SELECTING SUCCESSFUL RPD ABUTMENTS: CROWN TO ROOT RATIO

7B-5

NOVEMBER 18TH, 2020

ROUNDS TEAM

- **Group Leader: Dr. Rossi**
- **Specialty Leader: Dr. Chien**
- **Project Team Leader: Maggie Mueller**
- **Project Team Participants: Elbethel Defare, Kelsi Salzwedel, Jessica Wertz**

PATIENT: REZIQ

- 57 year old male
- CC: "I like my partial."

MEDICAL HISTORY

Significant for:

- Type II Diabetes – well managed
  - Patient takes his blood glucose daily
  - Last HbA1c was 6.8 in June
- Kidney stone removal - 2019

MEDICAL HISTORY

Medications:

- Metformin
- Glipizide
- Aspirin (81 mg)
- Vitamin D
- Potassium

DENTAL HISTORY

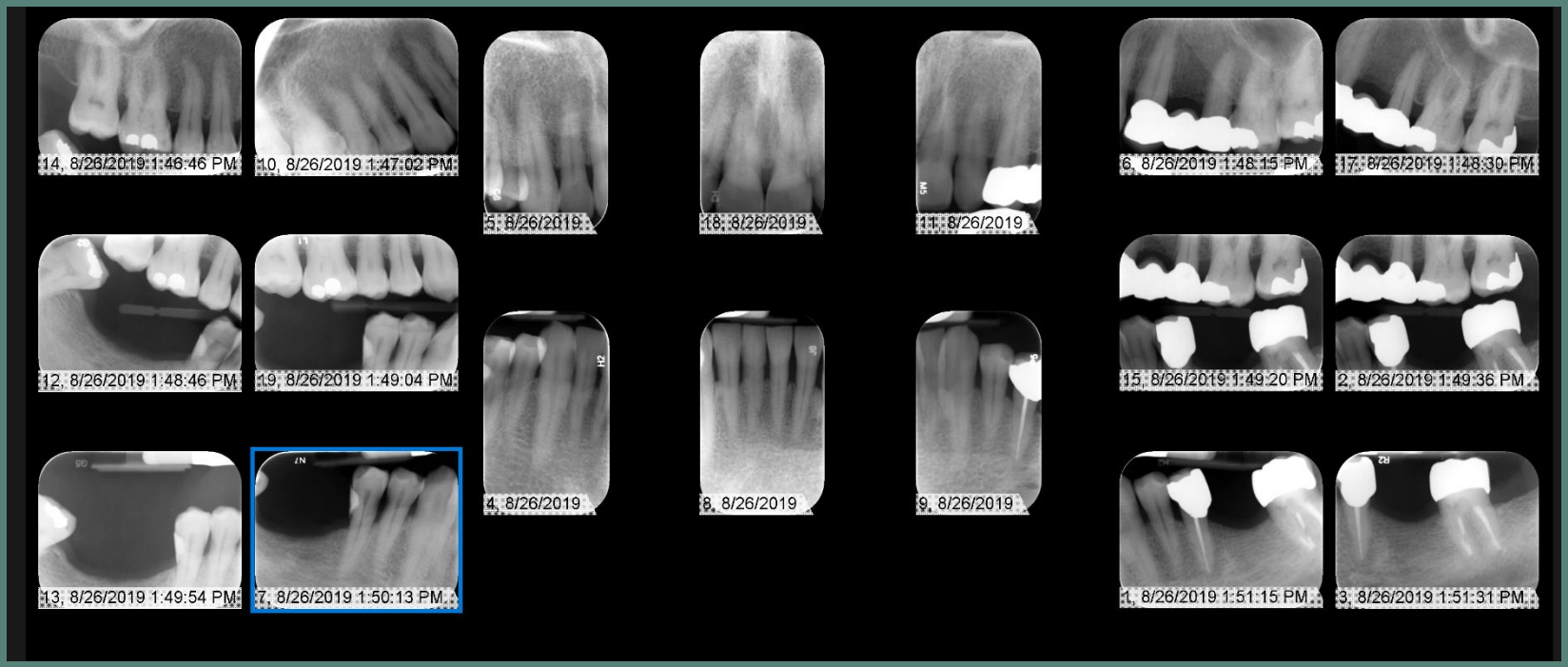
- Partial maxillary dentition (#12 missing)
- Partial mandibular dentition (#'s 19, 30, 31 missing)
- Previous History of Tx:
  - Restorative
  - Endo (#12, #20, #18 done before patient came to Marquette)
  - Fixed Pros –
    - Bridge #11-13
    - Crowns (#18, #20)
  - Extractions (#1, 12, 16, 17, 19, 30, 31)
- Removable Partial Denture
  - Class III Mod 1

CLINICAL PHOTOS

CLINICAL PHOTOS

CLINICAL PHOTOS

FMX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BW OF LOWER RIGHT

PA OF LOWER RIGHT

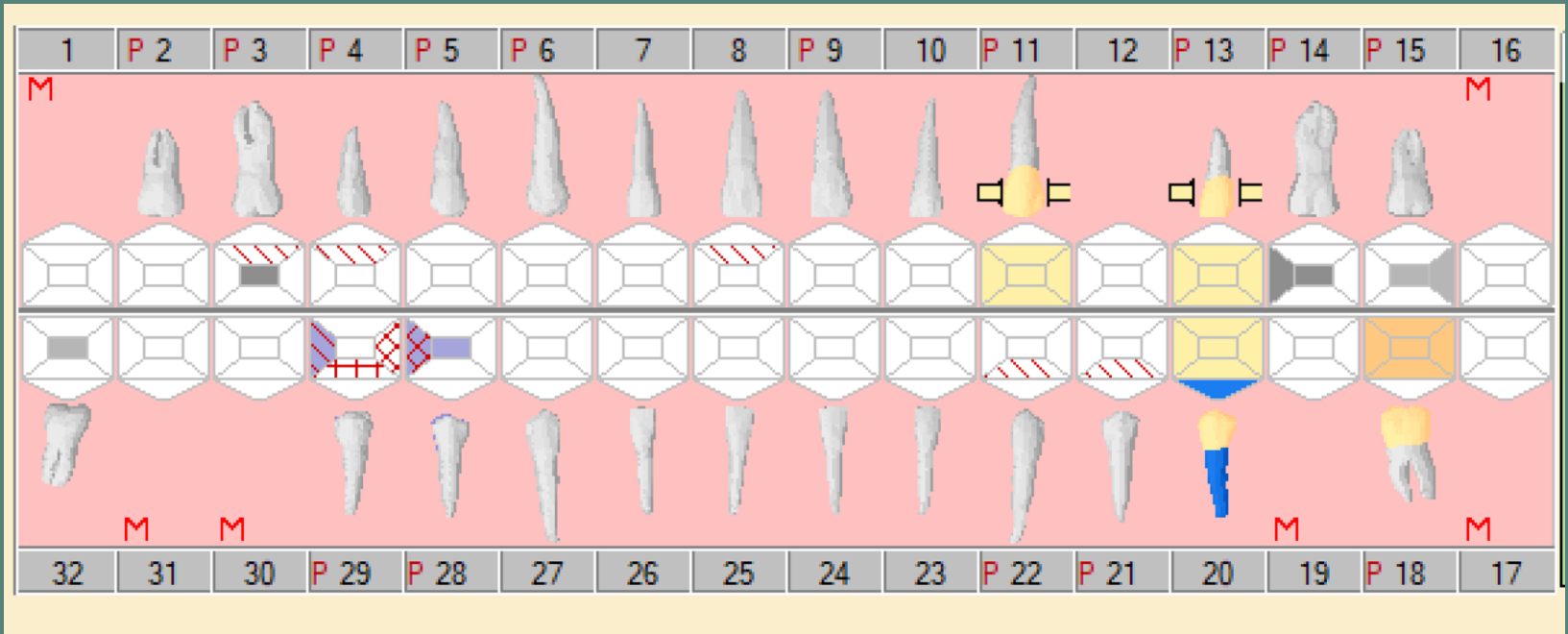
RADIOGRAPHIC FINDINGS

- Primary caries – Mesial of #29
- Recurrent caries – Distal of #28
- Overhanging margins – Distal of #15
- Partially obturated #18
- Moderate generalized bone loss

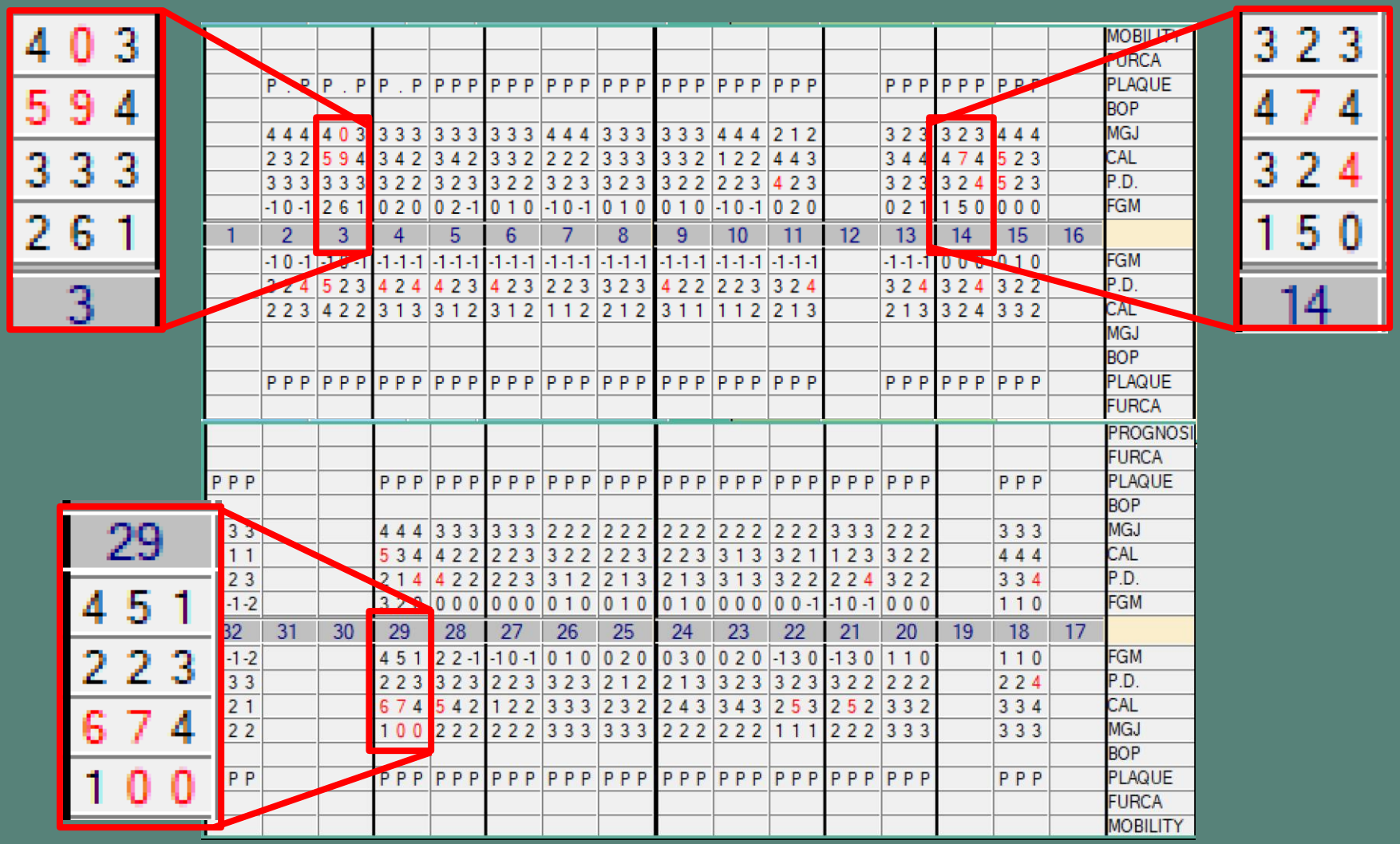
CLINICAL FINDINGS

- Primary caries – Mesial #29
- Recurrent caries – Distal #28
- Defective restoration Distal #28
- Non-carious cervical lesions – #'s 3, 4, 8, 21, 22, 29
- Perio: CAL up to 9 mm on #3, 7 mm on #14, and 7 mm on #29
  - With insufficient attached tissue on buccal of #3 and #29

UPDATED ODONTOGRAM



PERIODONTAL CHARTING



DIAGNOSIS

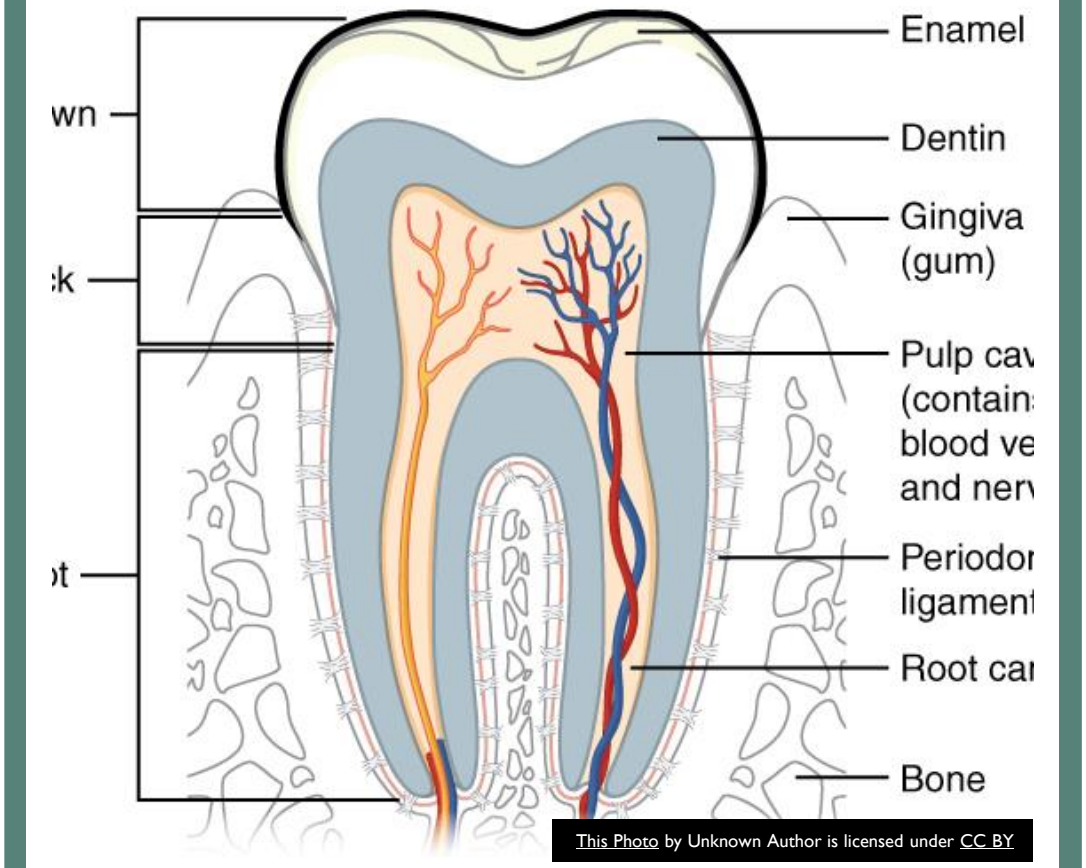
- Dental caries: #28, 29
- Invasion of biological width #28, 29
- Perio diagnosis: Stage III, Grade B localized periodontitis
  - Mucogingival insufficiencies on #3, 14, 20, and 29
  - Clinical attachment loss via generalized recession but particularly on #3, 4, 5, 13, and 14.
  - Treatment plan of connective tissue graft for #3 with a coronally positioned flap at #4 and #5, connective tissue grafts for #14, 21, 22, 24, and a free gingival graft for #29.

PROBLEM LIST

- Caries
- Defective restoration
- Missing teeth
- Perio disease
- Home care

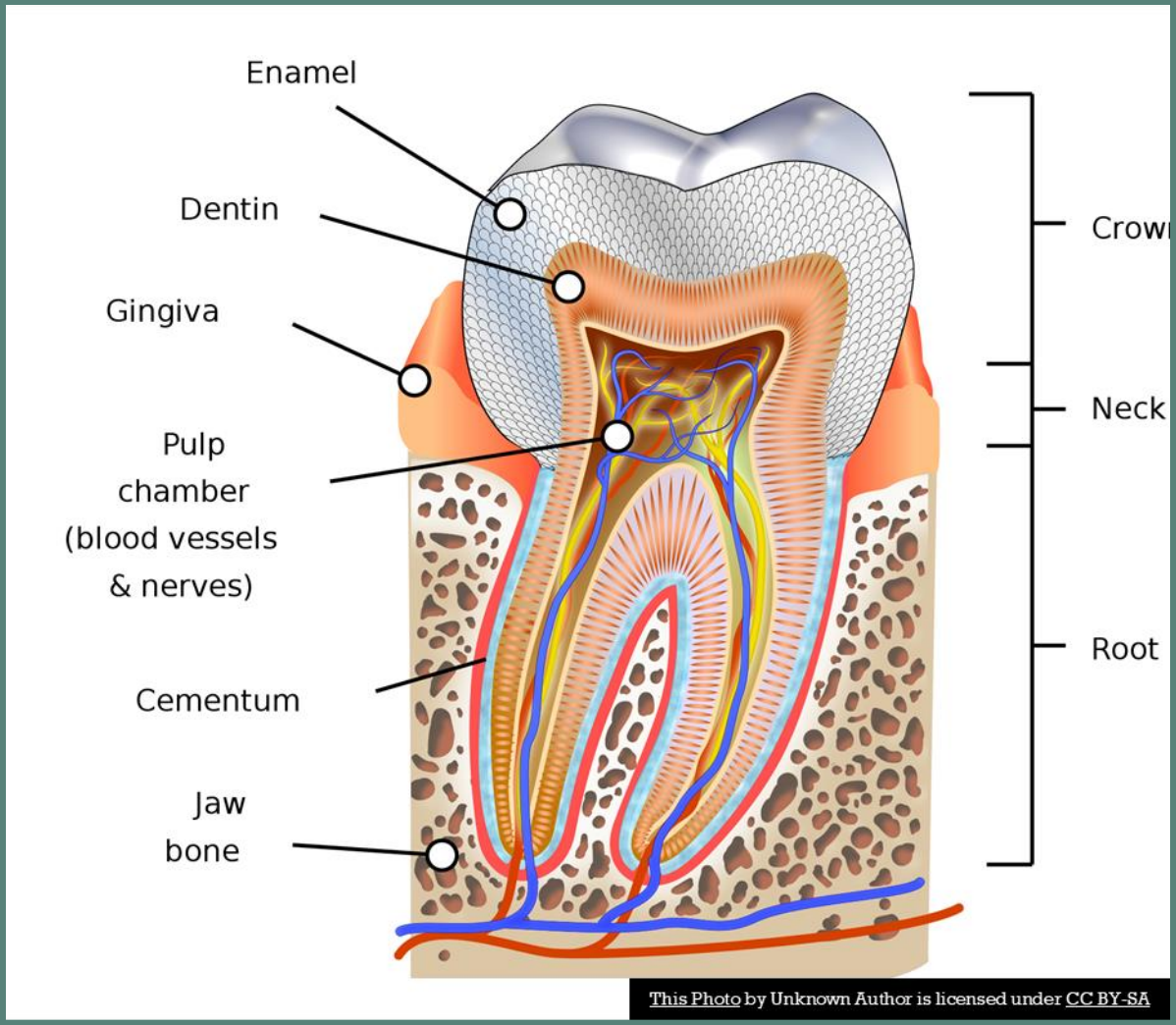
D1 BASIC SCIENCE: WHAT IS THE ANATOMY OF A TOOTH?

- *Anatomical crown*
- *Clinical crown*
- *Anatomical root*
- *Clinical root*
- *Root apex*
- *Apical foramen*
- *Enamel*
- *Dentin*
- *Cementum*

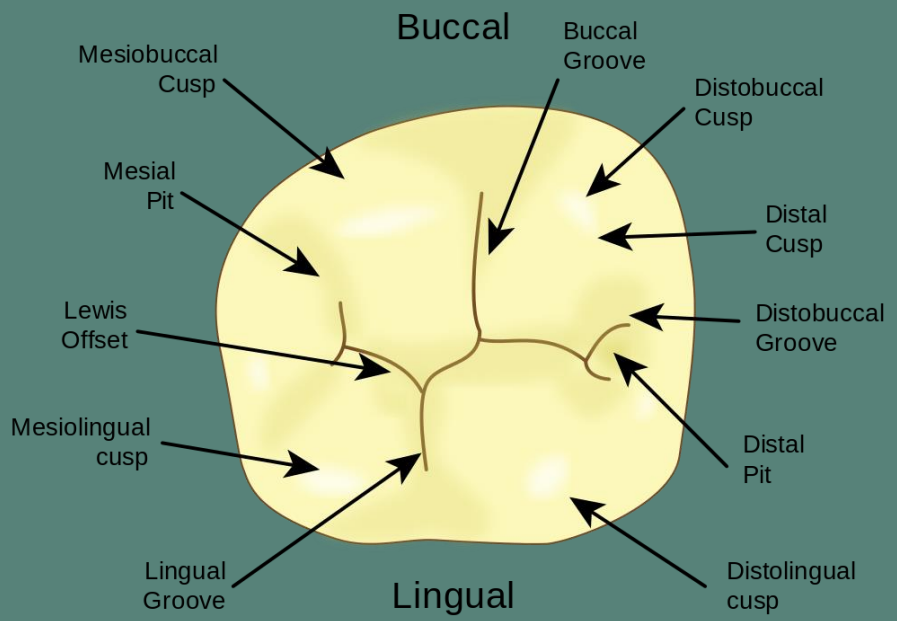


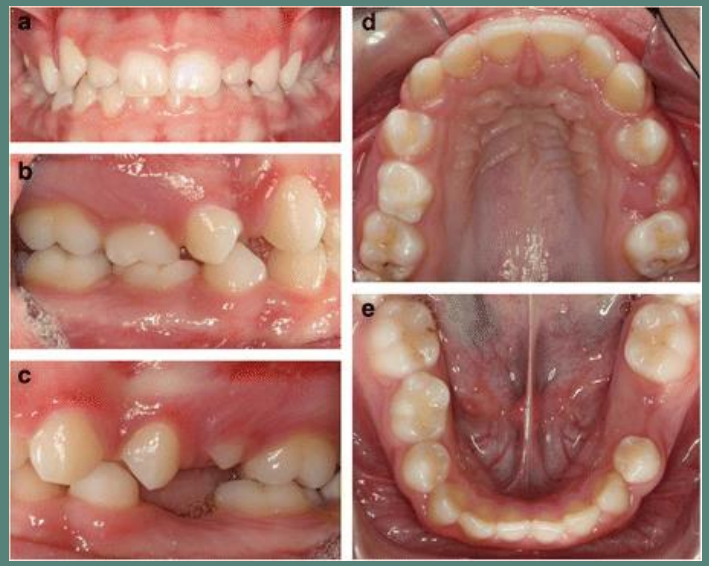
D1 BASIC SCIENCE: WHAT IS THE ANATOMY OF A TOOTH?

- Alveolar process
- Alveolar bone
- Gingiva
- Periodontal ligament



- Mesial surface
- Distal surface
- Labial/Buccal surface
- Lingual surface

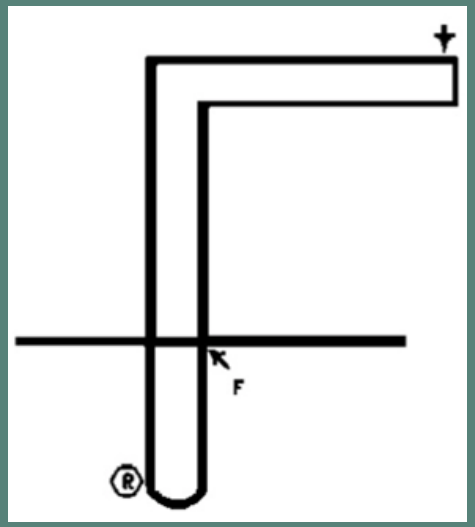


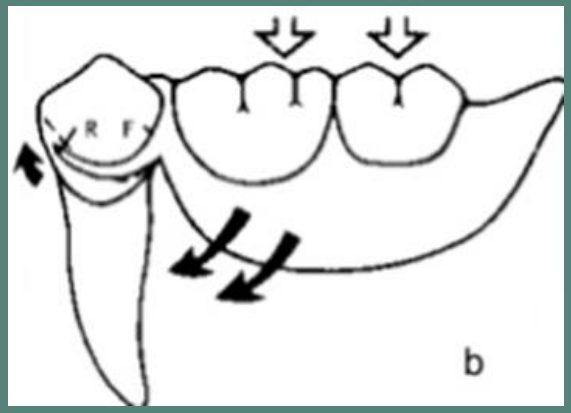


- Marginal ridges
- Triangular ridges
- Transverse ridges
- Oblique ridge
- Primary grooves
- Secondary grooves

D2 PATHOLOGY: WHAT DIRECTIONAL FORCES ARE DESTRUCTIVE TO AN RPD ABUTMENT?

- An RPD undergoes multiple stress types during function
- Cantilever forces are destructive to the abutment tooth
- A cantilever is a structure that is supported on one end and extends horizontally = distal extension of an RPD

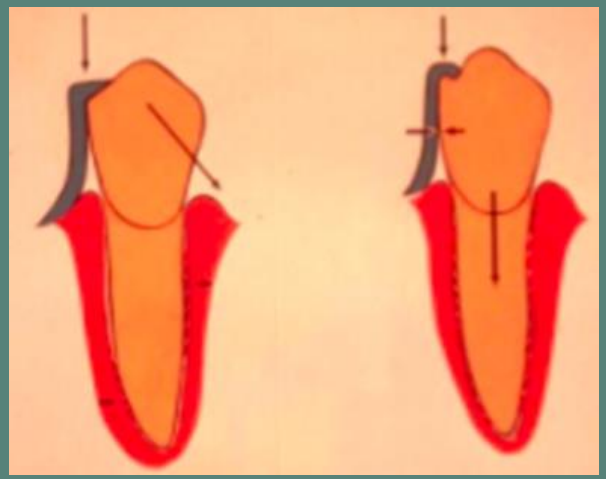




Kreyer, R. (2015, October). Biomechanics of Removable Partial Dentures. Retrieved November 10, 2020, from https://idt.cdeworld.com/courses/4965-biomechanics-of-removable-partial-dentures
Photos from: https://www.slideshare.net/AmalKaddah/02-forces-acting-on-rpd-134384074

D2 PATHOLOGY: WHAT DIRECTIONAL FORCES ARE DESTRUCTIVE TO AN RPD ABUTMENT?

- Support from the teeth and the edentulous ridge are not equal under occlusal loading
- Problem: class I lever forces = extraction forces on abutment
  - Goal: class III lever forces
  - Achieved by: using a stress releasing clasp
- Problem: B/L forces = orthodontic-like movement
  - Goal: apically directed forces
  - Achieved by: a positive rest seat to direct forces apically



Hussain, K., Azzeghaibi, S., Tarakji, B., Rajan, S., Sirajuddin, S., & Prabhu, S. (2015, June 26). Iatrogenic Damage to the Periodontium Caused by Removable Prosthodontic Treatment Procedures: An Overview. Retrieved November 10, 2020, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4541304/
Photo from: https://www.slideshare.net/DentistSaidFada/05-rests-rest-seats

D3 PICO

- **Clinical Question:**

- What is the minimum crown to root ratio for an RPD abutment?

PICO FORMAT

P: Removable partial denture abutment teeth

I: The clinically accepted crown to root ratio (~1:1)

C: Crown to root ratios that deviate from the clinically accepted ratio

O: Significantly better prognosis

PICO FORMATTED QUESTION

For removable partial dentures, does the clinically accepted crown to root ratio of 1 to 1 have a significantly better prognosis than an abutment that deviates from this ratio?

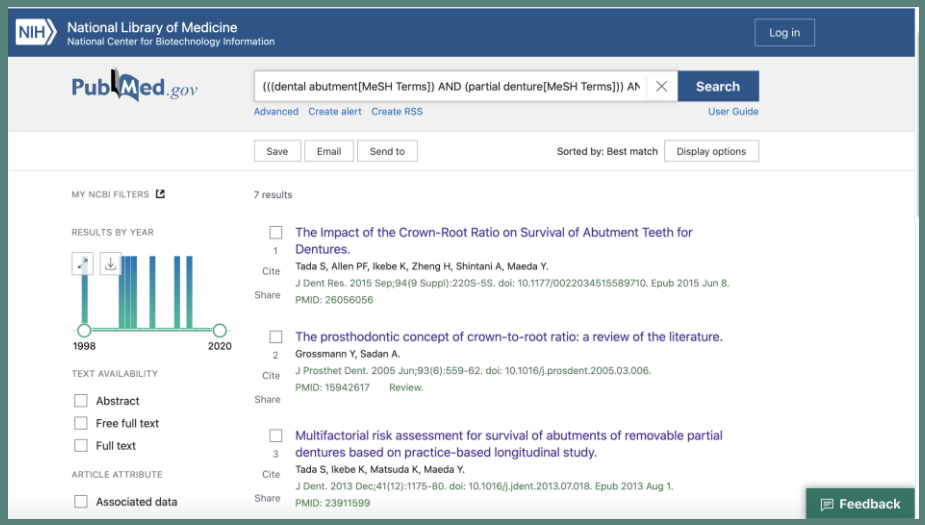
CLINICAL BOTTOM LINE

- When treatment planning for an RPD case with an abutment tooth that has a crown to root ratio that is less than the clinically accepted 1:1, is it advantageous to extract and utilize the adjacent tooth as the abutment?
- For this patient case, tooth #29 has a CRR of 1.13:1 and tooth #28 has a CRR of 1:1.26. Due to decay and restoration extent, crown lengthening would be required to reestablish biologic width. This would result in CRR of 1.63 to 1 for #29 and 1.29 to 1 for #28. These crown to root ratios deviate from the clinically accepted.

SEARCH BACKGROUND

MESH Terms :

- Dental abutments
- Denture, partial
- Prognosis
- Tooth Crown/anatomy & histology
- Tooth root/anatomy & histology



ARTICLE 1:

JDR Clinical Research Supplement September 2015

CLINICAL INVESTIGATIONS

The Impact of the Crown-Root Ratio on Survival of Abutment Teeth for Dentures

S. Tada[1]*, P.F. Allen[2], K. Ikebe[1], H. Zheng[3], A. Shintani[3], and Y. Maeda[1]

Abstract: *Crown-root ratio (CRR) is commonly recorded when planning prosthodontic procedures. However, there is a lack of longitudinal clinical data evaluating the association between CRR and tooth survival. The aim of this longitudinal practice-based study was to assess the impact of CRR on the survival of abutment teeth for removable partial dentures (RPDs). Data were collected from 147 patients provided with RPDs at a dental hospital in Japan. In total, 236 clasp-retained RPDs and 856 abutment teeth were analyzed. Survival of abutment teeth was assessed using Kaplan-Meier methods and Cox's proportional hazard (PH) regression. The Cox PH regression was used to assess the prognostic significance of initial CRR value with adjustments for clinically relevant similar and favorable. The multivariable analysis treating CRR as a continuous variable allowed estimation of the hazard ratio at any specific CRR value. When CRR = 0.80 was set as a reference, the estimated hazard ratio was 0.58 for CRR = 0.50 (95% confidence interval [CI], 0.36–0.91), 1.13 for CRR = 1.00 (95% CI, 0.93–1.37), 1.35 for CRR = 1.25 (95% CI, 1.02–1.80), 1.53 for CRR = 1.50 (95% CI, 1.15–2.08), or 1.95 for CRR = 2.00 (95% CI, 1.44–2.65). These practice-based longitudinal data provide information to improve the evidence-based prognosis of teeth in providing prosthodontic procedures.*

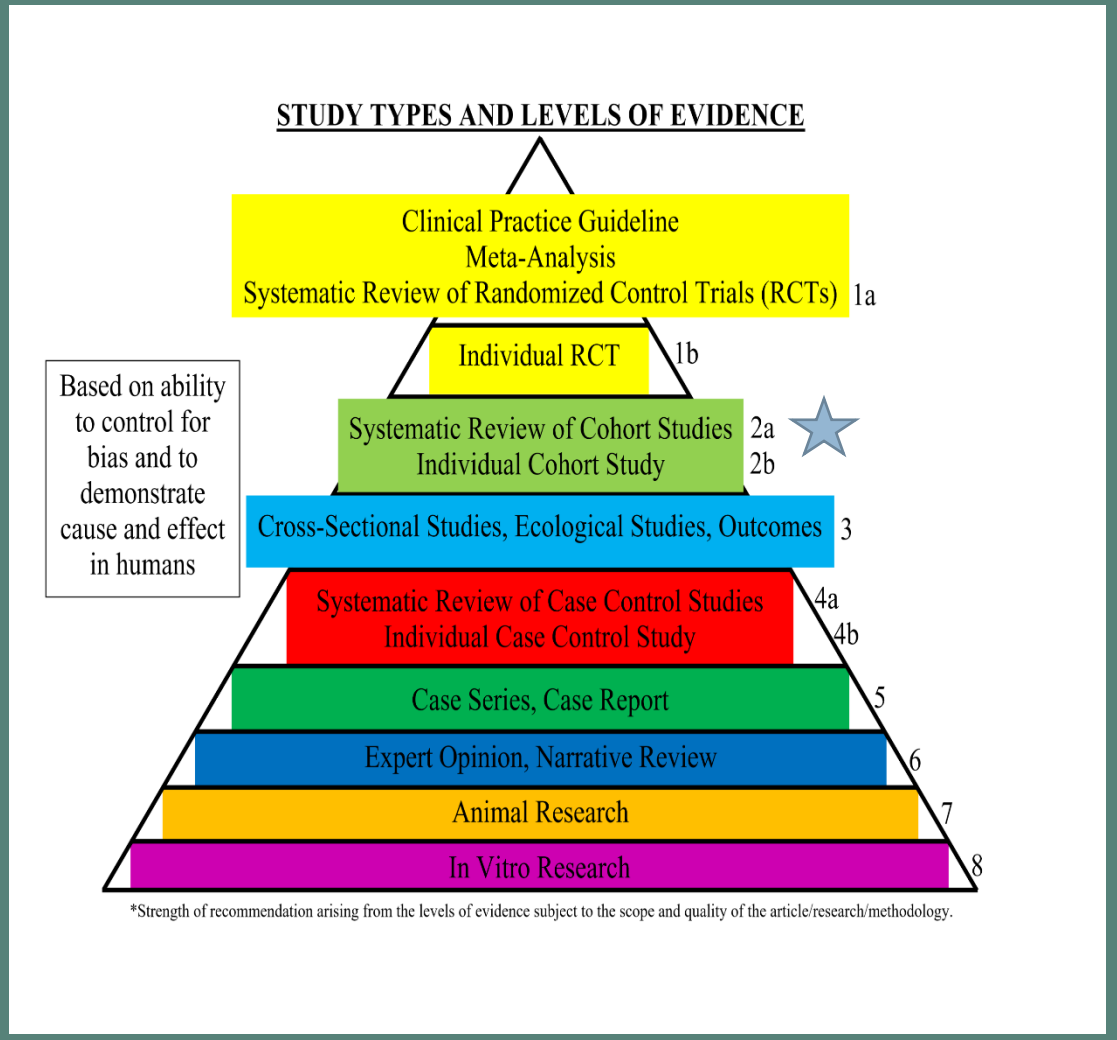
Key Words: removable prosthodontics, clinical outcome, prognosis, decision-

Glossary of Prosthodontic Terms 2005). Thus, the CRR is measured in relation to the alveolar bone support, which is quantified by dividing the length of the crown portion by length of the root portion (Grossmann and Sadan 2005; Schulte et al. 2007). Higher CRR indicates a tendency of a tooth losing some amounts of its bone support, and therefore it is less resistant to masticatory loads and lateral force transmitted in particular by removable partial dentures (RPDs) (Nyman and Lang 1994).

However, a literature review concluded that there was a lack of consensus for the prognostic value of CRR when planning for prostheses (Grossmann and Sadan 2005). One author suggested an ideal ratio of 1:2 (CRR = 0.5) with 1:1.5 (CRR = 0.67) considered acceptable

CHOICE OF ARTICLE 1

- Purpose:
  - Assess the impact of CRR on the survival of abutment teeth for removable partial dentures
- Study Design:
  - Longitudinal practice-based study/Individual cohort study



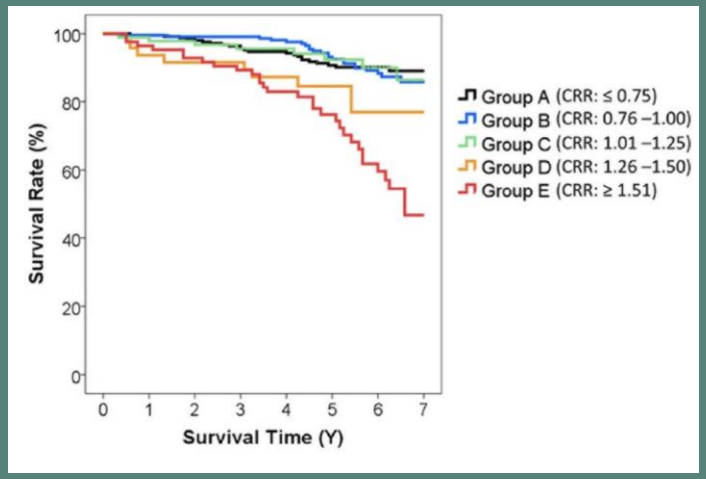
Citation: Tada S, Allen PF, Ikebe K, Zheng H, Shintani A, Maeda Y. The Impact of the Crown-Root Ratio on Survival of Abutment Teeth for Dentures. *J Dent Res*. 2015;94(9 Suppl):220S-5S. doi:10.1177/0022034515589710

ARTICLE 1 SYNOPSIS:

- Method: Data collected from 147 patients provided with RPDs at a dental hospital in Japan
  - 236 clasp-retained RPDs
  - 856 abutment teeth analyzed
  - Patients excluded if dentures were immediate RPDs and dentures with complex designs (Maxillofacial prostheses or attachment retained or lingual plate connected dentures) and patients who did not receive a conservative periodontal maintenance program at least once a year during the observational period
- Survival of abutment teeth assessed using Kaplan-Meier methods and Cox's proportional hazard regression
  - Adjustments made for clinically relevant factors including age, sex, frequency of periodontal maintenance programs, occlusal support area, type of abutment tooth, status of endodontic treatment, and probing pocket depth
- Abutment teeth were divided into 1 of 5 risk groups according to CRR
  - A (<0.75), B(0.76-1.00), C(1.01-1.25), D(1.26-1.50), E(>1.51)

ARTICLE 1 SYNOPSIS:

- Results:
  - 147 of the 236 RPDs met the inclusion criteria
  - The survival rates of groups A, B, and C were found to be similar and favorable
  - Groups D and E had poorer survival rates
  - Higher CRR was linked to a higher risk of abutment tooth loss and
- Conclusions:
  - A higher CRR was linked to a higher risk of abutment tooth loss among RPD wearers, but the survival outcomes between CRR = <0.75 to CRR =1.01-1.25 had preferable outcomes
- Limitations:
  - The patients were limited to those attending a university hospital and might therefore be a selective sample
  - Retrospective study = difficult to obtain complete data for all patients and some had to be excluded as a consequence



Survival curves of abutment teeth using Kaplan-Meier method. Abutment teeth were divided into 5 groups according to crown-root ratio (CRR): group A (≤0.75), group B (0.76–1.00), group C (1.01–1.25), group D (1.26–1.50), and group E (≥1.51).

ARTICLE 1 SELECTION:

- Reason for Selection:
  - This study looked at the long-term survival of abutment teeth with CRR that deviate from 1:1
  - Provides quantitative evidence to suggest the minimum ratio for abutment teeth under normal circumstances
- Applicability:
  - Directly applicable to determining the long-term prognosis of #29 and #28 as abutment teeth.
    - #29 CRR after the necessary crown lengthening = 1.63:1
      - This CRR would be classified as group E in this study, and would correlate with a significantly lower survival rate long term
    - #28 CRR after the necessary crown lengthening = 1.29:1
      - This would be classified as group D in this study and also have a lower survival rate long term

ARTICLE 2:

The prosthodontic concept of crown-to-root ratio: A review of the literature

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Case School of Dental Medicine, Case Western Reserve University, Cleveland, Ohio

Crown-to-root ratio is intended to serve as an aid in predicting the prognosis of teeth. However, controversy persists as to its impact on diagnosis and treatment planning. This article critically reviews the available literature on the crown-to-root ratio assessment and criteria for evaluation of abutment use of periodontally compromised teeth. A Medline search was completed for the time period from 1966 to 2003, along with a manual search, to locate relevant peer-reviewed articles and textbooks published in English. Key words used were "crown-to-root ratio," "periodontal compromised dentition," "mobility," and "biomechanics." There was a dearth of evidence-based research on the topic. Although the use of the crown-to-root ratio in addition to other clinical indices may offer the best clinical predictors, no definitive recommendations could be ascertained. (J Prosthet Dent 2005;93:559-62.)

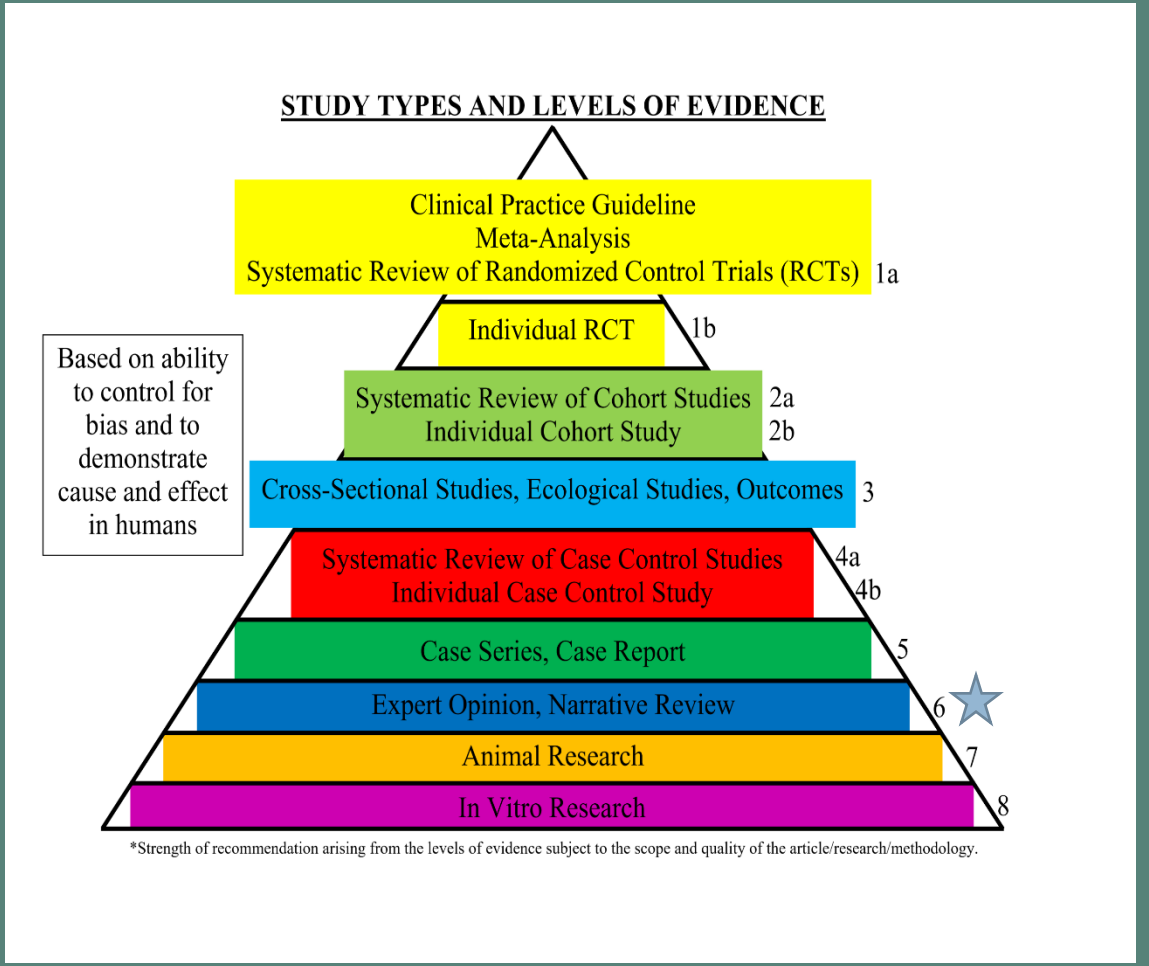
One of the most common, yet difficult clinical determinations is the prognosis of teeth that may serve as prosthetic abutments. With no definitive criteria to guide the clinician, the treatment plan is based, at best, on heuristic information and clinical experience. Because abutment teeth are subjected to higher than usual occlusal forces transmitted through the prosthesis, the clinician must evaluate the abutment teeth carefully. Some have attemped to establish objective standards for abutment evaluation[1,2] but have not presented evidence-based criteria. The crown-to-root ratio (CRR) is one of the primary variables in the evaluation of the suitability of a tooth as an abutment for a fixed or removable partial denture (FPD or RPD).[1-4] However, abutment mobility, alveolar bone support, root configuration and angulation, opposing occlusion, pulpal condition, presence of endodontic treatment, and the remaining tooth structure have also been cited as predictors for abutment longevity.[5-9]

This literature review investigates the assessment and

is defined as "the physical relationship between the portion of the tooth within the alveolar bone compared with the portion not within the alveolar bone, as determined radiographically."[10] The fulcrum, or center of rotation, of the Class I lever is in the middle portion of the root that is embedded in alveolar bone.[11,12] The CRR may increase over time, primarily as a result of loss of alveolar bone support; the crown portion of the fulcrum (effort arm) would then increase, and the root portion (resistance arm) would decrease. In addition, the center of rotation moves apically, and the tooth is more prone to the harmful effect of lateral forces.[2,6] Increasing the vertical dimension of occlusion to restore the dentition would also cause an increase in the CRR, without altering the root support. Therefore, some authors have suggested that teeth that may serve as abutments and be subjected to increased occlusal loads, such as in patients with extreme vertical overlap and bruxism, should be evaluated with other parameters as well as the measurement of CRR.[6,12]

CHOICE OF ARTICLE 2

- Purpose:
  - To analyze the controversy that persists as to the impact of crown-to-root ratio on diagnosis and treatment planning
- Study Design:
  - Literature review on the crown-to-root ratio assessment and criteria for evaluation of abutment use of periodontally compromised teeth



Citation: Grossmann Y, Sadan A. The prosthodontic concept of crown-to-root ratio: a review of the literature. *J Prosthet Dent*. 2005;93(6):559-562. doi:10.1016/j.prosdent.2005.03.006

ARTICLE 2 SYNOPSIS:

- Method:
  - A Medline search was completed for the time period from 1966 to 2003, along with a manual search to locate relevant peer-reviewed articles and textbooks

ARTICLE 2 SYNOPSIS:

- Results:
  - There is a lack of consensus and evidence-based research on the influence of CRR on diagnosis and treatment planning for periodontally compromised teeth
- Conclusions:
  - Clinical guideline for the evaluation of abutment teeth should include crown to root ratio only with other multiple clinical parameters
    - i.e. abutment mobility, total alveolar bone support, root configuration, opposing occlusion, presence of parafunctional habit, pulpal condition, presence of endodontic treatment, and the remaining tooth structure
  - Total remaining periodontal bone support provides more accurate information than the linear measurement of the ratio which is limited
- Limitations:
  - Long term prospective clinical studies are required to identify the exact prognostic value of each clinical requirement for abutments
  - Further research is required in the future to quantify the predictive indices

ARTICLE 2 SELECTION:

- Reason for Selection:
  - This review of literature directly related to our topic of interest (CRR), however due to the conclusion that further research is required along with the low level of evidence, this resource is limited in its usefulness for our case
- Applicability:
  - Multiple factors play a role in determining the prognosis of abutments considered for support of a fixed or removable prosthesis, as is the case for this individual
  - Future prosthodontic and periodontic consult is required for this patient

ARTICLE 3:

Multifactorial risk assessment for survival of abutments of removable partial dentures based on practice-based longitudinal study

Sayaka Tada, Kazunori Ikebe, Ken-ichi Matsuda, Yoshinobu Maeda*

Department of Prosthodontics, Gerodontology and Oral Rehabilitation, Osaka University Graduate School of Dentistry, Japan

ARTICLE INFO

Article history:
Received 25 May 2013
Received in revised form
18 July 2013
Accepted 23 July 2013

Keywords:
Abutment
Removable partial denture
Survival rate
Multifactorial risk assessment
Longitudinal study

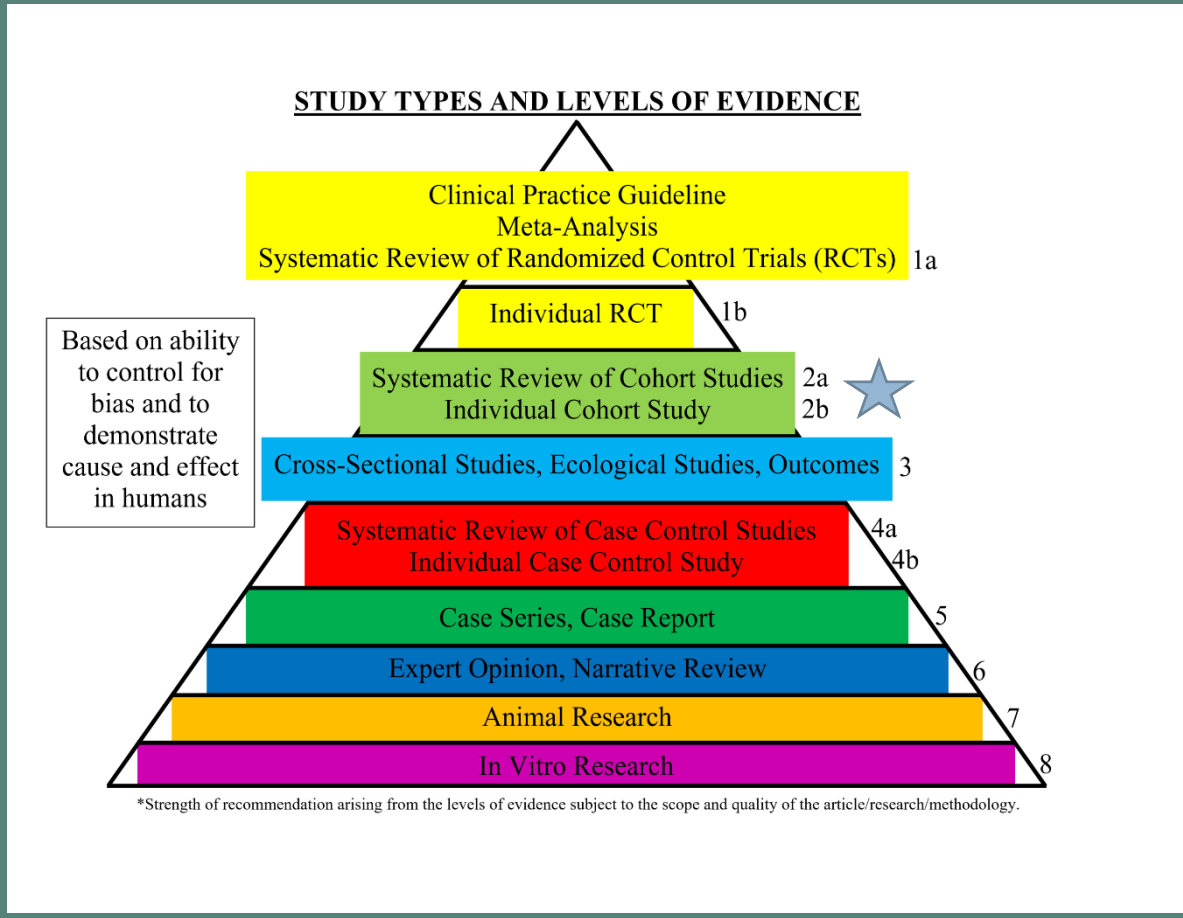
ABSTRACT

Objectives: Predicting the tooth survival is such a great challenge for evidence-based dentistry. To prevent further tooth loss of partially edentulous patients, estimation of individualized risk and benefit for each residual tooth is important to the clinical decision-making. While there are several reports indicating a risk of losing the abutment teeth of RPDs, there are no existing reports exploring the cause of abutment loss by multifactorial analysis. The aim of this practice-based longitudinal study was to determine the prognostic factors affecting the survival period of RPD abutments using a multifactorial risk assessment.
Methods: One hundred and forty-seven patients had been previously provided with a total of 236 new RPDs at the Osaka University Dental Hospital; the 856 abutments for these RPDs were analyzed. Survival of abutment teeth was estimated using the Kaplan–Meier method. Multivariate analysis was conducted by Cox's proportional hazard modelling.
Results: The 5-year survival rates were 86.6% for direct abutments and 93.1% for indirect abutments, compared with 95.8% survival in non-abutment teeth. The multivariate analysis showed that abutment survival was significantly associated with crown-root ratio (hazard ratio (HR): 3.13), root canal treatment (HR: 2.93), pocket depth (HR: 2.51), type of abutments (HR: 2.19) and occlusal support (HR: 1.90).
Conclusion: From this practice-based longitudinal study, we concluded that RPD abutment teeth are more likely to be lost than other residual teeth. From the multifactorial risk factor assessment, several prognostic factors, such as occlusal support, crown-root ratio, root canal treatment, and pocket depth were suggested.
Clinical significance: These results could be used to estimate the individualized risk for the residual teeth, to predict the prognosis of RPD abutments and to facilitate an evidence-based clinical decision making.

CHOICE OF ARTICLE 3:

- Purpose:
  - To determine the prognostic factors affecting the survival period of RPD abutments using a multifactorial risk assessment

- Study Design:
  - Practice-based longitudinal study/Individual cohort study



Citation: Tada S, Ikebe K, Matsuda K, Maeda Y. Multifactorial risk assessment for survival of abutments of removable partial dentures based on practice-based longitudinal study. *J Dent*. 2013;41(12):1175-1180. doi:10.1016/j.jdent.2013.07.018

ARTICLE 3 SYNOPSIS:

- Method: Data collected from 147 patients provided with RPDs at a dental hospital in Japan
  - 236 clasp-retained RPDs
  - 856 abutment teeth analyzed
  - 1114 residual (non-abutment teeth)
  - Patients excluded if dentures were immediate RPDs and dentures with complex designs (Maxillofacial prostheses or attachment retained or lingual plate connected dentures) and patients who did not receive a conservative periodontal maintenance program at least once a year during the observational period
- Kaplan-Meier survival analysis was performed to show the survival curve of direct and indirect abutments, as well as the other residual teeth
  - Survival distribution compared

ARTICLE 3 SYNOPSIS:

- Results:
  - 13.7% of abutment were lost
    - 17.9% of direct abutment
    - 8.5% of indirect abutment
  - 4.4% of non-abutment teeth
  - 5-year survival rate
    - 95.8% for non-abutment teeth
    - 93.1% for indirect abutments
    - 86.6% for direct abutments
- Conclusions:
  - Crown to root ratio, root canal treatment, pocket depth, type of abutment and occlusal support are significant prognostic factors in the abutment survival period
- Limitations:
  - Limited patient population

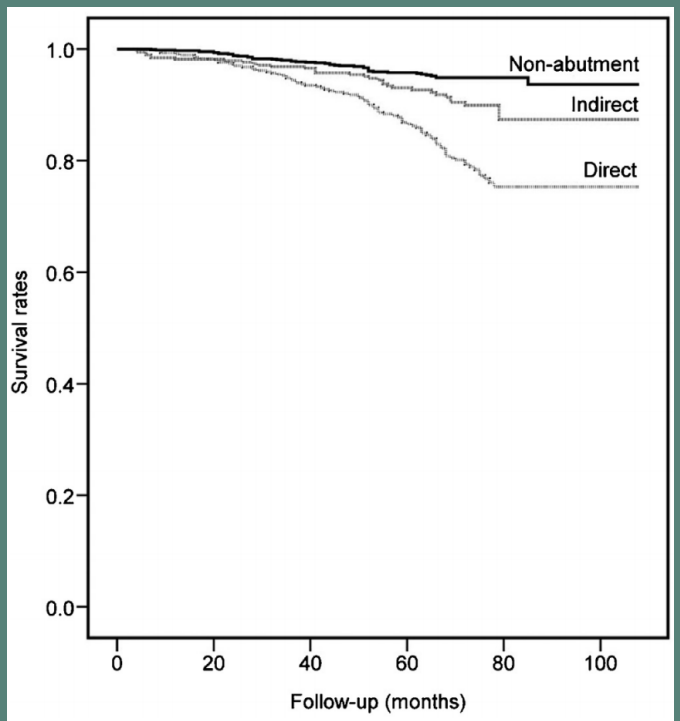


Fig. 1 – Kaplan–Meier survival curves for non-abutment, indirect abutment and direct abutment teeth.

ARTICLE 3 SELECTION:

- Reason for Selection:
  - Article discusses crown to root ratio, along with analyzing other confounding factors that would need to be taken into consideration when treatment planning an abutment tooth with undetermined prognosis
- Applicability:
  - Evaluate the other influencing factors besides the crown to root ratio when treatment planning for the RPD case

Summary of Research

Levels of Evidence: (For Therapy/Prevention, Etiology/Harm)

See http://www.cebm.net/index.aspx?o=1025

☐ **1a** – Clinical Practice Guideline, Meta-Analysis, Systematic Review of Randomized Control Trials (RCTs)

☐ **1b** – Individual RCT

☐ **2a** – Systematic Review of Cohort Studies

☒ **2b** – Individual Cohort Study

☐ **3** – Cross-sectional Studies, Ecologic Studies, "Outcomes" Research

☐ **4a** – Systematic Review of Case Control Studies

☐ **4b** – Individual Case Control Study

☐ **5** – Case Series, Case Reports

☒ **6** – Expert Opinion without explicit critical appraisal, Narrative Review

☐ **7** – Animal Research

☐ **8** – In Vitro Research

RECOMMENDATION LEVEL

Strength of Recommendation Taxonomy (SORT) For Guidelines and Systematic Reviews

See article **J Evid Base Dent Pract 2007;147-150**

☐ **A** – Consistent, good quality patient oriented evidence

☒ **B** – Inconsistent or limited quality patient oriented evidence

☐ **C** – Consensus, disease oriented evidence, usual practice, expert opinion, or case series for studies of diagnosis, treatment, prevention, or screening

D3 BOTTOM LINE

- Need more studies to be conclusive
- Evidence we have so far indicates that there is some deviation from the commonly accepted 1:1 ratio
  - However, at a certain CRR there appears to be a drop in prognosis
- As clinicians we can use this information to rule out teeth that should not be included in the RPD design due to their poor projected long-term prognosis

BOTTOM LINE

Based on your D3's bottom line recommendations, how will you ***advise*** your patient?

- Based of the poorer survival rates of teeth with larger crown to root ratios, I would advise my patient to forego crown lengthening and survey crown for both #28 and #29 and instead to use #27 as the abutment tooth.

How will you ***help*** your patient?

- Patient education is key to helping our patients because it allows us to give them the tools to prevent the need for treatment and to feel comfortable accepting the best treatment option for them when the need arises.

QUESTIONS ?

- Aside from the RPD abutment crown to root ratio, what other characteristics can contribute to a better prognosis?
- If a patient presents with only teeth 6 through 11 existing and both canines lack ideal crown to root ratio, is it better to still use these abutments or to transition the patient to an interim max CD?
  - This is a good question because it forces us to think about the multi-variable nature of prognosis.