	9	0	0	0	0	21	Fail	APPROVED
333	0	0	0	0	1	1	0	0	6	0	0	0	0	8	Fail	APPROVED
334	0	0	0	0	4	5	0	0	18	0	0	0	0	27	Fail	DENIED
335	0	0	0	0	2	4	0	0	18	0	0	0	0	24	Fail	DENIED
338	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
339	0	0	0	0	3	0	0	12	9	0	0	0	0	24	Fail	APPROVED
340	0	0	0	0	2	4	0	0	15	0	0	4	0	25	Fail	APPROVED
341	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
342	0	0	0	0	0	3	15	0	0	0	0	0	0	18	Fail	APPROVED
343	0	0	0	0	5	5	0	0	0	5	0	0	0	15	Fail	DENIED
344	0	0	0	0	2	3	0	0	6	0	0	0	0	11	Fail	DENIED
345	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
347	0	0	0	0	4	4	0	0	3	5	5	0	0	21	Fail	DENIED
348	0	0	0	1	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
351	0	0	0	0	5	4	0	0	12	0	5	0	0	26	Fail	DENIED
353	0	0	0	0	0	1	10	0	15	0	5	0	4	35	Pass	APPROVED
354	0	0	0	0	1	2	0	0	12	0	0	0	0	15	Fail	DENIED
355	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
356	0	0	0	0	2	4	0	0	3	0	0	0	0	9	Fail	DENIED
357	0	0	0	0	3	0	0	4	0	0	0	0	0	7	Fail	APPROVED
358	0	0	0	0	2	2	0	0	0	0	0	4	0	8	Fail	DENIED
359	0	0	0	0	0	2	5	0	0	0	0	0	0	7	Fail	APPROVED
362	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
363	0	0	0	0	2	2	0	0	3	0	0	0	0	7	Fail	DENIED
364	0	0	0	0	6	2	0	0	0	0	0	0	0	8	Fail	DENIED
369	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
370	0	0	0	0	0	2	20	0	0	5	0	0	0	27	Fail	APPROVED
371	0	0	0	0	0	4	20	0	0	0	0	0	0	24	Fail	APPROVED
374	0	0	0	0	3	3	0	0	6	5	0	0	0	17	Fail	DENIED
375	0	0	0	0	0	0	5	0	0	5	0	2	4	16	Fail	DENIED
379	0	0	0	0	6	5	0	0	0	5	0	0	0	16	Fail	DENIED
380	0	0	0	0	8	4	0	0	0	5	0	0	0	17	Fail	DENIED
381	0	0	0	0	0	1	5	0	0	0	0	0	0	6	Fail	APPROVED
383	0	0	0	0	7	5	0	0	3	0	0	0	0	15	Fail	APPROVED
384	0	0	0	0	4	3	0	0	9	5	0	0	0	21	Fail	DENIED
385	0	0	0	0	2	1	0	0	9	0	0	0	0	12	Fail	DENIED
386	0	0	0	0	3	2	0	0	9	0	0	4	4	22	Fail	APPROVED
387	0	0	0	0	3	3	0	0	18	0	0	0	0	24	Fail	APPROVED
388	0	0	0	0	4	2	0	0	6	5	0	4	0	21	Fail	DENIED
389	0	0	0	0	0	1	25	0	0	0	0	0	0	26	Fail	APPROVED
390	0	0	0	0	4	2	0	0	12	0	0	0	0	18	Fail	DENIED
391	0	0	0	0	3	2	0	0	6	0	0	0	0	11	Fail	DENIED
392	0	0	0	0	2	2	0	0	9	0	5	0	0	18	Fail	APPROVED
393	0	0	0	0	3	4	0	0	12	0	0	0	0	19	Fail	DENIED
396	0	0	0	0	2	1	0	0	3	5	0	0	0	11	Fail	DENIED
397	0	0	0	0	3	1	0	0	24	0	0	0	0	28	Pass	DENIED
399	0	0	0	0	2	2	0	0	3	0	0	0	4	11	Fail	APPROVED
400	0	0	0	0	0	0	25	28	0	5	5	0	0	63	Pass	DENIED
401	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
404	0	0	0	0	0	0	20	16	0	5	0	0	0	41	Pass	APPROVED
406	0	0	0	0	1	0	0	20	6	0	0	0	0	27	Fail	DENIED
408	0	0	0	0	2	4	0	0	3	0	5	0	4	18	Fail	DENIED
409	0	0	0	0	2	2	0	0	3	0	5	0	0	12	Fail	DENIED
410	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
411	0	0	0	0	6	3	0	0	15	0	0	3	0	27	Fail	APPROVED
412	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
413	0	0	0	0	4	3	0	0	0	0	0	0	0	7	Fail	DENIED
415	0	0	0	0	4	2	0	0	3	5	0	0	0	14	Fail	APPROVED
418	0	0	0	0	2	4	0	0	0	0	5	6	0	17	Fail	DENIED
420	0	0	0	0	3	3	0	0	6	0	0	0	0	12	Fail	DENIED
424	0	0	0	0	7	0	0	4	3	0	5	6	0	25	Fail	APPROVED
428	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED

APPENDIX C (continued)

435	0	0	0	0	2	1	0	0	0	5	0	0	0	8	Fail	DENIED
436	0	0	0	0	0	1	5	0	0	5	5	0	4	20	Fail	APPROVED
439	0	0	0	0	5	4	0	0	3	0	0	4	0	16	Fail	DENIED
441	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
443	0	0	0	0	0	2	15	0	0	0	0	0	0	17	Fail	APPROVED
445	0	0	0	0	2	2	0	0	0	5	0	0	0	9	Fail	APPROVED
446	0	0	0	0	5	2	0	0	0	0	0	0	0	7	Fail	DENIED
447	0	0	0	0	1	1	0	0	6	0	5	6	0	19	Fail	APPROVED
449	0	0	0	0	3	1	0	0	6	5	5	0	0	20	Fail	APPROVED
450	0	0	0	0	2	2	0	0	0	0	0	0	0	4	Fail	DENIED
452	0	0	0	0	2	3	0	0	3	0	5	5	4	22	Fail	APPROVED
453	0	0	0	0	0	0	0	0	12	0	5	6	4	27	Fail	APPROVED
454	0	0	0	0	4	2	0	0	12	0	0	0	0	18	Fail	APPROVED
456	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
457	0	0	0	0	2	5	0	0	6	0	5	0	0	18	Fail	DENIED
460	0	0	0	0	4	4	0	0	0	0	0	0	0	8	Fail	DENIED
463	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
465	0	0	0	0	0	0	10	4	15	0	0	0	4	33	Pass	APPROVED
467	0	0	0	0	4	3	0	0	6	0	0	0	0	13	Fail	DENIED
469	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
473	0	0	0	0	2	2	0	0	15	0	0	0	0	19	Fail	APPROVED
474	0	0	0	0	4	2	0	0	0	0	0	0	0	6	Fail	DENIED
475	0	0	0	0	3	2	0	0	3	0	0	0	0	8	Fail	DENIED
476	0	0	0	0	2	0	25	0	0	0	0	0	0	27	Fail	APPROVED
479	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
480	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
483	0	0	0	0	7	3	0	0	6	5	0	0	0	21	Fail	APPROVED
485	0	0	0	0	1	1	0	0	3	0	0	0	0	5	Fail	APPROVED
490	0	0	0	1	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
492	0	0	0	0	3	2	0	0	0	5	5	0	0	15	Fail	DENIED
493	0	0	0	0	2	3	0	0	0	5	5	0	0	15	Fail	DENIED
497	0	0	0	0	4	2	0	0	6	0	5	0	0	17	Fail	DENIED
499	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
501	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
504	0	0	0	0	2	2	0	0	18	0	0	0	0	22	Fail	APPROVED
506	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
507	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
510	0	0	0	0	3	4	0	0	6	0	0	0	0	13	Fail	DENIED
511	0	0	0	0	0	2	25	0	6	0	0	0	0	33	Pass	APPROVED
512	0	0	0	0	7	2	0	0	12	0	0	5	0	26	Fail	APPROVED
514	0	0	0	0	0	2	15	0	0	0	0	0	0	17	Fail	APPROVED
515	0	0	0	0	0	4	20	0	0	5	0	0	0	29	Pass	APPROVED
518	0	0	0	0	4	1	0	0	24	0	0	0	0	29	Pass	DENIED
524	0	0	0	0	0	0	0	0	6	5	5	0	4	20	Fail	DENIED
525	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
528	0	0	0	0	3	3	0	0	12	5	0	0	4	27	Fail	DENIED
529	0	0	0	0	2	3	0	0	18	0	0	0	0	23	Fail	DENIED
530	0	0	0	0	7	2	0	0	15	0	0	0	0	24	Fail	DENIED
531	0	0	0	0	2	3	0	0	0	5	5	0	0	15	Fail	DENIED
532	0	0	0	0	1	1	0	0	3	5	0	0	0	10	Fail	APPROVED
533	0	0	0	0	1	0	0	2	6	0	0	0	4	13	Fail	APPROVED
536	0	0	0	0	7	0	0	4	12	0	0	0	0	23	Fail	APPROVED
537	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
538	0	0	0	0	2	3	0	0	3	0	0	1	0	9	Fail	DENIED
541	0	0	0	0	1	1	0	0	0	5	0	0	4	11	Fail	APPROVED
542	0	0	0	0	0	5	25	0	0	0	5	0	0	35	Pass	APPROVED
544	0	0	0	0	0	0	15	4	9	0	5	0	0	33	Pass	APPROVED
545	0	0	0	0	6	2	0	0	12	0	5	0	4	29	Pass	APPROVED
546	0	0	0	0	0	2	25	0	6	0	0	0	0	33	Pass	APPROVED
547	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
549	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
554	0	0	0	0	4	4	0	0	6	0	5	0	0	19	Fail	APPROVED
555	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
556	0	0	0	0	1	0	0	8	0	0	0	0	4	13	Fail	APPROVED
557	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
565	0	0	0	0	2	1	0	0	0	0	0	0	4	7	Fail	DENIED
568	0	0	0	0	6	5	0	0	0	5	0	0	0	16	Fail	APPROVED
569	0	0	0	0	2	1	0	0	3	0	0	0	0	6	Fail	DENIED

APPENDIX C (continued)

570	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
572	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
573	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
574	0	0	0	0	0	3	30	0	0	0	0	0	4	37	Pass	APPROVED
575	0	0	0	0	4	1	0	0	15	0	5	0	4	29	Pass	APPROVED
577	0	0	0	0	5	2	0	0	0	5	5	0	4	21	Fail	DENIED
578	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
579	0	0	0	0	8	2	0	0	6	5	0	0	0	21	Fail	DENIED
581	0	0	0	0	0	2	15	0	0	5	5	0	4	31	Pass	APPROVED
584	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
585	0	0	0	0	2	4	0	0	6	5	0	0	0	17	Fail	APPROVED
586	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
588	0	0	0	0	5	4	0	0	0	5	5	0	0	19	Fail	DENIED
597	0	0	0	0	0	0	15	12	9	0	5	0	0	41	Pass	APPROVED
598	0	0	0	0	0	0	0	0	6	0	5	0	0	11	Fail	APPROVED
600	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
602	0	0	0	0	0	4	15	0	0	5	0	0	0	24	Fail	APPROVED
608	0	0	0	0	0	1	5	0	0	5	5	0	0	16	Fail	DENIED
610	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
618	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
619	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
621	0	0	0	0	0	0	20	24	0	0	5	0	0	49	Pass	APPROVED
623	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
624	0	0	0	0	4	1	0	0	0	0	0	0	0	5	Fail	DENIED
625	0	0	0	0	4	2	0	0	0	0	0	0	0	6	Fail	DENIED
626	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
628	0	0	0	0	7	0	0	4	9	0	0	0	0	20	Fail	DENIED
632	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
633	0	0	0	0	0	7	25	0	6	0	0	0	4	42	Pass	APPROVED
634	0	0	0	0	7	4	0	0	12	0	0	0	0	23	Fail	APPROVED
635	0	0	0	0	2	2	0	0	0	5	0	0	0	9	Fail	DENIED
636	0	0	0	0	1	1	0	0	0	0	0	0	4	6	Fail	DENIED
637	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
638	0	0	0	0	2	0	0	16	0	0	0	0	0	18	Fail	DENIED
640	0	0	0	0	1	1	0	0	15	0	5	0	0	22	Fail	DENIED
643	0	0	0	0	2	3	0	0	6	0	0	0	0	11	Fail	DENIED
644	0	0	0	0	3	2	0	0	9	0	0	0	0	14	Fail	DENIED
645	0	0	0	0	2	2	0	0	3	5	0	0	0	12	Fail	APPROVED
646	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
648	0	0	0	0	1	0	20	0	9	0	5	0	4	39	Pass	APPROVED
650	0	0	0	0	2	0	0	2	9	0	5	0	4	22	Fail	APPROVED
651	1	0	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
654	0	0	0	0	5	4	0	0	0	0	0	0	4	13	Fail	DENIED
655	0	0	0	0	8	4	0	0	12	5	0	0	4	33	Pass	DENIED
661	0	0	0	0	0	5	20	0	3	0	0	0	0	28	Pass	APPROVED
663	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	DENIED
664	0	0	0	0	4	0	0	32	12	0	0	0	4	52	Pass	APPROVED
665	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
666	0	0	0	0	1	1	0	0	6	0	5	0	4	17	Fail	APPROVED
667	0	0	0	0	0	3	20	0	0	5	5	0	0	33	Pass	DENIED
670	0	0	0	0	2	2	0	0	0	5	5	0	0	14	Fail	DENIED
699	0	0	0	0	7	2	0	0	0	5	5	0	4	23	Fail	APPROVED
708	0	0	0	0	10	5	0	0	15	0	5	0	0	35	Pass	APPROVED
711	0	0	0	0	0	0	0	0	9	0	5	0	0	14	Fail	APPROVED
712	0	0	1	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
714	0	0	0	0	0	5	25	0	0	0	0	0	4	34	Pass	APPROVED
717	0	0	0	0	7	4	0	0	0	5	5	0	0	21	Fail	DENIED
718	0	0	0	0	4	1	0	0	6	0	5	0	0	16	Fail	DENIED
719	0	0	0	0	2	2	0	0	0	0	0	0	0	4	Fail	APPROVED
720	0	0	0	0	2	2	0	0	3	0	0	0	0	7	Fail	DENIED
721	0	0	0	0	10	1	0	0	12	0	5	0	0	28	Pass	DENIED
722	0	0	0	0	5	1	0	0	9	0	5	0	0	20	Fail	DENIED
723	0	0	0	0	4	4	0	0	0	0	5	0	0	13	Fail	DENIED
736	0	0	0	0	1	1	0	0	12	0	0	0	4	18	Fail	APPROVED
737	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
738	0	1	0	0	0	0	0	0	0	0	0	0	0	A Pass	Pass	APPROVED
739	0	0	0	0	5	0	0	8	0	0	0	0	0	13	Fail	DENIED

VITA

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University of Illinois, Chicago, IL, Certificate, Orthodontics, May 2020

University of Illinois, Chicago, IL, D.D.S., May 2017

B.D.S., College of Dentistry University of Baghdad, Baghdad, Iraq, 2006

AWARD: Best Resident Clinical/CTS" award at the UIC-COD clinic and research day event on March 5th, 2020.

Frances Best Watkins Award at the UIC-COD event on May 3rd, 2017.

PROFESSIONAL: American Association of Orthodontists, 2017-present

MEMBERSHIPS: Illinois Society of Orthodontists, 2017-present

American Dental Association, 2015-present

Chicago Dental Society, 2015-present