FACTORS INFLUENCING THE DENTIST'S DECISION TO PROPOSE A TOOTH

AUTOTRANSPLANTATION IN THE FACULTY OF DENTISTRY,

CHULALONGKORN UNIVERSITY

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จุฬาลงกรณ์มหาวิทยาลัย
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ปัจจัยที่มีอิทธิพลต่อการตัดสินใจของทันตแพทย์ในการเสนอแผนการปลูกถ่ายฟัน
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น.ส.ธันย์ชนก ศิลประเสริฐสุข

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ธันย์ชนก ศิลประเสริฐสุข : ปัจจัยที่มีอิทธิพลต่อการตัดสินใจของทันตแพทย์ในการเสนอแผนการปลูกถ่ายฟันในคณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย. (FACTORS INFLUENCING THE DENTIST'S DECISION TO PROPOSE A TOOTH AUTOTRANSPLANTATION IN THE FACULTY OF DENTISTRY,CHULALONGKORN UNIVERSITY) อ.ที่ปรึกษาหลัก : ผศ. ทพ.ขนิษฐุ์ ธเนศวร

บทคัดย่อ

จุดประสงค์: เพื่อศึกษาปัจจัยที่มีอิทธิพลต่อการตัดสินใจของทันตแพทย์ในการนำเสนอแผนการปลูกถ่ายฟัน

วัสดุอุปกรณ์และวิธีการ: การศึกษาภาคตัดขวางในกลุ่มทันตแพทย์ 99 คน ตั้งแต่มกราคมถึงมีนาคม ปี 2564 โดยมีองค์ประกอบ ดังนี้ ข้อมูลทั่วไป, สถานการณ์แบบไม่ชี้นำ, สถานการณ์แบบชี้นำ, เหตุผลในการตัดสินใจ, ประสบการณ์, และความรู้เกี่ยวกับการปลูกถ่ายฟัน โดยวิเคราะห์ทางสถิติด้วยไคสแควร์ การทดสอบของแมคนีมาร์และการถดถอยพหุแบบลอจิสติค

ผลการศึกษา: ผู้ตอบแบบสอบถามเป็นหญิง 73 คน ชาย 26 คน อายุเฉลี่ย 30.84 ±6.238 ปี พบความสัมพันธ์อย่างมีนัยสำคัญ ระหว่างสาขาที่ถนัด ประสบการณ์ ความรู้เรื่องข้อบ่งชี้ ผลลัพธ์และประโยชน์เกี่ยวกับการปลูกถ่ายฟันต่อการตัดสินใจในสถานการณ์ก่อนชี้นำ ขณะที่ประสบการณ์ ความรู้เกี่ยวกับการติดตามผลและผลลัพธ์ มีผลในสถานการณ์หลังชี้นำ ผู้ตอบแบบสอบถามที่เคยเสนอการปลูกถ่ายฟันมีโอกาสนำเสนอมากกว่าคนที่ไม่เคย คิดเป็น 9.592 เท่าในสถานการณ์ก่อนชี้นำ และเพิ่มขึ้นเป็น 3 เท่า หลังชี้นำแล้ว

สรุป: ปัจจัยที่เกี่ยวกับทันตแพทย์มีอิทธิพลต่อการตัดสินใจในการนำเสนอการปลูกถ่ายฟัน ดังนั้นเพื่อ ปรับให้มีทัศนคติที่ถูกต้องต่อการปลูกถ่ายฟัน ควรมีการพัฒนาการศึกษาเรื่องการปลูกถ่ายฟันที่เหมาะสมในอนาคตแก่นิสิตทันตแพทย์ทั้งระดับปริณญาบัณฑิตและ

สาขาวิชา	ศัลยศาสตร์ช่องปากและแม็กซิลโลเฟเชียล	ลายมือชื่อนิสิต ....
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Abstract

Objectives: To study factors which influence a dentist's decision to propose the Tooth Autotransplantation (AT).

Material and methods: A cross-sectional study was conducted among 99 dentists between January and March 2021. A questionnaire comprised demographic characteristics, unprimed scenario, primed scenario, reasoning behind decisions, experience, and knowledge of AT. Data were analyzed using the Chi-square test, McNemar's test, and multiple logistic regression.

Results: The respondents comprised 73 females and 26 males with a mean age of 30.84 ± 6.238 years. In the unprimed scenario, there were significant associations between fields of expertise, experience, knowledge of current indications, outcomes, and the benefits of AT with the dentists' decision to propose AT, whereas in the primed scenario, experience in proposing AT, knowledge of follow-ups, and outcomes were significant. Respondents with experience in the proposing AT were 9.592 times more likely to propose AT in the unprimed scenario, a value which tripled once primed.

| Field of Study: | Oral and Maxillofacial Surgery | Student's Signature .... |
| Academic Year: | 2021 | Advisor's Signature .... |

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CHAPTER I

Background and rationale

Tooth loss is one of the most common oral health problems globally. According to Kassebaum el al. [1], tooth loss remained a global problem from 1990 to 2015. The causes of tooth loss consist of trauma, dental caries, periodontitis, endodontic problems, eruption problems, prosthetics or orthodontics reasons, and agenesis[2-7]. Generally, dental caries and periodontitis are major contributing factors that often result in a need to extract[8]. This is a major public oral health concern particularly in developing countries in which populations have higher incidence of dental caries[8, 9]. In Thailand, according to the 2017 National Oral Health Survey[10], using data collected from 2000 to 2017, it was found that the percent of samples with dental caries in subjects aged 15, 35-44, and 60-74 increased from 62.1% to 62.7%, 85.6% to 91.8%, and 95.6% to 98.5%, respectively. Moreover, the 8-12 age-group indicated the highest incidence for traumatic dental injuries to the anterior maxillary area[11].

There are many options for dental substitutions of a single missing tooth including use of conventional fixed bridges, acid-etched bridges, dental implants, removable partial dentures, tooth autotransplantation and orthodontic space closure[12-14]. The advantages and disadvantages of each option are unique[12]. From previous studies[15-18], the 5-year survival rate of conventional fixed bridges, acid-etched bridges, and single dental implants are 89.1%, 87.5% and 94.5%, respectively.

Nowadays, due to dental implants being predictable, having a high survival rate and good long-term outcomes, they are becoming one of the most preferred treatments for replacing missing teeth in patients. Nevertheless, dental implants are not frequently utilized with growing patients due to the risk of infraocclusion, an inability to be moved by orthodontic force, and the high cost of such treatment[19, 20]. Moreover, other disadvantages of dental implants include long-term esthetic outcomes that may be inferior to orthodontic space closure, and difficulties incurred by the soft tissue especially for interdental papilla in aesthetic zones[21].

Likewise, growing patients, who often have large pulp chambers, are contraindications of conventional fixed bridges due to an increased risk of pulp necrosis incurred through preparation processes. Although acid-etched bridges are used to solve this problem, long-term retention is still questionable[21]. Furthermore, damage of adjacent tooth surfaces is a disadvantage of both options because adjacent teeth have to be prepared[21].

Orthodontic space closure may be appropriate for younger individuals and is dependent upon a number of factors contributing to the outcome. Regardless, patients receiving such treatment may require further restorative treatment especially in aesthetic zones[21].

Autogenous tooth transplantation, (i.e., transplantation of a donor tooth from one site to a missing space or recipient site), is an option for replacing missing teeth with surgery[22]. Even though the overall success rate of tooth autotransplantation was recently reported to be more than 90%[23, 24], a value similar to dental implants, the number of patients choosing this method was observed to be less. However, there are a lot of superior advantages of tooth autotransplantation with regards to function, aesthetic, time, and cost[19]. Namely, the transplanted tooth is an individual natural tooth which is not necessary for any reason such as an embedded tooth, a wisdom tooth or a tooth that is planned to be extracted for orthodontic purposes[22]. This technique makes use of the patient's own tooth, unlike other prosthetic restorations such as dental implants which make use of biocompatible material. Furthermore, both stages of incomplete and a completed root formation can be successfully used in the tooth autotransplantation[24-26], if they can fit into the recipient site. In young patients with an incomplete root formation, pulp can be revascularized without endodontic treatment after transplanting[27]. The transplanted teeth are still alive and thus have a vital Periodontal Ligament (PDL), which serves as a shock absorber and a proprioceptive receptor in function, and is capable of continual root formation[28]. In addition, the transplanted teeth can maintain the alveolar bone volume and induce normal gingival contour and can be moved by orthodontic or physiological forces[22, 29-31]. Furthermore,

tooth autotransplantation costs significantly less than other options including dental implants, prosthetic restoration, and/or orthodontic space closure, although some patients might be burdened with extra costs for the rehabilitation of the donor site[19]. Due to the above, tooth autotransplantation is generally considered to be a more affordable option for patients[19]. Moreover, the public insurance is covering this treatment in Thailand.

The observed differences in preference between the two procedures may stem from the fact that tooth autotransplantations require a donor tooth from the patient. Moreover, this technique is quite sensitive and requires a certain level of surgical skill[19].

Further, the two main components involved in deciding between treatment options consist of the dentist and the patient. Clinical decision making is an important component of everyday dentistry. The dentist plays an important role in planning and offering patients alternative and appropriate treatments based on the patient's information such as chief complaint, history taking, clinical examination, and radiographic examination.

The dentist's decision to incorporate alternative treatment can be influenced by several clinical and non-clinical factors (i.e., patient-related factors and physician-related factors).[32-35] Nevertheless, It is possible that concrete determination of the relevant importance of either factor is challenging due to differences in treatment options[32-39].

On the other hand, the patient plays a role in receiving information of the alternative treatments and deciding on a final treatment. The most common need for replacement of missing teeth is to restore patients' aesthetic, function, or both[40]. In many cases, patients are presented with more than one option which reflect the patient's individual needs and characteristics[41].

Nowadays, there are many new innovations used to increase the likelihood of successful outcomes and reduce the complications of tooth autotransplantation. First, cone beam computed tomography (CBCT) has been used for preoperative evaluations of tooth autotransplantation[42]. In addition, CBCT is a useful tool for capturing the 3D

characteristics of a donor tooth in creating a donor-like template or replica by using a computer-aided rapid prototyping model (CARP). With this template, fitting can be conducted into the recipient site which decreases the extra-socket period of the actual donor teeth. The purpose of this technique is to enhance the predictable outcome and survival rate of the tooth autotransplantation[42-44]. According to Verweij et al.[45], it was reported that the survival rate of tooth autotransplantation using CARP of a 3D replica of the donor was between 95.5-100%. Second, using virtual surgical planning software, 3D-printed guiding templates, and tooth replicas, the correct position of the donor and dimensions of proper recipient site can be determined[46]. The intraoperative apicoectomy technique is the third innovation used to improve the prognosis of donors with complete root formation by enhancing revascularization[47]. Finally, given the limitation of tooth autotransplantation, patients must have a proper donor tooth. The use of bioengineered teeth(BioTeeth)[48] which are developed in vitro using stem cells from the patient to prevent immune rejection, is the next interesting innovation. This innovation may assist practitioners in the future to overcome limitations concerning applicable donor teeth.

The aforementioned innovative techniques and procedures ultimately stand to improve the predictability of the tooth autotransplantation techniques and simplify the process. Hence, such techniques could increase the usefulness of autotransplantation as one of the treatment options employed to replace missing teeth.

However, according to data from the Department of Dentistry, Chulalongkorn University over the last ten years the number of patients who underwent tooth autotransplantation was only 40 cases. Fewer patients opted for tooth autotransplantation when compared with alternatives such as prosthetic options (e.g., dental implants) and orthodontic options for the same purpose, although tooth autotransplantation has been developed and improved with new innovations.

To date, no studies regarding factors related to the dentist's decision to propose autotransplantation have been conducted, and as a result, research is lacking. The low prevalence of this treatment option led this study to consider factors affecting the

decision to propose tooth autotransplantation. Hence, this study seeks to answer why such a small number of patients were treated with tooth autotransplantation in this department. This research will make use of a cross-sectional survey to be distributed to relevant dentists.

CHAPTER II

Literature Review

2.1 Tooth autotransplantation

Autogenous tooth autotransplantation is one of many treatments in oral and maxillofacial surgery. Tooth autotransplantation can be classified into 3 groups.[20]The first group is conventional transplantation. This is the most common group that involves moving a proper donor tooth from one site to the site of a tooth with a hopeless prognosis in the same individual. The proper features of donor teeth include simple root shape, appropriate stage of root formation, ease of extraction, and matching size with this recipient socket. The recipient site, replaced by the donor tooth, refers to missing teeth and teeth with poor prognosis due to dental caries, periodontal diseases, congenital agenesis, or trauma.[19, 20] The donor teeth can be both anterior and posterior teeth that are nonfunctional, in an ectopic position, or teeth planned for extraction for orthodontic treatment.[19,20] Intra-alveolar transplantation is the second group. This group includes uprighting a tooth within the initial socket with surgical technique instead of orthodontics. In short, it involves reposition of a tooth into the same socket. The last group is intentional replantation. A tooth that cannot be fixed by a conventional root canal treatment but has proper features for tooth autotransplantation is extracted, partially cut by 3 mm from the apex, and retrofilled extra-socket before being replanted into the former socket.

However, the contraindications of tooth autotransplantation comprise patients with severe medically compromised and uncontrolled systemic diseases. Moreover, improper behaviors like smoking should be avoided due to the incurred reduction of the blood supply and the potential wound healing after surgery.[49]

There are a lot of advantages of tooth autotransplantation for replacing single missing tooth when compare with the other options including conventional fixed bridges, acid-etched bridges, a single dental implant, removable partial denture, and orthodontic space closure[19]. First, the transplanted tooth is the individual's natural tooth and may be

an embedded tooth, a wisdom tooth or a tooth that is planned for extraction for orthodontic purposes[22], unlike other prosthetic restorations which are made from other biocompatible materials. Furthermore, the tooth autotransplantation can successfully use a donor tooth with both an incomplete and a completed root formation [24-26]. Specific to the donor teeth with an incomplete root formation, pulp can be revascularized without endodontic treatment after autotransplantation[27]. The transplanted teeth are still alive and thus have a vital Periodontal Ligament (PDL), which serves as a shock absorber and a proprioceptive receptor in function, and is capable of continual root formation[28]. In addition, the transplanted teeth can preserve the alveolar bone volume and induce normal gingival contour and can be moved by orthodontic or physiological forces[22, 29-31]. The tooth autotransplantation costs significantly less than other prosthetic and orthodontic options, although some patients might be burdened with extra costs for the rehabilitation of the donor site[19]. Hence, this option is affordable for general patients[19].

The limitations of tooth autotransplantation include a proper donor tooth from the patient, technique sensitivity, and needs of a doctor's surgical skill[19].

The sequence of classical tooth autotransplantation[19, 20] begins with clinical, radiographic examination, diagnosis and treatment planning steps. Every case is evaluated against clinical appearance and radiographic imagery as to whether tooth autotransplantation is appropriate. The preoperative information, including features of donor teeth and whether they fit with the recipient site, stage of donor's root development, (i.e., whether they can be extracted in an atraumatic manner), and appropriate preparation of the recipient site, should be known for planning[19, 20]. Following this, surgical processes can commence. The classical tooth autotransplantation technique involves the removal and transplantation of a donor tooth as a template to prepare the recipient site or alveolar bone socket in the same person[19, 20]. First, the donor tooth should be removed as gently and atraumatically as possible to avoid damage of PDL before being examined for shape, size and PDL condition prior to preparing the recipient socket. It should be returned into the donor socket, while

preparing the recipient socket to decrease the extra-socket period. The storage medium, properly maintaining the vitality of periodontal ligament cells on the donor root surface, is Hank's balanced salt solution[19, 20]. Then, the recipient socket, prepared with surgical burs with low speed and cooling with saline, should be expanded to a slightly larger size than the donor[19, 20]. After attempts of fitting, the primary closure of the gingiva around the donor tooth with a suture is important for the outcome of the transplanted tooth and prevents against infection from bacterial leakage into the blood clot[19, 20]. The next step is stabilization of the donor tooth with stabilizers such as sutures, as well as wire and adhesive resin. The selection of material of stabilizers which hold the transplanted tooth, depends on stability of the donor tooth and how much occlusal adjustment is done[19, 20]. The occlusal level of the donor tooth should be a little lower than the opposite tooth to prevent occlusal interference or premature contact. The sequence of the transplanted tooth's occlusal adjustment depends on types of splints used for donor stabilization. It should be done extra-orally before transplanting or intraorally before extraction of the donor, in case using a suture is used for splinting. In contrast, if wire stabilizes are used with a transplanted tooth, it should be done after splinting[19, 20]. Allowing for some little movement of a transplanted tooth decreases the potential of ankylosis and adverse effects on the pulpal and periodontal healing of the transplanted tooth. Furthermore, for the purposes of preventing against infection in the transplanted area, surgical dressing should be done immediately during the first few days to support wound healing and removed at about 3-4 days after surgery. The fixation should be removed 1 to 2 months after surgery[19, 20].

Root canal treatment of a donor tooth should be done in cases of complete or fully developed roots prior to transplanting due to the low opportunity of revascularization and pulp healing [28, 50]. In other cases, endodontic treatments should be performed if the transplanted tooth exhibits abnormal sign and symptom such as root resorption, pulp necrosis and periapical inflammation in clinical and/or radiographic features in order to avoid failure in the future[51].

For the purpose of function and aesthetic, some transplanted teeth may be restored with appropriate treatments depending on restorative indications. Such treatments may include filling an access cavity of a root canal treated tooth, creating proximal contact of the donor tooth, and recontouring the shape of donor's crown. In addition, for aesthetic purposes, restorative treatment can comprise resin composite fillings and use of a fixed crown[19, 20].

The follow-up examinations are important for the first year after surgery. According to Andreasen[22], the frequency of follow-up appointments influences the success of outcomes of tooth autotransplantation cases. The follow-up period should be at 1, 2, 4, and 8 weeks and 3, 6, and 12 months after surgery. The clinical and radiographic examination should be assessed for evaluating periodontal and pulpal healing and being a baseline[22].

Maintenance and compliance after surgery are also important for successful long-term outcomes of transplanted teeth. The patient's transplanted teeth should be checked with the same standard protocol as normal teeth[20].

There are many important requirements of autotransplantation that influence a successful outcome[19, 20, 27, 28, 51, 52]. The related factors of successful healing outcomes of tooth autotransplantation can be divided to 4 factors[19].

First, factors related to the patients involve age, systemic and metabolic problems, cooperative attitude, and specific habits (e.g., smoking). The patients should have good health and oral hygiene and sufficient cooperation in undergoing the procedure. Despite no clear age limits, younger patients have been found to have better outcomes than other age groups. [19, 20, 27, 28, 51, 52]

Second, factors related to the donor tooth include the developmental stage, and the root anatomy of the donor tooth. The first requirement is that patients must have teeth eligible for the procedure. In addition, the proper features of donor teeth include teeth which are in healthy condition and possess a single and cone-shaped root with ¾ to 4/5 root formation. Moreover, it is essential that the donor tooth matches the size of the recipient site[19].

Third, factors relating to the recipient site involve the existence of adequate alveolar bone support in all dimensions, as well as the absence of acute infection and chronic inflammation at the recipient site. For the recipient site, eligible sites should have sufficient bone width and height to accept a donor tooth[19].

Last, a number of factors have been characterized by different authors as prognostic factors, these include, (1) atraumatic surgical handling of the donor tooth, (2) proper preservation of the donor tooth, (3) the degree of adaptation of the donor tooth when placed into the recipient socket, (4) the duration of stabilization, (5) the used method of stabilization of the donor tooth immediately after transplantation, and (6) the postoperative care of the patient. Additional studies indicate still further prognostic factors such as the experience and skill of the surgeon, the prevention of postoperative premature contact during the healing period, and the timing and quality of endodontic treatment of the autotransplanted tooth. Moreover, the experience and skill of the surgeon is also important for case selection, planning, atraumatic extraction of donor teeth, proper preparation of the recipient socket, and management of hard and soft tissue[19, 20, 27, 28, 51, 52].

The key factor for a successful clinical outcome of an autotransplantation procedure is the preservation of PDL vitality of the transplanted tooth during the surgical procedure. This can be achieved mainly by avoiding the application of high pressure or traumatic pressure and reducing the extra-socket time of the donor tooth during transplantation[19, 20, 27, 28, 51, 52].

The most common reported complications of transplanted teeth are root resorption, ankylosis and pulp necrosis [23, 28, 50]. According to Andreasen et al.[27], post-surgery root resorption can usually be detected in radiographic and/or clinical examination within 4 to 8 weeks. Some studies found that the estimated first year root resorption rate was 2.9%[24] in cases with incomplete root formation and 2.1% in cases with complete root formation[26]. The stage of root formation is closely related to the negative outcome of root resorption, ankylosis and pulp necrosis. [25, 27] In addition, gentle manipulation of the donor teeth may decrease the occurrence of root resorption.

Specific to ankylosis, this complication can be diagnosed within the first year after surgery. Two systematic studies[24, 26] reported that the estimated occurrence of ankylosis within the first year was 2%[24] in cases with incomplete root formation and 1.2% in cases with complete root formation[26]. It is assumed that ankylosis may have resulted from traumatic injuries during donor extraction or from extraoral endodontic treatment of the donor tooth[26].

The next complication is pulp necrosis. According to Andreasen et al.[28], after autotransplantation pulp necrosis was usually detected within 8 weeks. The study found that the stage of root formation is strongly related to pulpal healing[28]. One systematic study[24] reported that the estimated occurrence of pulp necrosis within the first year was 3.3% for incomplete root formation donor cases. However, those with complete root formation were found to have a higher risk of developing pulp necrosis[28]. Such cases should be endodontically treated 4 weeks after surgery[28].

Almpani et al.[25], considers the complication and risk factors contributing to negative outcomes in tooth autotransplantation including the need for extraction as a primary outcome in a in a systematic review and meta-analysis. According to this study, in sever circumstances where autotransplantation fails, this may result in extraction of the transplanted tooth. This study reported that the need for extraction on average was less than 10%, although the included evidence was heterogeneous. The risk of failure in open apex donors when compared with closed apex donors was reported to be less. However, the failure rates of previous reports in the field of tooth autotransplantation are not identical due to the heterogeneity of the studies[25].

2.1.1 Historical Development of Tooth Autotransplantation

Tooth autotransplantation was first recorded in the 18th century, in which a watercolor painting by Thomas Rawlandson depicts a 'fashionable dentist engaged in tooth transplantation'[15]. Tooth autotransplantation, replacing decayed first molars with immature third molars, was described for the first time in 1950[53]. At that time, the first series of cases used immature premolars to be transplanted to the anterior maxilla region in the late 1950s[54]. The approximately 50% success rate was reported in this

period due of the difficulty in predicting root development and dental root resorption after transplantation[53] in addition to an unfavorable survival rate of mature transplanted teeth[50]. The complications involving inflammatory root resorption and replacement root resorption occurred in cases of donor teeth with complete root formation[50]. Moreover, knowledge concerning the causes and preventions of root resorption of transplanted autogenous teeth was lacking and the procedure was used infrequently. Since the 1990s, many studies have examined the healing process of periodontal tissues, the periodontal membrane, and dental root resorption. The results of such studies lead to a rapid increase in success and survival rates of tooth autotransplantation drawing new clinical and academic interest. [20, 27, 28, 51, 52]. Many previous studies reported success and survival rates for autotransplanted immature teeth to be 82% to 96% and 56.6% to 100% respectively[15, 28, 50]. These studies, conducted by Andreasen et al.[27, 28, 51, 52], collectively put forth a standardized surgical technique in addition to clarifying issues concerning the prognosis and risk factors of tooth autotransplantation. They found that the risk of root resorption is related to the stage of root formation and increases with increasing root formation. In addition, the extra-socket time of a donor tooth significantly increases the chance of pulp necrosis and damage to periodontal ligament cells due to lacking nutrient supply. This may be due to conventional techniques of tooth autotransplantation, in which the donor teeth were moved from their socket multiple times to prepare the recipient site. The more extra-socket time the donor teeth incurs, the greater the risk of trauma to the periodontal membrane.[55, 56]

According to Czochrowska et al.[57], 30 autotransplanted immature teeth in the aesthetic zone had a 90% long-term survival rate and a 79% success rate with the mean observation period of 26.4 years (range, 17-41 years). Barring the appearance of pulp obliteration, the transplanted teeth were found to be similar to natural control teeth when subjected to clinical and radiographic inspection. Moreover, the researchers also assessed the post-operative perception for aesthetic outcome of autotransplanted premolar in the maxillary anterior site in patients and professionals and found that more than 80% of both groups indicates satisfactory or acceptable levels of satisfaction.[57].

In 2001, Lee et al.[58] considered the use of conventional spiral Computerized Tomography (CT) in generating a 3D image with accurate dimensions of a donor tooth and then fabricating a resin model of the donor tooth by using computer-aided rapid prototyping (CARP). The authors concluded that CARP may reduce the extra-socket time of a donor tooth and the probability of damage to periodontal ligaments of a transplanted tooth during the fitting process.

Following this novel application of technology, cone beam computed tomography (CBCT), which exposes patients to less radiation than conventional CT, was used for a preoperative evaluation for tooth autotransplantation. Since 2010, CBCT has allowed practitioners to gain useful insight into a number of factors such as the size of donor teeth, recipient site, vital structures, and bone volume [42]. Furthermore, this device is also used to capture the 3D characteristics of a donor tooth to build up a donor-like template or a replica with 3D software. The replica of the donor teeth, having been printed with variable materials such as metal, resin and titanium, can then be fitted into the recipient site to decrease both the extra-socket period and risk of damage to the PDL. The purpose of this technique is to enhance the predictable outcome and survival rate of the tooth autotransplantation[42-44]. In a study conducted by Day et al.,[59] the researchers designed and fabricated surgical templates of brass or copper to assist in premolar autotransplantation surgical procedures. This was done in order to reduce the probability of trauma to the PDL during fitting of the donor tooth. The authors established and replicated the root dimensions of the donor premolar tooth that were extracted for orthodontic purposes to create these surgical templates. In addition, Verweij et al.[45] reported that the success and survival rates of tooth autotransplantation which employed 3D replicas generated by CARP were between 80.0-91.1% and 95.5-100%, respectively.

For cases with complete root formation, Abella et al.[46] demonstrated that clinical outcomes were enhanced in 24 third molar autotransplantations when virtual surgical planning software, and 3D-printed guiding templates and tooth replicas were used similarly to techniques employed for dental implants. These autotransplantations saw

the design of 3D guiding templates incorporating occlusal surfaces of the adjacent teeth to position the donor teeth in the recipient sites. Both the donor teeth replicas and the templates were printed in a biocompatible resin. In some cases, the donor teeth had a 3- or 4-mm apicoectomy to reduce the preparation of the recipient site. After an average follow-up of 24.8 months, the authors reported a 91.7% success rate of transplanted teeth where no pathological condition were present in radiographic imagery such as root resorption. Based on the aforementioned results, this study concluded that digital planning techniques appear to provide an accurate alternative to traditional techniques employed in tooth autotransplantation.

The estimated 1- and 5-year survival rate of transplanted teeth with complete root formation was 98.0% and 90.5% in 2014, respectively; however, these findings were reported on cases in which a root canal treatment was performed after transplantation.[26]. To correct the inferior outcome of donor teeth with complete root formation, a new technique, called intraoperative apicoectomy, is currently being considered so as to improve revascularization. Research indicates that in order to support revascularization, an ideal diameter of the donor's apical foramen of 1 mm is to be achieved[27]. Further studies in animals[60, 61] corroborate this finding as mature teeth having undergone an apicoectomy were able to revascularize after transplantation. In a case study conducted by Norbert et al. [47], it was found that autotransplanted apicoectomized mature teeth were still alive with no complications after an 18-month follow up. The hypothesis that intraoperative apicoectomy of a donor tooth with complete root formation may improve the prognosis for revascularization was supported by this case. However, further controlled clinical studies on intraoperative apicoectomy techniques and their potential influence to outcomes of autotransplantation are needed [47].

As autotransplantation requires patients to have an appropriate donor tooth, this may correspondingly limit applications when this technique may be employed. According to Sartaj et al., [48] bioengineered teeth (BioTeeth), developed in vitro using stem cells from the patient to prevent immune rejection, are a possible solution to this

limitation. Hence, this technology could be an alternative method for replacing lost or damaged teeth in the future.

Currently, a review of literature reveals that the overall success rates of tooth autotransplantation occupies a wide range. This is due to the fact that there is no precise definition of success rate, which is consistently agreed upon in literature, or put forth by regulatory bodies. Some bodies of research have broadly defined success rate as a transplanted tooth being alive [4, 5]. According to other studies success rate included those transplanted teeth which underwent successful endodontic treatment to correct pulp necrosis[2, 3, 62]. The common variables of success considered in definitions of success rate were no sign of root resorption, ankylosis, abnormal probing depth, improper crown-to-root ratio, inflammation of pulpal or periapical regions, and physiological mobility [2-5, 23, 43, 62]. In order to identify all of the aforementioned variables of success, sometimes radiographic signs or clinical signs alone are insufficient, and require both to be used in conjunction[2-5, 23, 43, 62].

From the above, it may be clear that there are only few meta-analysis and review studies which analyze the overall success rate of tooth autotransplantation [23, 24]. Similarly, in previous studies, it was reported that the success rate of incomplete root formation donors was around 89.7%[23] to 96.6%[24].

For the larger part, researchers defined the survival rate as the presence of the donor tooth throughout the follow up period of each study. From previous research, it has been found that the survival rate of tooth autotransplantation in the short-term is more than 90% [23, 24, 26]. In long-term studies, survival rate was reported to be up to 98% in a group of incomplete root formation donors[23, 24]. In another group, with complete root formation donors, an unfavorable survival rate was reported in the past[50]. This may be due to conventional techniques of tooth autotransplantation, in which the donor teeth were moved from their socket multiple times to prepare the recipient site. The more extra-socket time the donor teeth incurs, the greater the risk of trauma to the periodontal membrane[55, 56].

Research conducted by Czochrowska et al. [57], assessed the post-operative perception for aesthetic outcome of autotransplanted premolars at the maxillary anterior site in patients and professionals and found that more than 80% of both groups had satisfactory or acceptable outcomes. In 2015, in another survey study[63] concerning patients' and parents' satisfaction after autotransplantation, both parties indicated high levels of satisfaction with all aspects of their premolar transplant. Moreover, respondents to the survey indicated that they felt there was a 'large improvement in dental appearance' (Mdn = 8) and appearance of the site post-surgery was highly satisfactory (Mdn = 8). Importantly, patients reported experiencing moderate discomfort during their premolar transplant (Mdn = 6), while a great majority (92%) of these individuals stated that they would recommend tooth autotransplantation to other patients or parents.

There is only one study[64] that evaluated a long-term cost-effectiveness of tooth autotransplantation in the anterior region compared with four alternatives including single-tooth implant, resin-bonded fixed partial denture (FPD), cantilever FPD, and full-coverage FPD. The cost-effectiveness was analyzed as the ratio of the survival rate of each alternative from previous published studies divided by the cost including clinical and laboratory cost. The result showed that tooth autotransplantation was the most cost-effectiveness treatment, whereas the least cost-effectiveness was full-coverage FPDs. Nevertheless, there are many factors such as patient's age, occlusion, stage of tooth development, and tooth conservation that affect the choice of restoration.

2.2 Decision making

Making a decision has been defined in prior research with many vast and varied indications[65-67]. The definitions adopted in such studies, generally hold that making a decision involves a process of reasoning which results in the selection of one of many possible options. This can be extended to include comprehensive considerations of the advantages and disadvantages incurred by a given selection. Furthermore, this is done so as to arrive at the best choice which is most aligned with the overarching goals of the individual and all those involved.

2.2.1 Factors affecting doctors' decision making

Clinical decision making is an important complex process which is consistently used in clinical practice. Such decisions may involve a coalescence of multiple concerns as well as collaborations of skills including biomedical knowledge and applications of clinical knowledge, consideration of probabilities and various outcomes, problem-solving, and balancing risk-benefit[33]. Another dimension of analysis of such decisions could maintain that it involves balancing between personal experience and prevalent knowledge[68]. Although the majority of factors contributing to a doctor's decision certainly make use of scientific criteria, they are also influenced by doctor-patient interactions and by sociocultural setting[69].

As the risks and occurrence of medical diseases differ across several dimensions when compared with oral disease, the decision-making process for either must also reflect such variations. Be it that medical conditions are urgent, difficult to forecast, even more difficult to plan for in a fiscal sense, or otherwise, these two fields correspondingly have developed differing systems and factors which influence a practitioner's decisions. Specifically, oral diseases lack the essential characteristics of an insurable risk in addition to progressing slowly, often without initial symptoms, thus appropriate treatment is often postponed[70].

According to previous medical studies, the factors affecting doctor's decision to propose treatment options consist of clinical factors and non-clinical factors (i.e. patient-related factors and doctor-related factors) [33-35]. Nevertheless, the relative importance of these is understudied and the relationship between either factor depends heavily on the types of treatments[32].

Although clinical decisions are based on traditional clinical characteristics, they are also influenced by non-clinical factors[71]. In addition, the differences between either set of factors are often obscure, such that certain factors may not clearly be identified as clinical factors or non-clinical factors[71]. For example, patient's age can be considered as a clinical factor because it relates to physical ability and other co-morbidities. On the other hand, patient's age can be a non-clinical factor as well, because elders often

experience difficulty in arranging transportation thus making multiple check-ups or appointments to some extent impractical[34]. Hence, it is difficult to clearly delineate between clinical and non-clinical factors[71] .

In the field of dentistry, according to a classical study[32], factors influencing dentists' decisions in choosing between treatment options, such as crown vs filling, fixed bridge vs removable partial denture, and prophylaxis vs subgingival curettage or periodontal scaling, were divided to 2 main factors involving technical and patient factors. The technical factors considered in this study consist of the dentist's ability and clinical characteristics such as caries rate, missing teeth, periodontal status, tooth mobility, and difficulty in canals to name a few. Conversely, the patient factors consist of the patient's preference, oral hygiene status, ability to tolerate procedure, previous experience, etc. This study found that the dentists are often more concerned with technical factors than patient factors in selecting various treatment options. Furthermore, as a result of the several years of dentists' experience, their treatment options depended on personal aptitude. Of the doctors considered in this study, only one-third reported to place more importance in patient factors as opposed to technical factors[32]. This is important, as when a dentist is less concerned about patient-related factors, proposed treatment options may not include all possible treatments due to limitations of technical aptitude or other reasons[72].

In addition to the aforementioned classical definitions, previous studies [32-35, 71] provide further divisions of non-clinical factors, which be divided into the following two categories of factors:

1. Patient-related factors

    1.1 Demographic factors: Patient's gender, age, race, and others

    1.2 Socio-economic factors: Patient's level of education, income, social class, ability to pay, and career

1.3 Patient's attitude, behavior, wishes, preferences, concern, and worries

1.4 Others: Influences of patient's family members and friends, and faith

Such factors are cited throughout many bodies of research, a sample of which can be seen in the below *Table1*.

Table 1: Examples of Patient-Related Factors in Treatment Decisions

Item	Examples of Patient-Related Factors in Previous Studies
1	Elders always have uncomfortable transportation that is difficult to making multiple check-up or appointments[34]. Moreover, elder patients may restrict doctor's options[73].
2	Patient skin color or race influenced the doctor's choice of treatment. In general, black patients receive referrals for cheaper, simpler procedures[74].
3	Patient's ability to pay a cost of treatment is influencing doctor's decision making to offer treatment options so this choice may not an ideal option[35].
4	Patients will need some treatment by their wishes and preferences even though that treatment will not an ideal treatment or needed treatment. Thus, the patient's preferences will be an influencing factor of doctor's decision-making[71].
5	When the patient has cancer, the patient's family can influence decisions, with respect to selection of the patient's physicians, hospitals and treatment options. Also, in patients with advanced lung cancer a patient's faith in God has been shown to influence treatment choices[71].

2   Doctor-related factors

2.1 Demographic factors: Doctor's gender, age, and others

2.2 Socioeconomic factors: Doctor's level of education, income, skill and experience

2.3 Doctor's professional interaction: relationship with colleagues, hospital staff and with pharmaceutical industry, health care system

2.4 Doctor's attitude, knowledge, experience and skills

2.5 Doctor-patient relationship model consists of the paternalistic model, informative model, interpretative model, and deliberative model

2.6 Practice-related factor

2.6.1 Type of practice (e.g., private vs public), Size of practice, practice organization, geographical location, and availability of health resources

2.6.2 Management policies/implication of treatment cost

When doctors are faced with a case of professional uncertainty in diagnosis of disease, it is understandable that proposed treatment options will depend on their personal aptitude as opposed to the characteristic or severity of the disease[37]. Moreover, when professional agreement is high, the doctor may be more driven by financial self-interest and fear of malpractice[37]. As a result of such concerns, variations in treatment options may occur.

This is corroborated by a survey of general dentists which found that proposed treatments depended largely on their personal ability and certainty[75]. Furthermore, doctor's attitude to offer various treatment options is has been found to be correlated with the doctor's level of education, personal finance, and cultural background[76]. In addition to this, one study[77] found that doctors who work in public sectors offer different methods and treatment options for replacing missing teeth when compared with the doctors in private sector.

Emanuel and Emanuel [78] described that the doctor's relationship with the patient (Figure 1) can be classified into 4 models comprising the paternalistic model, informative model, interpretative model, and deliberative model. Each model is unique and depends on situation and context. However, these models play an important role to doctor's diagnosis and clinical decision-making because the effectiveness of treatment depends on information provided by patients.
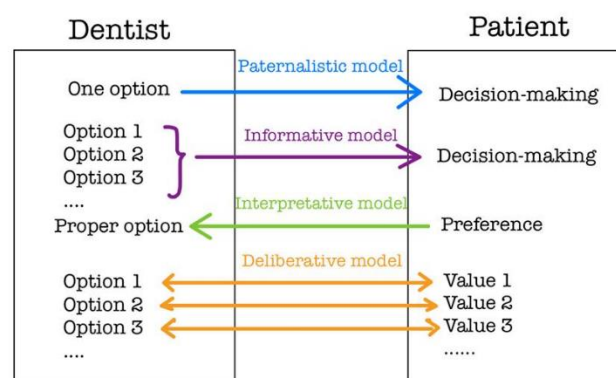
Figure 1: Four models of the doctor-patient relationship[78]

The first model is the paternalistic model, where doctors play a role as a father and choose the best treatment for patients. In this model, patients have the freedom to decide whether the doctor's recommendation will be accepted or rejected, but ultimately the doctor's recommendations limit the patient's ability to choose from other options.

Second, the informative model, sees doctors acting as a competent technical expert, whereby all relevant information is provided about each treatment option. Based on the information provided by the doctor, the patients then select the final treatment.

The interpretative model is the third model. The patients play an important role in telling their preferences and values to the doctor. Then, doctors act as a counselor or adviser to offer the treatment that best suits the patient's preferences or values.

The last model is the deliberative model, in which doctors approach patients as a friend, or teacher in providing holistically considered recommendation based on a number of values and limitations from the client.

2.2.2 Previous associated studies

Several previous studies report decision-making processes which make use of similar factors to those considered in or contributing to a decision to perform tooth autotransplantation. From systematic reviews conducted by Torabineja and Goodacre[79], it was found that there are 3 main factors influencing dentist's treatment planning for compromised teeth. These include patient-related factors (i.e., systemic and oral health, comfort and treatment perceptions), tooth- and periodontium-related factors (i.e., pulpal and periodontal conditions, color and characteristics of the teeth, quantity and quality of bone, and soft-tissue anatomy), and the treatment-related factors (i.e., the potential for procedural complications, required adjunctive procedures and treatment outcomes).

Further research conducted by Brigitte et al. [80], found that when confronted with decisions to perform root canal therapy or extraction, the doctor's own specialty status was a significant source of influence. In addition, Lang-Hua et al. [81] report that the practitioners with postgraduate implant qualifications and practitioners undergoing training for postgraduate implant qualifications decided to retain periodontally compromised teeth instead of extraction more than the practitioners without postgraduate implant qualifications in three times as many cases. The authors concluded that there are indeed variations in proposals of treatment of periodontally compromised teeth which stem from implant training statuses. The authors further posit that the extend of these differences extended to decisions as to how the teeth were retained and how the dental arch was rehabilitated.

In a survey polling 2,058 Swedish general dentists conducted by Kronstrom et al.[82, 83], results demonstrated that the most important factors considered by dentist in deciding between fixed and removable partial denture choices are the patient's wish, condition of possible abutment, and prognosis for delivered treatment. Similarly,

between fixed partial dentures and single implant choices, dentists were concerned about prognosis for delivered treatment and the patient's wish.

A study form Cosyn et al. [84] concluded that oral factors and doctor-related factors affected the decision to perform single implant treatment after tooth extraction by general practitioners in a private, fee-for-service setting. In this study, doctor's demographics, such as biological sex, were found to affect the doctors' decisions to perform implant treatment. Moreover, dentists who have experience in implant prosthetics were more positively associated with the decision to perform single implant treatment.

To date, there are few previous studies[85, 86] concerning factors affecting doctor's decision to offer treatment options for replacing missing teeth. Moreover, no studies have been found which specifically include tooth autotransplantation as a treatment option in conjunction with other factors affecting the doctor's decision-making process. Because the factors affecting doctor's decision-making to offer tooth autotransplantation is unknown, this study will present initial findings on this topic. In seeking to survey and determine which factors affect the doctor's decision, this study aims to provide an explanation and motivation in understanding the low prevalence of tooth autotransplantation cases.

2.3 Research question

Which factors influencing dentist's decision-making process to propose a tooth autotransplantation in the Faculty of Dentistry, Chulalongkorn University?

2.4 Research objectives

To study factors that influence a dentist's proposed treatment plan to propose tooth autotransplantation in the Faculty of Dentistry, Chulalongkorn University.

2.5 Research hypothesis

Null Hypothesis(H_0):

Clinical factors and non-clinical factors do not influence the dentist's decision to propose tooth autotransplantation.

Alternative Hypothesis(H_1):

Clinical factors and non-clinical factors influence the dentist's decision to propose tooth autotransplantation.

2.6 Conceptual framework
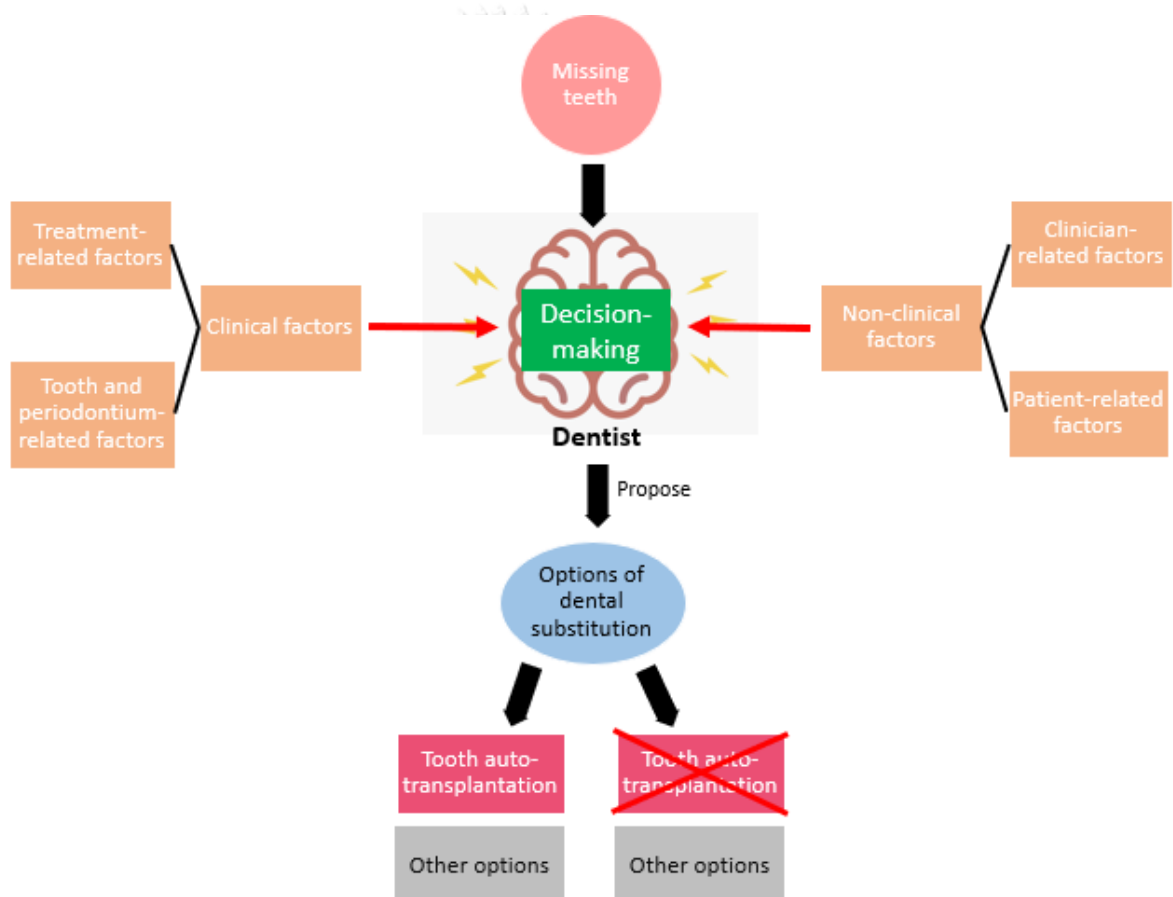
Figure 2: Conceptual framework

2.6.1 The Independent variable can be divided into 3 factors

1) Non-clinical factors

    1.1) Dentist-related factor

- Demographic data: gender, age
- Socioeconomic status: education level, salary, and work address

- Particular skills and confidence

- Knowledge and attitude

- Dentist-Patient Relationship: paternalistic, informative, interpretive, or deliberative model.

- Practice-related factor: Private or public

1.2) Patient-related factor

- Demographic data: Patient's age, gender, and others

- Socioeconomic status: Cost

- Behavior: Patient's compliance, oral hygiene status

- Attitude: Dental phobia, fear

2) Clinical factors

2.1) Treatment-related factors

- The potential for procedural complications, required adjunctive procedures and treatment outcomes

2.2) Tooth and periodontium-related factors

- Pulpal and periodontal conditions, characteristics of the teeth, quantity and quality of bone, and soft tissue anatomy

2.6.2 Dependent variables

Dentist's decision-making to propose tooth autotransplantation as one of the treatment options for replacing missing teeth to the patients.

2.7 Research design

Cross-sectional research

2.8 Keywords

Autotransplantation, Decision-making, Proposal

CHAPTER III

Material and Method

3.1 Research design

This research makes use of an online questionnaire distributed via Google Forms to dentists in the Faculty of Dentistry, Chulalongkorn University.

3.2 Population and sample size

3.2.1 Population

All practicing dentists in the Faculty of Dentistry, Chulalongkorn University, who propose treatment options for replacing missing teeth to restore occlusion or for aesthetic purposes, with proficiency in Thai language, and possess sufficient skills and knowledge to access the questionnaire via Google Forms.

3.2.2 Sample size

3.2.2.1 Pilot study

The 30 practicing dentists working outside the Faculty of Dentistry, Chulalongkorn University, who propose treatment options for replacing missing teeth to restore occlusion or for aesthetic purposes, with proficiency in Thai language, and possess sufficient skills and knowledge to access the questionnaire via Google Forms. The goal of this pilot study is to calculate the sample size to be used in main study and survey the dentist's reasons in deciding to offer treatment options. In addition, the results of the pilot study will be used to scrutinize the fitness of the questionnaire.

3.2.2.2 Main Survey

Inclusion criteria

The 100 dentists in the Faculty of Dentistry, Chulalongkorn university, who propose treatment options for replacing missing teeth to restore occlusion or for aesthetic purposes, with proficiency in Thai language, and possess sufficient skills and knowledge to access the questionnaire via Google Forms.

Exclusion criteria

Dentists who have not practiced after graduation

Survey respondents who provide incomplete or inconsistent responses

3.2.3 Sample size calculation

There is no previous study of factors affecting dentist's decision to propose a tooth autotransplantation. The size of the sample in this study was calculated from the results of the previously described pilot study.

After analyzing the data made available by the pilot study, two dentist-related factors were found to significantly influence the dentist's decision to propose tooth autotransplantation. The first significant relationship was found among the experience of dentists who have seen tooth autotransplantation as this was found to be significantly different in both case scenarios (χ^2 (1, N=31) = 4.918, p = 0.027, χ^2 (1, N=31) = 5.743, p = 0.017 respectively). In addition, having previous experience in proposing tooth autotransplantation to patients was found to produce a significant result with regards to the dentist's decision to propose this in the second case study. (χ^2 (1, N=31) = 4.014, p = 0.045).

Based on these significant finding, and in conjunction with the Two Independent Proportions Formula[87, 88] a sample size can be calculated. Based on the results of either case, only the largest of derived sample sizes will be selected for the main study. The method adopted in calculating the Two Independent Proportions Formula is described below in *Figure 3*.

$$n_1 = \left[\frac{z_{1-\frac{\alpha}{2}} \sqrt{\bar{p}\bar{q}\left(1+\frac{1}{r}\right)} + z_{1-\beta} \sqrt{p_1 q_1 + \frac{p_2 q_2}{r}}}{\Delta} \right]^2$$

$$r = \frac{n_2}{n_1}, q_1 = 1 - p_1, q_2 = 1 - p_2$$

$$\bar{p} = \frac{p_1 + p_2 r}{1+r}, \bar{q} = 1 - \bar{p}$$

Figure 3 Two Independent Proportions Formula

Proportion in group1 (p_1) = 0.714

Proportion in group2 (p_2) = 0.353

ratio (r) = 1.00

Alpha (α) = 0.05, Z(0.975) = 1.959964

Beta (β) = 0.20, Z(0.800) = 0.841621

Sample size: Group1 (n_1) = 29, Group2 (n_2) = 29

Sample size by using a continuity correction: Group1 (m_1) = 35, Group2 (m_2) = 35

Group1 (m_1) + Group2 (m_2) = 70

Based on the above, and so as to mitigate risks of dropout rates and incompleteness, the sample size of main study will be 100 dentists.

3.3 Developing survey

The authors modified and created the questionnaire from previous related studies and documents which survey and analyze factors affecting the dentist's decision to offer treatment options, which were integrated with the results of the pilot studies.

The questionnaire was developed based on their feedback from the pilot study so as to ensure valid questionnaire design. The content validity index (CVI) [89] was measured by 3 specialists in order to develop and improve each sections of the main questionnaire. The specialists were asked to rate the relevance of each item on a 4-point scale (1= not relevant, 2= somewhat relevant, 3= quite relevant, 4= highly relevant). In order to determine the validity of the questionnaire, only those responses indicating a 'quite relevant' (3), or 'highly relevant' (4) level are considered[89]. Such responses are summed and divided by the total number of questions.   According to Polit and Beck[89], CVI should more than .80 in order to determine that the questionnaire is valid. The results indicated that the CVI was .972. The quality of this questionnaire will be proved for validity and reliability by an advisor, co-advisor, and specialist.

After proving and developing the questionnaire and incorporating feedback from pilot study, the edited questionnaire will be distributed to the sample of the main study. An online questionnaire-based survey via Google Forms was randomly distributed among dentists from all departments in the Faculty of Dentistry, Chulalongkorn University from January to March 2021.

Ethical approval and inform consent should be given by the participants before attending this research.
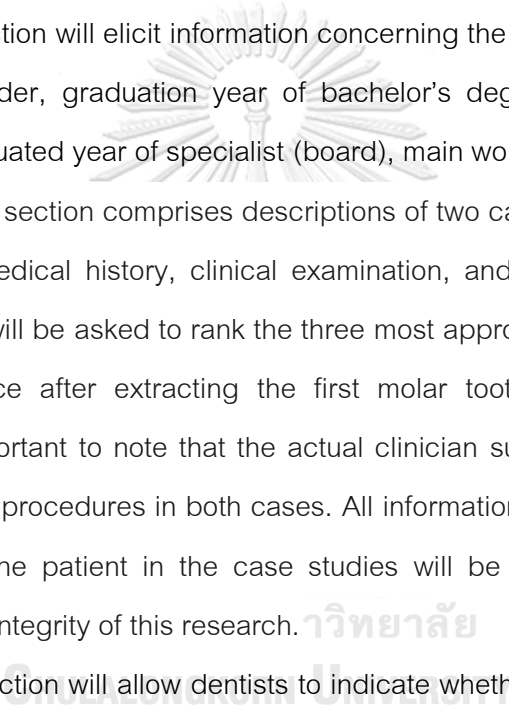
3.4 Research instruments

The research instruments of this study include an online questionnaire created and distributed by Google Forms which has been modified and created based on previous related studies and documents.

3.4.1 Pilot study questionnaire is divided into 7 sections

The aim of the pilot study is to aggregate and survey practicing dentist's reasons for offering or refusing to offer tooth autotransplantation as a treatment option for replacing missing teeth in patients.

The first section will elicit information concerning the dentist's demographic data involving age, gender, graduation year of bachelor's degree of dentistry, specialist branches and graduated year of specialist (board), main workplace, and income.

The second section comprises descriptions of two case scenarios with details of chief complaint, medical history, clinical examination, and radiographic examination. Then, the dentists will be asked to rank the three most appropriate treatment options for replacing the space after extracting the first molar tooth, based on their clinical judgment. It is important to note that the actual clinician successfully performed tooth autotransplantation procedures in both cases. All information and data which are linked to the identity of the patient in the case studies will be anonymized to ensure the anonymity and the integrity of this research.

The third section will allow dentists to indicate whether tooth autotransplantation for the case scenario in the second section would be an appropriate treatment alternative.

Fourth, this section will ask about the dentist's background and attitude of tooth autotransplantation.

The fifth section will require dentists to indicate the three most important reasons or supply their own reasons as to why they would or would not propose tooth autotransplantation in their options.

The sixth section will ask 8 facts about tooth autotransplantation such as advantages, indication, and limitation for surveying the dentist's knowledge and perception.

The last section will allow dentists to provide recommendations and feedback.

Based on responses, the 5th section of the main study will be amended to include reported reasons thus making the main questionnaire more streamlined and easier to complete.

3.4.2 **Main study questionnaire** is divided into 7 sections

The first section will elicit information concerning the dentist's demographic data involving age, gender, graduation year of bachelor's degree of dentistry, level of education, specialist branches and main workplace, and income.

Based on the results of the initial pilot study, one case study was selected to be used in probing respondents' choice of proposal to lessen the amount of time required to complete the survey. The second section comprises a description of a case scenario with details of chief complaint, medical history, clinical examination, and radiographic examination. The dentists will be asked to rank the three most appropriate treatment options for replacing the space after extracting the first molar tooth, based on their clinical judgment.

The third section will allow dentists to indicate whether tooth autotransplantation for the case scenario in the second section would be an appropriate treatment alternative. Another question will probe whether dentists propose tooth autotransplantation for patients when presented with the opportunity to do so.

Following this, the fourth section consists of two parts. The first part will require dentists to explain the reasons why they would or would not propose tooth autotransplantation to the patients whose teeth can be transplanted in relation to responses in section 3. The second part will require dentists to choose the three most important reasons or supply their own reasons from a dropdown form across three categories comprising clinical factors, and two non-clinical factors (patient-related

factors and dentist-related factors). Reasons in the dropdown form of the latter part were developed from the results of the pilot study.

The fifth section will ask about the dentist's background and attitude toward tooth autotransplantation.

The sixth section will probe dentists' knowledge concerning 10 aspects of tooth autotransplantation such as the advantages, indication, and limitation with answers being indicated by a Likert scale 1-10 (strongly disagree to strongly agree).

The last section will allow dentists to provide recommendations and feedback.

3.5 Data collection

Google Drive will be used to collect online questionnaires that can be accessed by link. The faculty staff in each department of the faculty of dentistry, Chulalongkorn University, will receive an accessible explanation and QR code.

Following approval by the Ethics Committee of Chulalongkorn University, the author will send the questionnaire link to the sample group, which grants access to the questionnaire and research explanation. Once sufficient data have been collected, the researcher will investigate the data before analyzing the data.

The identity of the respondent will be kept confidential and anonymous at all times and the access of the data will only be limited to the researcher.

3.6 Data analysis

Four types of analysis are proposed for this research.

First, descriptive statistics is used to capture and describe the participants' demographic data. Categorical data will be presented using frequency and percentage, while continuous data will be presented by means and standard deviations (SD). Data may be grouped or subdivided in order to achieve assumptions of various statistical tests, (e.g., grouping to achieve normal distribution).

Second, several statistical analyses will be conducted. Here, a Chi-square Test for Independence will allow the researcher to determine the independence of variables with others in the dataset. In the section probing reasons for the respondents' decisions, reasons will be categorized into positive and negative response prior to analysis.

Treatment-related reasons will be categorized into outcome and procedure groups. For the patient-related reasons, patient's affordability, patient's behavior, and patient's affectation of AT will be the main categories. Finally, the dentist-related reasons are categorized into 4 groups comprising the dentist's knowledge, dentist's experience and confidence, dentist's expertise, and dentist's environment. Similarly, when appropriate, independent t-tests can be employed in order to quantify the extent to which respondents understood various information when divided into 'propose' and 'not propose' groups. In addition, in order to more efficiently determine relationships among questions probing knowledge and the other variables, responses will be divided based on level of understanding, such that scores higher than 8 will be considered to be 'understood' and scores lower, 'not fully understood'. This will allow for the research to potentially identify gaps in knowledge or understanding related to the tooth autotransplantation. In addition, the McNemar test will allow for changes before and after priming to be made explicit and determine whether a statistically significant difference was observed.

The study will make use of multiple logistic regression to qualify the relationship between the independent variable and dentist's unprimed and primed decisions to produce a formula which captures this relationship.

3.7 Expected benefits

The data of this study will provide insight into which factors affect the dentist's decision to propose a tooth autotransplantation and elucidate current gaps of knowledge which may contribute to whether the dentist's decision was limited.

The result will show perceived strengths and drawbacks of tooth autotransplantation and how these affect the dentist's decision. Such weaknesses, if present, will can be identified and improved upon across many fields of use. On the other hand, strengths will be encouraged and stand to support increased usage of tooth autotransplantation by general dentists as a treatment for replacing missing teeth in the future.

This is important as such gaps in knowledge inevitably stem from outdated forms of dental practice instruction in dental curricula, which may need to be modified to incorporate effective and efficient practices. Moreover, the results of this study will behoove pursuits of evidence-based practice.

Additional continuing education courses for tooth autotransplantation practices could be offered to dentists who are unfamiliar with this practice or doubtful about tooth autotransplantation. Ultimately, it is the patients who will receive the greatest benefits from this solution. The benefits of this procedure will allow patients to make use of their own tooth which serves as a shock absorber and a proprioceptive receptor in function. Moreover, it is markedly more cost effective when compared with other treatment options and is covered by public health insurance policies, meaning that general patients can easily access this form of treatment.

3.8 Project management plan

Year / Procedure	2019 Nov	Dec	2020 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Literature Review	■	■	■	■										
Proposal preparation		■	■	■	■	■								
Proposal defense						■	■							
Submit ethical committee for pilot study							■							
Pilot study								■						
Submit ethical committee for main study								■	■					
Main survey									■	■	■			
Data collection and analysis										■		■		
Thesis and manuscript preparation											■	■	■	
Manuscript submission												■	■	■

3.9 Budget of Research

N	Item	Cost
1	Project participants: Compensation 200 x 100	THB 20,000.00
2	Survey Supplies & Expenses:	THB 1,000.00
	QR Code Printing	-
	PR Printing	-
3	Data Entry & Pre-processing	THB 2,000.00
4	Research Publishing	THB 2,000.00
	GRAND TOTAL	THB 25,000.00

CHAPTER IV

Result

Part 1

       1.1 Demographic information of respondents is summarized in the below Table 1, which contains information comprising gender, age, clinical experience, postgraduate qualifications (i.e., board certification), main workplace, group of income, and field of expertise.

Table 2: Demographic Information of Respondents.

Demographic information		Data	n(99)	%
1	Gender	Male	26	26.3
		Female	73	73.7
2	Age (Mean 30.84 yr., SD 6.238),	< 30 years	61	61.6
		≥ 30 years	38	38.4
3	Postgraduate experience (Mean 7.22 yr., SD 6.426)	< 7 years	66	66.7
		≥ 7 years	33	33.3
4	Postgraduate qualification	General dentists	79	79.8
		Specialist (Board)	20	20.2
5	Field of expertise	General Dentistry	24	24.2
		Oral and Maxillofacial Surgery	22	22.2
		Periodontics	4	4
		Orthodontics	5	5.1
		Prosthodontics	6	6.1
		Pediatric Dentistry	3	3
		Endodontic	17	17.2
		Operative Dentistry	13	13.1
		Oral Medicine	1	1
		Occlusion and Orofacial Pain	4	4

6	Main workplace	Dental school	34	34.3
		Public hospital	33	33.3
		Private hospital, dental clinics	32	32.3
7	Groups of income	< 50,000 baht	58	58.6
		≥ 50,000 baht	41	41.4

A total of one hundred four responses were collected through the online questionnaire (response rate = 104%), of these, one duplicate and four inconsistent responses were excluded from the dataset producing a total of ninety-nine responses. The respondents comprised 73 females (73.7%) and 26 males (26.3%) with a mean age of 30.84 years (SD 6.238). Average clinical experience was found to be 7.22 years (SD 6.426) with a majority of the respondents being general dentists (79.8%) and the remainder being board-certified specialists (21.2%). Fields of expertise were found to be General Dentistry (24.2%), Oral and Maxillofacial Surgery (22.2%), Endodontics (17.2%), Operative Dentistry (13.1%), Prosthodontics (6.1%), Orthodontics (5.1%), Periodontics (4%), Occlusion and Orofacial Pain (4%), Pediatric Dentistry (3%), and Oral Medicine (1%). In addition, respondents indicated a number of workplaces, which comprised dental schools (34.3%), public hospitals (33.3%), as well as private hospital and dental clinics (32.3%). Fifty-eight respondents (58.6%) had income less than 50,000 baht per month.

Table 2: Dentist's Experience with Tooth Autotransplantation (n=99).

	Variables	Data	n	%	Unprimed Response		Primed Response	
					Propose (%)	Not (%)	Propose (%)	Not (%)
1	Experience with AT*							
	Learn	Yes	94	94.9	54(57.4%)	40(42.6%)	78(83.0%)	16(17%)
		No	5	5.1	3(60%)	2(40%)	4(80%)	1(20%)
	Seen	Yes	44	44.4	32(72.7%)	12(27.3%)	39(88.6%)	5(11.4%)
		No	55	55.6	25(45.5%)	30(54.5%)	43(78.2%)	12(21.8%)

	Done	Yes	5	5.1	3(60%)	2(40%)	5(100%)	0(0%)
		No	94	94.9	54(57.4%)	40(42.6%)	77(81.9%)	17(18.1%)
	Propose	Yes	53	53.5	43(81.1%)	10(18.9%)	52(98.1%)	1(1.9%)
		No	46	46.5	14(30.4%)	32(69.6%)	30(65.2%)	16(34.8%)
2	Proposal Style	Deliberative model	27	27.3	13(48.1%)	14(51.9%)	22(81.5%)	5(18.5%)
		Informative model	73	72.7	44(61.1%)	29(38.9%)	60(83.3%)	13(16.7%)

*AT = Tooth Autotransplantation

Responses revealed that 94 respondents (94.9%) have learned about AT in their courses of study, while only 5 (5.1%) had not learned about this treatment. Of those who had learned about AT, 54 respondents (57.4%) indicated that AT would be a proposed treatment option in the unprimed case scenario, while 78 (83.0%) indicated AT as a proposed treatment when primed for bias. Of the 5 respondents who had not learned about AT in previous courses of study, 3(60%) proposed AT as a treatment option. Once primed and provided the opportunity to reassess the same case (primed), 4 (80%) indicated AT as a possible option.

A total number of 44 respondents (44.4%) indicated that they have seen AT conducted by another clinician. Of these 32 (72.7%) respondents chose to propose this treatment in the unprimed case scenario, while 39 (88.6%) indicated AT as a possible treatment once primed. Fifty-five respondents (55.6%) indicated that they have not seen AT. Of these, 32 respondents (72.7%) chose to propose AT in the unprimed case scenario, while once primed, 39 respondents (88.6%) proposed AT.

Of the 5 respondents (5.1%) who have applied this treatment, 3 (60%) indicated AT as a possible treatment in the unprimed case scenario, and within this group all participants (100%) proposed AT once primed on the same case scenario. Responses revealed that 94 respondents (94.9%) have not applied this treatment. In the unprimed case scenario, 54 of these respondents (57.4%) chose to propose AT as one of treatment options, while 77 respondents (81.9%) chose to propose this treatment when primed.

Fifty-three participants (53.5%) indicated that they have proposed AT to patients in clinical settings. Of these, 43 participants (81.1%) chose to propose AT in the

unprimed case study. Once primed, 52 (98.1%) of 53 respondents proposed AT as a possible treatment. Of the 46 participants (46.5%) who have not proposed AT to patients, 14 (30.4%) proposed AT as a treatment option prior to priming. When primed to reassess the same case, 30(65.2%) indicated AT as one of the options.

In terms of proposal styles, of the 27 respondents (27.3%) who adopt a deliberative style, 13 people (48.1%) indicated that they would propose AT as a treatment option in the unprimed case study, while 22 (81.5%) proposed AT once primed. For the 73 (72.7%) respondents who adopt an informative approach to treatment proposal, 44 (61.1%) indicated AT as one of the proposed treatment options in the unprimed case scenario, yet 60 (83.3%) indicated AT once primed.

Table 3 : Comparison of Unprimed and Primed Responses.
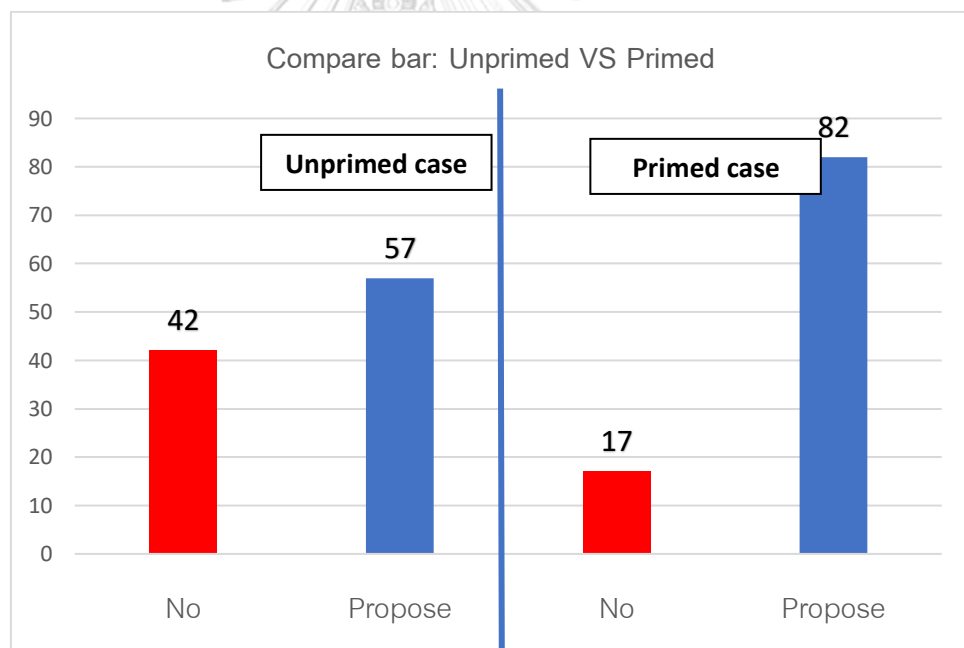
As can be seen, the number of respondents who chose to propose AT changed once primed, such that after being primed and notified that AT was a viable treatment option an increase of 25.2% (25 respondents) in proposals was observed.
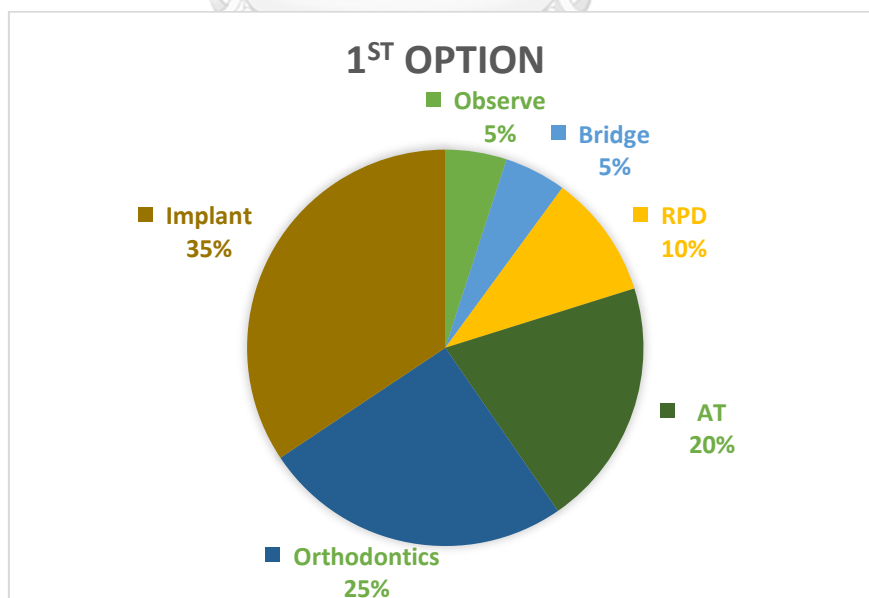
1.2 Descriptive data from unprimed case scenario (Unprimed).

Table 4 : Respondents' Decision to Propose AT in an Unprimed Case Scenario.
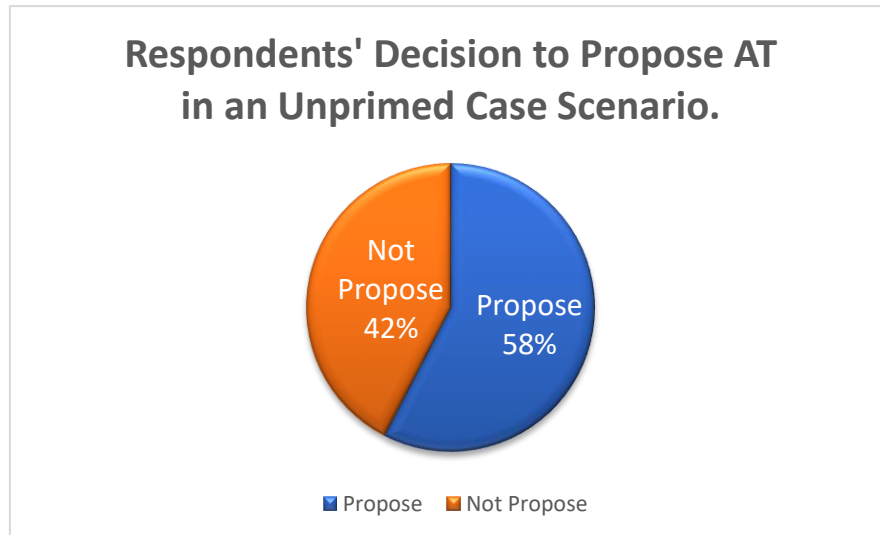
Overall, 57.6% (57) of respondents proposed AT as a potential treatment option in the unprimed case scenario.

Table 5 : The Primary Option that the Respondents Proposed to the Patient in Unprimed Case Scenario.

In terms of preference, 34.3% of respondents indicated implants as a first treatment option in the unprimed case study. This was followed by orthodontic treatment at 25.3%, AT at 20.2%, RPD at 10.1%, bridges at 5.1%, and observation at 5.0%.

1.3 Descriptive data from case scenario (primed).

Table 6 : Respondents' Decision to Propose AT in a Primed Case Scenario.

Respondents' Decision to Propose AT in a Primed Case Scenario.
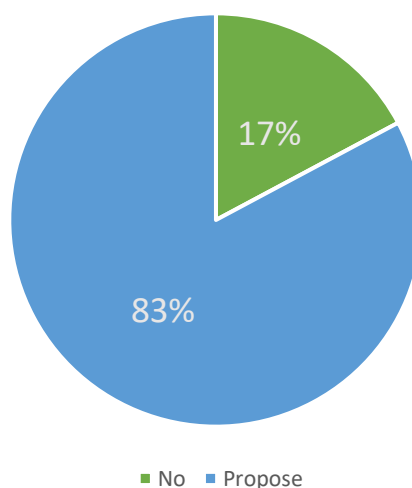
■ No ■ Propose

The percentage of dentist who proposed tooth autotransplantation as one of option when primed was found to be 82.8%.

1.4 The primary reasons why dentists would or would not propose AT to the patients in applicable case (Primed case).
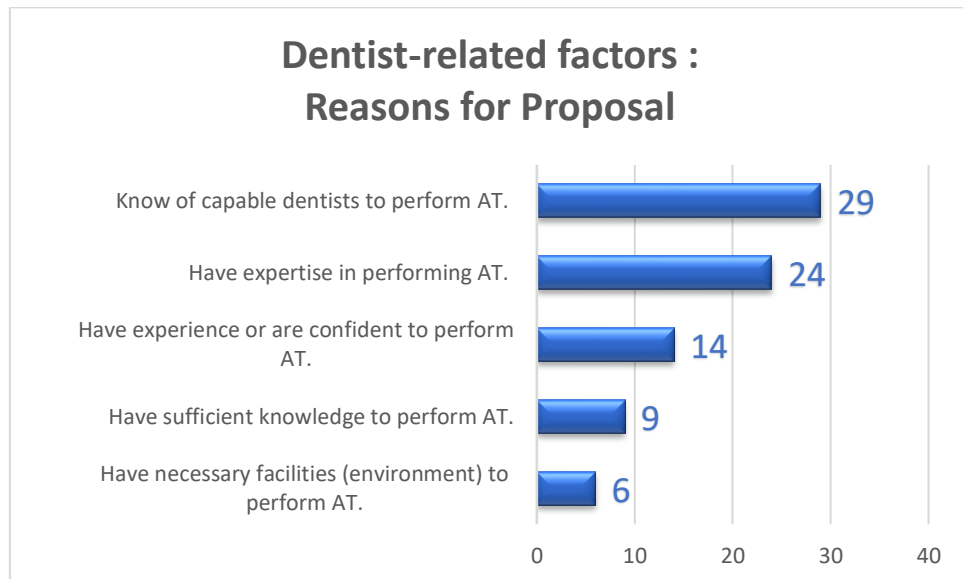
1.4.1 Dentist-related factors as Reasons for Proposal

Table 7 : The primary reasons why dentists would propose AT to the patients in applicable cases (Primed case)

For respondents who chose to propose AT to patients, of the 5 available reasons, the most frequently selected was "Knowledge of capable dentists to perform AT" with 29 responses (35.4%). Following this "Expertise in performing AT" accounted for 29.3% of total responses (24), "Experience or Confidence to perform AT" at 17.1% (14), "Sufficient Knowledge to perform AT" at 11% (9), and last "Necessary facilities (environment to perform AT with 7.3% (6).

Table 8 : The primary reasons why dentists would not propose AT to the patients in

applicable cases (Primed case)
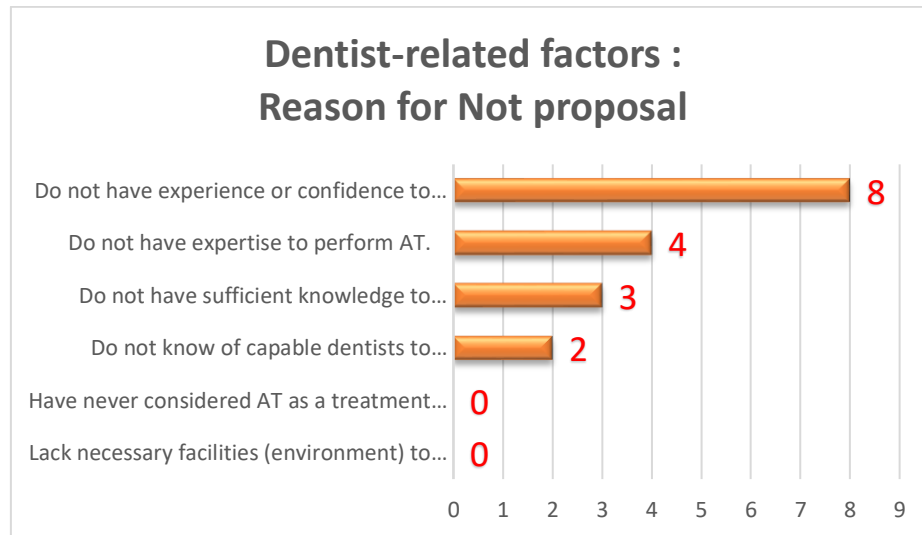
For respondents who chose not to propose AT to patients, of the 6 available reasons, the most frequently selected was "Insufficient Experience or Confidence to perform AT" with 8 responses (47.1%). Following this "Insufficient Expertise in performing AT" accounted for 29.4% of total responses (4), "Insufficient knowledge to perform AT" at 17.6% (3), and "Unknowledge of capable dentists to perform AT" at 11.8% (2). No respondents chose "Having never considered AT as a treatment option" and "Lack necessary facilities (environment) to perform AT" as a possible reason to support their decision to not propose AT.

1.4.2 Patient-Related Factors as Reasons for Proposal.

Table 9 : The primary reasons why dentists would propose AT to the patients in

applicable cases (Primed case)
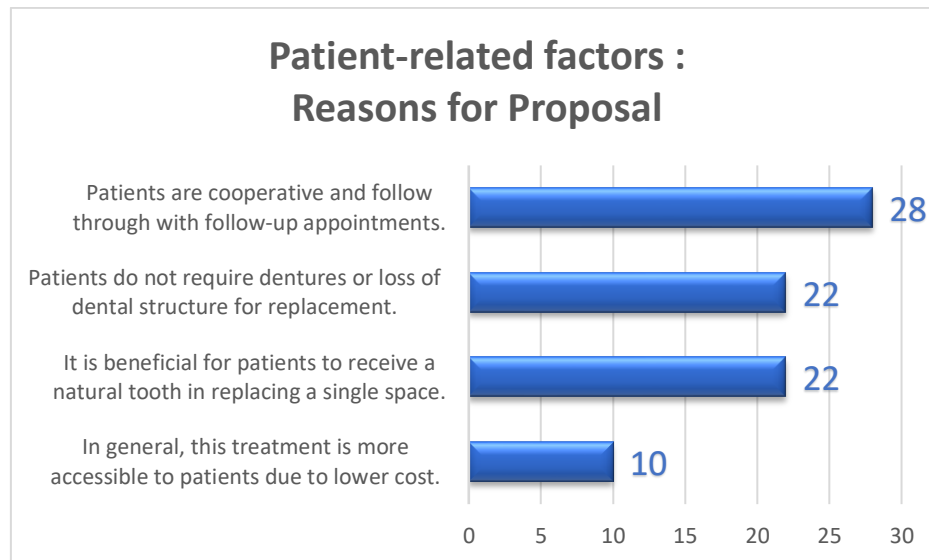
With regards to patient-related reasons among dentists who chose to propose AT as a treatment option, the most frequently indicated response was "Patients are cooperative and follow through with follow-up appointments" accounting for 34.1% (28) of all responses. Both "Patients do not require dentures or loss of dental structure for replacement" and "It is beneficial for patients to receive a natural tooth in replacing a single space" were selected 22 times, each, and accounted for 26.8% of total responses. The least frequently indicated response was "In general, this treatment is more accessible to patients due to lower cost", with 10 total responses (12.2%).

Table 10 : The primary reasons why dentists would not propose AT to the patients in applicable cases (Primed case).

Of the 4 possible reasons for dentists who chose not to propose AT, the most frequently selected option was "Patients are required to pay for root canal treatments and crown after AT" with was selected a total of 8 times (47.1%). All remaining three options were selected 3 times each, accounting for 17.6%, and comprising "Patients may experience discomfort with AT due to treatment duration and procedures", "Patients are not cooperative and do not attend follow-up sessions", and "Patients have to experience discomfort in two positions".
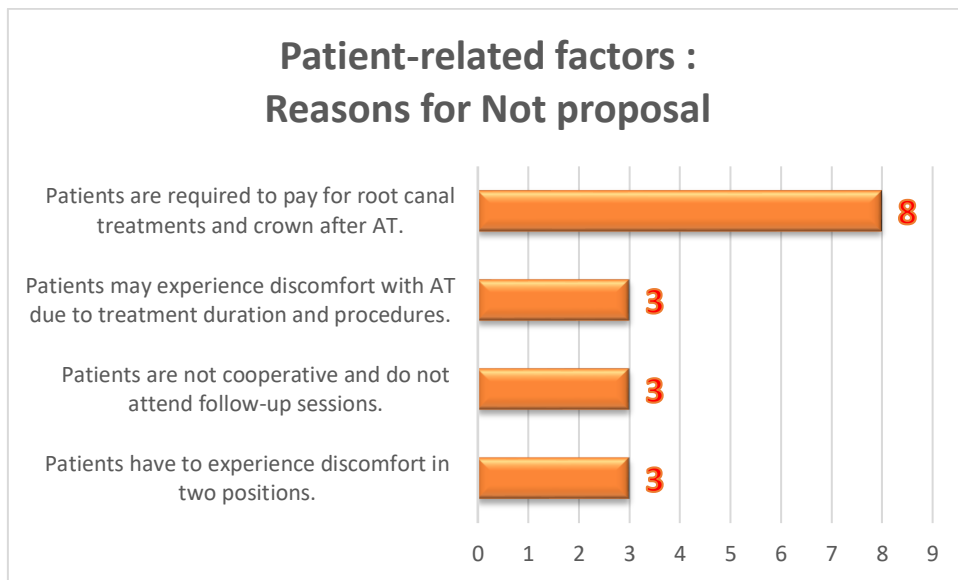
1.4.3 Treatment-Related Reasons as Reasons for Proposal.

Table 11 : The primary reasons why dentists would propose AT to the patients in

applicable cases (Primed case)

Within the group of dentists who proposed AT as a possible treatment option, a majority of respondents indicated that the presence of a proper donor tooth was the primary reasons for proposing AT, accounting for 63.4% (52) of total responses. Following this, 16 dentists (19.5%) indicated that there was a greater chance that AT could successfully resolve the case, while 14 (17.1%) adopted reasoning that a natural tooth would be more aesthetically appropriate.
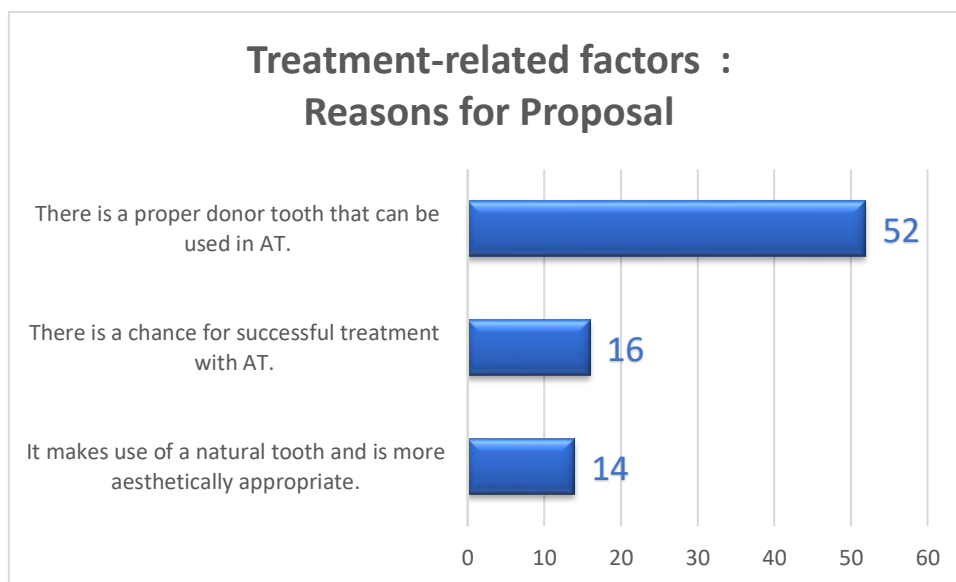
Table 12 : The primary reasons why dentists would not propose AT to the patients in applicable cases (Primed case).

**Treatment-related factors :
Reasons for Not proposal**

AT is a sensitive treatment which easily leads to complications.	7
Other treatment options are better, e.g., implant, bridge, orthodontic treatment,…	6
There is a small chance of successful treatment with AT.	4
Root canal treatment and crown are required after AT.	0
The procedure is lengthy and is complicated.	0
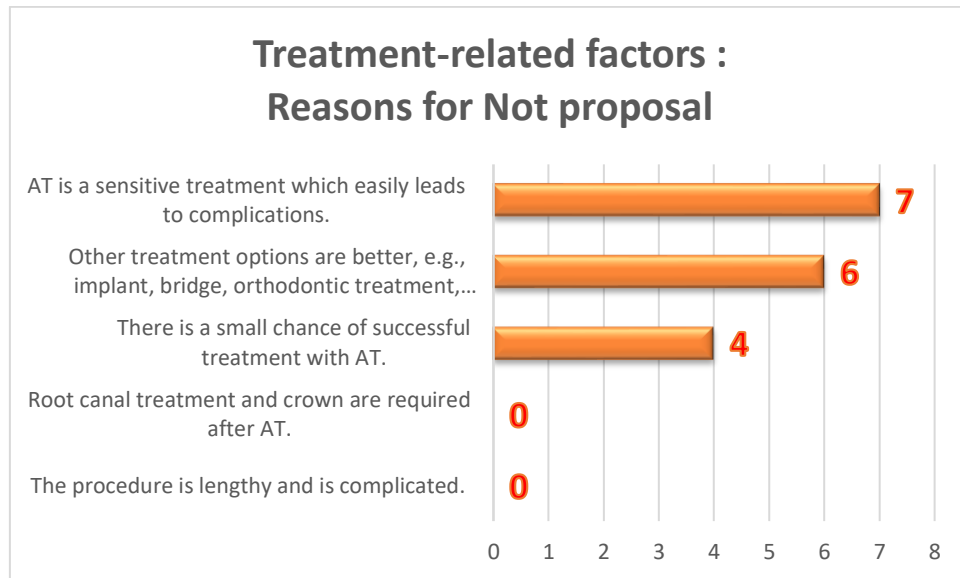
Seven dentists (41.2%) indicated that "AT is a sensitive treatment which easily leads to complications" as a primary reason for not proposing AT. Following this, 6 dentists (35.3%) felt that other treatment options may produce better results, e.g., implants, bridges, orthodontic treatment, or removable dentures. Only 4 dentists (23.5%) adopted reasoning that there was a small chance of success for AT, while no dentists selected "Root canal treatment and crown are required after AT" and "The procedure is lengthy and is complicated".

1.5 Changes in Proposal pre and post priming

Upon priming participants with knowledge that AT is an applicable solution to the case study, a total of 31 participants changed their decision, either from "propose" to "not propose" (3%) or from "not propose" to "propose" (28.3%). The remaining 68 participants adopted the same response in both unprimed and primed case scenarios. Consistent non-proposers totaled 14 (14.1%), while consistent proposers numbered 54 (54.5%).

Table 13 : Groups by Dentist's Decision to Propose AT in Both Unprimed and Primed

Case Scenarios

Group	Dentist's decision to propose AT		
	Unprimed	Primed	Amount (%)
1	No	Propose	28 (28.3%)
2	No	No	14 (14.1%)
3	Propose	No	3 (3%)
4	Propose	Propose	54 (54.5%)

1.5.1 Group 1

Group 1 will refer to the group of individuals who changed decisions from "not propose" to "propose" in either scenario. This group comprises 28 participants (28.3%), who further provided the following primary reasons to support their decision to propose AT post-priming in both open-ended and closed-ended questions.

Table 14 : The Most Common Reasons of Three Factors in Group 1.

Factors	The most common reasons	Percent
Treatment-related factors	Patient possessed a proper donor tooth which could be used to fill the gap.	50%
Patient-related factors	This procedure would be beneficial for the patient as it makes use of a natural tooth to fill a gap.	42.9%
Dentist-related factors	Knowledge of a dentist or specialist to whom the patient could be referred to undergo this procedure.	46.4%

Citing treatment-related factors, 50% of respondents chose to present AT as a possible treatment option and supported this decision with the fact that the patient possessed a proper donor tooth which could be used to fill the gap, i.e., teeth which have incomplete root formation, the patients is still young, and may heal favorably, to mention a few. Within this group, 42.9% of respondents provided patient-related factors such as the fact that this procedure would be beneficial for the patient as it makes use of a natural tooth to fill a gap. Reasons included that the natural tooth still possesses a functioning proprioceptive receptor, that there would be no need for removable dentures, and that the procedure incurs a relatively low cost. Some 46.4% of respondents made use of dentist-related factors to support their decision to propose AT, namely, that the respondents know of a dentist or specialist to whom the patient could be referred to undergo this procedure.

1.5.2 Group 2

Group 2 refers to the group of individuals who consistently did "not propose" despite being primed. In total this group comprised 14 members (14.1%).

Table 15 : The Most Common Reasons of Three Factors in Group2.

Factors	The most common reason	Percent
Treatment-related factors	Other treatment options are better, e.g., implant, bridge, orthodontic treatment, removable dentures, etc.	42.9%
Patient-related factors	Patients are required to pay for root canal treatments and crown after AT	42.9%
Dentist-related factors	The dentist lacks experience or confidence to perform AT	57.2%

Within this group, 42.9% of respondents provided treatment-related factors such as other treatment options are better, e.g., implant, bridge, orthodontic treatment, removable dentures, etc. Reasons included that AT was suggested to have a low success rate and unpredictable outcome. Citing patient-related factors, 42.9% of

respondents chose not to present AT as a treatment option and supported this decision

with the fact that the patients are required to pay for root canal treatments and crown

after AT. Some 57.2% of respondents made use of dentist-related factors to support

their decision not to propose AT citing that the respondents did not have sufficient

experience or confidence to perform AT.

       1.5.3 Group 3

Group 3 will refer to the group of individuals whose decisions went in the

opposite direction from Group 1, that is, dentists who changed their answer from

"propose" to "not propose" after being primed. In total, this group comprised 3

individuals (3%).

Table 16 : The Most Common Reason of Three Factors in Group3.

Factors	The most common reasons	Percent
Treatment-related factors	AT is a sensitive treatment which easily leads to complications	66.7%
Patient-related factors	Patients are required to pay for root canal treatments and crown after AT	66.7%
Dentist-related factors	Lack expertise to perform AT	66.7%

Some 66.7% of respondents made use of treatment-related factors to support

their decision not to propose AT in primed case indicating that AT is a sensitive

treatment which easily leads to complications. With regards to patient-related factors,

within group 3, 66.7% of respondents chose not to propose AT as the patients are

required to pay for root canal treatments and crown after AT. Similarly, the same number

of group members cited dentist-related factors as reasons for not presenting AT as a

treatment option and supported this decision with the fact that they lack expertise in this

domain.

1.5.4 Group 4

Group 4 refers to the group of individuals who consistently chose to "propose" AT in both unprimed and primed case scenarios. In total, this group comprised 54 members (54.5%).

Table 17 : The Most Common Reasons of Three Factors in Group4.

Factors	The most common reasons	Percent
Treatment-related factors	There is a proper donor tooth that can be used in AT	68.5%
Patient-related factors	Patients are cooperative and follow through with follow-up appointments	40.7%
Dentist-related factors	Knowledge of capable dentists to perform AT	29.6%
	Have expertise in performing AT	27.8%

Citing treatment-related factors, 68.5% of respondents chose to present AT as a treatment option and supported this decision with the fact that there is a proper donor tooth that can be used in AT. Some 40.7% of respondents made use of patient-related factors to support their decision to propose AT in primed case indicating that the patients are cooperative and follow through with follow-up appointments. For dentist-related factors, there are two reasons which were selected with a similar prevalence. The most commonly selected reason is having "knowledge of capable dentists to perform AT" (29.6%) follow by "having expertise in performing AT" (27.8%).

Part 2

2.1 Non-Parametric Statistical Tests

2.1.1　Chi-square:

A univariate analysis was conducted employing the Chi-square test of independence in order to examine associations among variables comprising clinical and non-clinical factors, and dentists' decision to propose tooth autotransplantation in both primed and unprimed case scenarios. The results of these calculations are summarized in the following tables.

1 Non-clinical factors

1.1 Dentist-related factors

Table 18 Association between Dentist-related Factors and Dentist's Decision to Propose AT (n=99).

Non-clinical factors								
1.Dentist-related factors								
Variables		Data	n	%	Unprimed (% Propose)	P-value	Primed (% Propose)	P-value
1	Gender	Male	26	26.3	14(53.8%)	0.654	21(80.8%)	0.746
		Female	73	73.7	43(58.9%)		61(83.6%)	
2	Age	< 30 years	61	61.6	38(62.3%)	0.229	50(82.0%)	0.773
	(Mean 30.84 yr., SD 6.238),	≥ 30 years	38	38.4	19(50%)		32(84.2%)	
3	Postgraduate experience	< 7 years	66	66.7	41(62.1%)	0.196	55(83.3%)	0.851
	(Mean 7.22 yr., SD 6.426)	≥ 7 years	33	33.3	16(48.5%)		27(81.8%)	
4	Postgraduate qualification	General dentists	79	79.8	47(59.5%)	0.443	66(83.5%)	0.743
		Specialist (Board)	20	20.2	10(50%)		16(80%)	
		≥ 50,000 baht	41	41.4	21(51.2%)		34(80.5%)	
5	Field of expertise	General Dentistry	24	24.2	10(41.7%)	0.005***	18(75.0%)	0.165
		Oral and Maxillofacial Surgery	22	22.2	19(86.4%)		21(95.5%)	
		Others	53	53.5	28(52.6%)		43(81;1%)	
6	Main workplace	Dental school	34	34.3	21(61.8%)	0.777	30(88.2%)	0.567
		Public hospital	33	33.3	19(57.6%)		27(81.3%)	
		Private hospital and dental clinics	32	32.3	18(53.1%)		26(78.8%)	
7	Groups of income	< 50,000 baht	58	58.6	36(62.1%)	0.282	49(84.5%)	0.604
		≥ 50,000 baht	41	41.4	21(51.2%)		34(80.5%)	

*Note(s): *** indicates p < 0.05 (Chi-square test)*

<u>Demographic factors</u>

The univariate analysis revealed no significant associations between gender (Unprimed: $\chi2$ (1, n=99) = 0.201, p = 0.654; Primed: $\chi2$ (1, n=99) =0.105, p = 0.746), age (Unprimed: $\chi2$ (1, n=99) = 1.449, p = 0.229; Primed: $\chi2$ (1, n=99) = 0.083, p = 0.773), postgraduate experience (Unprimed: $\chi2$ (1, n=99) = 1.675, p = 0.196; Primed: $\chi2$ (1, n=99) = 0.036, p = 0.851), postgraduate qualification (Unprimed: $\chi2$ (1, n=99) = 0.589, p = 0.443; Primed: $\chi2$ (1, n=99) = 0.141, p = 0.707), field of expertise (Primed: $\chi2$ (2, n=99) = 3.607, p = 0.165), main workplace (Unprimed: $\chi2$ (2, n=99) = 0.504, p = 0.777; Primed: $\chi2$ (2, n=99) = 1.134, p = 0.567), and group of income (Unprimed: $\chi2$ (1, n=99) = 1.158, p= 0.282; Primed: $\chi2$ (1, n=99) = 0.270, p = 0.604), and dentist's decision to propose a tooth autotransplantation. However, a significant association was found between field of expertise and the dentist's decision in the unprimed case scenario ($\chi2$ (2, n=99) = 10.440, p=0.005).

Table 19 : (con.): Association between Dentist-related Factors and Dentist's Decision to Propose AT (n=99).

Non-clinical factors							
1.Dentist-related factors							
Variables		Data	n	%	Unprimed (% Propose)	P-value	Primed (% Propose)	P-value
8	Experience of AT							
	Learn	Yes	94	94.9	54(57.4%)	0.910	78(83.0%)	0.863
		No	5	5.1	3(60%)		4(80%)	
	Seen	Yes	44	44.4	32(72.7%)	0.006***	39(88.6%)	0.171
		No	55	55.6	25(45.5%)		43(78.2%)	
	Done	Yes	5	5.1	3(60%)	0.910	5(100%)	0.296
		No	94	94.9	54(57.4%)		77(81.9%)	
	Propose	Yes	53	53.5	43(81.1%)	<0.001***	52(98.1%)	<0.001***
		No	46	46.5	14(30.4%)		30(65.2%)	
9	Proposal Style	Deliberative model	27	27.3	13(48.1%)	0.245	22(81.5%)	0.828
		Informative model	73	72.7	44(61.1%)		60(83.3%)	

*Note(s): *** indicates p < 0.05 (Chi-square test)*

Dentist's experience of tooth autotransplantation and proposal style

In the unprimed case scenario, having "seen" and "proposed" tooth autotransplantation were significantly associated with the dentists' decision to propose AT (Seen: χ^2 (1, n=99) = 7.444, p-value = 0.006; Propose: χ^2 (1, n=99) = 25.913, p < 0.001). Having "proposed" AT was also significantly associated with the respondents' decisions to propose this treatment in the primed case scenario as well (Propose: χ^2 (1, n=99) = 18.736, p-value < 0.001). However, individual proposal styles were not significantly associated with decisions to propose AT in either case scenario.

The univariate analysis revealed no significant associations between having "learned" (Unprimed: χ^2 (1, n=99) = 0.013, p = 0.910; Primed: χ^2 (1, n=99) =0.030, p = 0.863), "seen" (Primed: χ^2 (1, n=99) = 1.878, p = 0.171), or "done" (Unprimed: χ^2 (1, n=99) = 0.013, p = 0.910; Primed: χ^2 (1, n=99) =1.092, p = 0.296) AT with the respondent's decision to propose AT. Similarly, no significant association between "proposal style" and the respondent's decision was observed (Unprimed: χ^2 (1, n=99) = 1.351, p = 0.245; Primed: χ^2 (1, n=99) =0.047, p = 0.828).

The primary reason why respondents would or would not propose AT to AT-eligible patients (Primed case)

Table 20 : Association between Dentist-related Factors and Dentist's Decision to Propose AT (n=99).

Non-clinical factors						
1.Dentist-related factors						
Variable		Data	n	%	Primed (% Propose)	P-value
1 The primary reason		Knowledge	12	12.1	9(75.0%)	0.443
		Others	87	87.9	73(83.9%)	
		Experience and confidence	22	22.2	14(63.6%)	0.007***
		Others	77	77.8	68(88.3%)	
		Expertise	28	28.3	24(85.7%)	0.633
		Others	71	71.7	58(81.7%)	
		Environment	37	37.4	35(94.6%)	0.016***
		Others	62	62.6	47(75.8%)	

*Note(s): *** indicates p < 0.05*

    In the primed case scenario, a significant association was revealed between dentists' concern about "experience and confidence in performing AT" with the dentists' decision to propose AT (χ^2 (1, n=99) = 7.325, p = 0.007). Moreover, having a "proper environment and equipment" were significantly associated with the dentists' decision (χ^2 (1, n=99) = 5.751, p = 0.016) in the primed case.

    No significant association between the dentist's "knowledge" (χ^2 (1, n=99) = 0.588, p = 0.443), or "expertise in AT" (χ^2 (1, n=99) = 0.229, p = 0.633) and the dentists' decision was found.

1.2 Patient-related factors

Table 21 : Association between Patient-related Factors and Dentists' Decision to

Propose AT (n=99).

Non-clinical factors						
2.Patient-related factors						
	Variable	Data	n	%	Primed (% Propose)	P-value
1	The primary reason	Patient's affordability	18	18.2	10(55.6%)	0.001***
		Others	81	81.8	72(88.9%)	
		Patient's behavior	34	34.3	28(82.4%)	0.928
		Others	65	65.7	54(83.1%)	
		Patient's impression of AT	47	47.5	44(93.6%)	0.007***
		Others	52	52.5	38(73.1%)	

Note(s): *** indicates p < 0.05

Concerns of the patient's ability to "afford the treatment" as well as concerns of the patient's "impression of AT" were both significantly associated with the dentists' decision to propose AT ($\chi 2$ (1, n=99) = 11.505, p = 0.001; $\chi 2$ (1, n=99) = 7.323, p = 0.007, respectively) in the primed case.

Conversely, no association between "patient's behavior" and the dentist's decision to propose AT were found ($\chi 2$ (1, n=99) = 0.008, p = 0.928).

1.3 Treatment-related factors

Table 22: Association between Treatment-related Factors and Dentists' Decision to Propose a AT (n=99).

Clinical factors						
3. Treatment-related factors						
Variable		Data	n	%	Primed (% Propose)	P-value
1	The primary reason	Outcome	42	42.4	31(73.8%)	0.041***
		Other	57	57.6	52(89.5%)	
		Procedure	57	57.6	52(89.5%)	0.041***
		Other	42	42.4	31(73.8%)	

*Note(s): *** indicates p < 0.05*

In the primed case scenario, both concerns of "treatment outcome" and "treatment procedure" were revealed to be associated with the dentist's decision to perform AT (χ^2 (1, n=99) = 4.172, p = 0.041; χ^2 (1, n=99) = 4.172, p = 0.041, respectively).

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2.2 Independent T-test

Table 23: Results of Independent t-test between facts about AT in unprimed and primed case scenarios

No.	Facts	Groups	Unprimed				Primed			
			n	Mean	SD	P-value	n	Mean	SD	P-value
1	Both incomplete and complete root formation can be transplanted.	Propose	57	7.53	2.331	<0.001***	82	6.80	2.701	0.151
		No	42	5.24	3.207		17	5.35	3.807	
2	Not only young patient but also older patients are eligible for AT.	Propose	57	6.47	2.414	0.052	82	6.16	2.589	0.267
		No	42	5.40	2.988		17	5.35	3.239	
3	Not only the third molars but also any non-functional natural tooth is an eligible donor for AT.	Propose	57	7.95	2.371	0.349	82	7.87	2.557	0.351
		No	42	7.38	3.320		17	6.94	3.816	
4	AT requires a donor tooth from the patient that fits the recipient site.	Propose	57	8.77	2.018	0.981	82	8.82	1.988	0.595
		No	42	8.76	2.034		17	8.53	2.183	
5	AT costs less than dental implants.	Propose	57	7.86	2.474	0.077	82	7.68	2.610	0.055
		No	42	6.88	2.965		17	6.29	3.037	
6	The procedure is lengthy and is complicated.	Propose	57	6.33	2.911	0.236	82	6.22	2.902	<0.001***
		No	42	7.02	2.763		17	8.59	1.543	
7	AT requires a high level of surgical skill for atraumatic extraction and preparation of the recipient site to fit donor tooth.	Propose	57	9.51	0.889	0.580	82	9.44	0.904	0.545
		No	42	9.40	0.964		17	9.59	1.004	
8	After transplantation, the patient has to follow up frequently.	Propose	57	8.91	1.672	0.960	82	8.87	1.639	0.470
		No	42	8.93	1.520		17	9.18	1.425	
9	Success rates and survival rates of the transplanted tooth are more than 90%.	Propose	57	7.53	1.691	0.001***	82	7.34	1.604	0.002***
		No	42	6.10	2.218		17	4.88	2.713	

10	After transplantation, the donor tooth has a chance to revascularize without using a root canal treatment.	Propose	57	5.95	2.682	0.007***	82	5.45	2.663	0.335
		No	42	4.50	2.412		17	4.76	2.635	

Note(s): *** indicates p < 0.05 (independent T-test)

Dentists' knowledge concerning 10 aspects of tooth autotransplantation

The mean Likert score in both "propose" and "not propose" groups' responses concerning 10 facts about AT are shown in Table 23.

In the unprimed case scenario, a significant difference was revealed between the dentists' decision to propose AT (M=7.53, SD =2.331) and not propose AT (M=5.24, SD=3.20) with the scores of fact no.1 (t(71.229) = -3.923, p <0.0001). Similarly, fact no. 9 and 10 were both found to have significant differences as well (Propose: M=7.53, SD=1.691; Not Propose: M=6.10, SD=2.218, t(97) = -3.644, p<0.0001; and Propose: M=5.95, SD=2.682, Not Propose: M=4.50, SD=2.412, t(97) = -2.768, p=0.007, respectively). No significant differences between means were observed with other facts in the unprimed case study.

In the primed case study, both fact no. 6 and fact no 9. were observed to have significantly different means among responses of the "propose" and "not propose" groups (Propose: M=6.22, SD= 2.902; Not Propose: M=8.59, SD =1.543, t(43.433) = 4.807, p<0.0001; and Propose: M=7.34, SD=1.604, Not Propose: M=4.88, SD = 2.713, t(18.384) = -3.609, p=0.002, respectively). No other significant differences were found in the remaining facts.

2.3 McNemar Test:

Table 24 : McNemar Test Compare Unprimed and Primed.

Unprimed	Primed	
	Not Propose	Propose
Not Propose	14	28
Propose	3	54

Test Statistics[a]	Unprimed & Primed
N	99
Chi-Square[b]	18.581
Asymp. Sig.	.000

a. McNemar Test b. Continuity Corrected

The dentist's decision to propose AT significantly changed after being primed (χ^2 (1, n=99) = 18.581, p < 0.0001).

Part 3

The multiple logistic regression to qualify the relationship between the independent variable and the dependent variable and to create a formula which captures this relationship is presented in the below tables.

Table 25 : Logistic Regression Models for The Association Between Variables and Dentist's Decision to Propose AT in Unprimed case.

Variables (Unprimed)		Dentist's decision to propose AT (Propose)	
		Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Postgraduate experience	< 7 years	1	1
	≥ 7 years	0.574(0.247-1.336)	0.289(0.080-1.046)
Field of expertise	General Dentistry	1	1
	Oral and Maxillofacial Surgery	8.867(2.052-38.305) **	5.588(0.976-33.132)
	Others	1.568(0.592-4.154)	2.199 (0.622-7.780)
Dentist's experience of AT			
Seen	No	1	1
	Yes	3.200(1.368-7.484) **	1.034(0.313-3.418)
Propose	No	1	1
	Yes	9.829(3.872-24.951) ***	9.592(2.927-31.432) ***
Knowledge			
Fact No.1	Score < 8	1	1
	Score ≥ 8	4.431(2.017-11.570) ***	4.035 (1.262-12.901) *
Fact No.5	Score < 8	1	1
	Score ≥ 8	2.000(0.883-4.532)	1.391(0.448-4.319)
Fact No.9	Score < 8	1	1
	Score ≥ 8	4.730(1.951-11.468) ***	1.171(0.278-4.940)
Fact No.10	Score < 8	1	1
	Score ≥ 8	3.415(1.150-10.139) **	1.345(0.221-8.166)

*Note(s):   *** indicates p< 0.001; ** indicates p< 0.01; * indicates p<0.05; CI: confidence interval*

The multivariable analysis revealed that dentists who have previously proposed AT to patients were 9.592 times more likely (95% C.I., 2.927 – 31.432) to propose AT as a possible treatment in the unprimed case. Similarly, dentists who provided scores higher than 8 on the 10-point Likert scale of fact no. 1 were found to be 4.035 times

more likely (95% C.I., 1.262 - 12.901) to propose AT than those who provided lower scores.

Table 26 : Logistic Regression Models for The Association Between Variables and Dentist's Decision to Propose AT in the Primed case.

Variables (Primed)		Dentist's decision to propose AT	
		Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Field of expertise	General Dentistry	1	1
	Oral and Maxillofacial Surgery	7.000(0.769-63.723)	2.834 (0.203-39.590)
	Others	1.433(0.453-4.536)	2.448 (0.516-11.605)
Dentist's experience of AT			
Seen	No	1	1
	Yes	2.177(0.703-6.737)	0.465 (0.089-2.442)
Propose	No	1	1
	Yes	27.733(3.501-219.706) **	27.967 (2.754-284.040) **
Knowledge			
Fact No.5	Score < 8	1	1
	Score ≥ 8	2.476(0.853-7.185)	2.454 (0.627-9.600)
Fact No.6	Score < 8	1	1
	Score ≥ 8	2.943(0.943-9.039)	2.175 (0.540-8.771)
Fact No.8	Score < 8	1	1
	Score ≥ 8	0.401(0.107-1.496)	0.413 (0.065-2.615)
Fact No.9	Score < 8	1	1
	Score ≥ 8	7.875(1.692-36.647) **	5.637 (0.883-35.983)

Note(s): *** indicates p< 0.001; ** indicates p< 0.01; * indicates p<0.05; CI: confidence interval

In the primed case scenario, multivariable logistic analysis revealed several significant likelihoods. Dentists who indicated that they have proposed AT to patients, were 27.967 times more likely (95% C.I., 2.754 – 284.040) to propose AT in the case scenario.

CHAPTER V

Discussion

A vast array of literature supports the fact that certain dentist-related, patient-related, and treatment-related factors influence a dentist's decision to propose treatment options for a patient[79, 83, 84, 86, 90, 91]. As can be seen in the results section of this study, tooth autotransplantation is no exception to this rule given that several factors were identified to produce statistically significant likelihoods relating to the dentist's decision to propose AT.

Priming respondents had a clear effect on respondent's decisions to propose AT as a possible treatment. Responses can be clearly divided into 4 distinct groups as proposed in Table 13 above. These divisions are useful as they allow for more granular consideration of tendencies and trends in responses.

Group 1 respondents provided indication that the case scenario was a suitable candidate for AT only after being primed and reminded of AT as a possible treatment. This provides further stock to the assumption that this group may have been largely unaware of AT and were made aware through the priming process.

Sharply contrasting with the above Group 1 is Group 2, which despite priming chose to not propose this option due to concerns of experience and confidence in performing this procedure. Despite their opposition to proposing AT, as can be inferred from the aforementioned reasoning, it is clear that experience and confidence were of greatest concern to this group. This, ultimately, supports the fact that previous exposure and use of AT, i.e., experience and confidence, are important to the decision-making process of this cohort.

Group 3, despite comprising only 3 individuals, unanimously chose to change their responses to not propose AT after being primed. The authors of this study assume that this was due to questionnaire fatigue or even possibly a misunderstanding in the prompt of the primed case study. Reasons provided for this decision centralized on reasoning similar to that provided in Group 2 which was concerned with experience.

The final major group, Group 4, correctly chose to propose AT in both the unprimed and primed case scenarios, and the main reasons adopted in this group oriented around the donor tooth assessment. This should be adopted in future educational promotion so that more dentists are aware of when patient has an appropriate donor tooth.

From the results of the Chi-square analyses it was revealed that a significant proportion of respondents with backgrounds in oral and maxillofacial surgery (OMFS) consistently proposed AT as one of treatment options. These respondents have garnered sufficient experience in closely observing and employing this treatment and are therefore more confident in their ability to successfully manage AT in the dental school setting employed in this study. In addition, having seen and proposed AT as well as having knowledge about AT was also significantly associated with the dentist's decision to propose AT with frequently cited concerns relating to experience and confidence, and the dentist's environment, (e.g., equipment, and facilities). Having proposed AT prior to the case study was the only significant variable observed in both the unprimed and primed case scenarios. This may indicate that experience with AT is an important factor, as if an individual has proposed or performed a procedure before and are informed that this procedure is an applicable treatment option, it is more likely that they will do so in subsequent cases.

Brigitte et al.'s [80] findings support this observation, and found that dentists with specializations in respective fields are more like to propose treatment options consistent with their field of specialization, (i.e., Endodontists consistently recommend treatment which falls within the scope of their practice such as root canal treatment or tooth conservation). Similar research conducted by Junges et al. [91] suggest that dentists' decision-making process may not have incorporated evidence present in the case, but was more closely associated with factors such as professional expertise and patients' preferences. Put simply, their findings indicate that different areas of specialization corresponded to different consideration of factors regarding decision making. Further support of these findings is found in studies conducted by Zitzmann et al. [91, 92] and

Cosyn et al. [84]. Both studies posit strong correlations between dentist-related factors such as experience and specialization with the dentist's decision to propose treatment options.

Be this as it may, research conducted by Lang-Hua et al. [81] found an opposing tendency in a group of specialists who had undertaken training in dental implants, such that postgraduate practitioners with implant training were three times more likely not to propose dental implant. The authors posit that this tendency may be due to familiarity with various better alternative methods of treatment, thus comprising dentist-related factors.

Such conclusions were apparent in studies conducted by Kronstorm et al. [82, 83], whose findings indicate that dentist-related factors had little bearing on the dentist's decision to propose fixed and removable partial dentures in a cohort of Swedish dentists. This discrepancy among findings may stem from several factors, as the discussed cohorts may have varying levels of preference and experience with different treatments[32]. Form this, it is possible that the decision to propose AT may be more susceptible to dentist-related factors, (e.g., specialization, experience, etc.), when compared with other treatments.

Aside from dentist-related factors, indicators comprising both treatment-related (i.e., outcome, procedure) and patient-related factors (i.e., affordability and affectation) were also found to be significantly associated with respondents' decisions to propose AT. This observation is supported by research conducted by Cosyn et al. [84] and Torabineja and Goodacre [79], who despite considering various forms of treatment, found similar associations with treatment-related and patient-related factors in their cohort and systematic reviews, respectively.

Specifically, fact no. 9 was observed to have a significant and strong association in both unprimed and primed case scenario. Given that the 'not propose' group obtained lower scores than the 'propose' group, this implies that some dentists misunderstand or are not up-to-date on recent evidence about success and survival rates of AT where recent research reports overall success rates of tooth

autotransplantation to be more than 90%[23, 24]. Many of the previous limitations of tooth

AT have been lessened by technologies such as CBCT, CARP, virtual surgical planning

technology, apicoectomy techniques, and Bioteeth[42-44]. Moreover, such suggestions are

line with the fundamental duty of practicing dentists to adopt an evidence-based

approach for treatment as opposed to relying on experience[92].

      As the hypothesis of this study was primarily concerned with dentist-related

factors, while treatment-related and patient-related factors were not included in the

multiple logistic regression analysis. In the unprimed case, dentists with experience in

proposing AT were nearly ten times more like to propose AT, and this likelihood tripled

once primed. As one of the central questions this study seeks to engage relates to

dentists' abilities to provide comprehensive treatment options to patients, this particular

finding may indicate that further training and awareness around this treatment option

may stand to benefit both practitioners and patients alike.

      In the unprimed regression analysis, respondents who responded correctly to

fact no. 1 were over 4 times more likely to propose AT. This did not carry over to the

regression analysis after being primed, respondents knew that AT was a possible

treatment. In addition, no knowledge-related factors were significantly associated with

the decision to propose this treatment in the primed case scenario.

RECOMMENDATIONS

      Ultimately the results of this study indicate that the dentist's knowledge,

experience, and confidence significantly affect their decision to propose AT. Therefore,

it is reasonable to conclude that when presented with low instances of this treatment,

faculty may need to consider methods of increasing dentist's knowledge, experience

and confidence of AT. One way to do so could be to create media about AT for dentists.

As was observed, knowledge pertaining to AT was lacking in some participants,

specifically, questions probing knowledge of success rates, indications, and benefits of

the treatment were found to be closely associated with the decisions to propose AT. This

indicates that these topics are germane concerns which may still be misunderstood in a significant proportion of the cohort. Media may incorporate concepts such as the updated indications of AT, where it is now possible to transplant both teeth with complete and incomplete root formations[15]. The effect of having up-to-date knowledge was also observable in the ages of respondents, where respondents with a correct understanding of fact no. 1 were found to be on average 2 years younger than others. This suggests that the younger respondents were aware of the new indications of this treatment, thus, having access to up-to-date information is important.

In addition, experience and confidence were found to be frequently provided reasons supporting the dentist's decision to propose AT. From this, it stands to reason that increasing dental students' exposure, both observational and practical, to this treatment will provide them with experience and facilitate confidence. For post-graduation dentists, schools of dentistry may want to consider offering continued education that allows such individuals to develop their knowledge and skills of AT. In addition, given that a statistical significance was observed between unprimed and primed decisions to propose, a screening checklist concerning the applicability of AT can be a good method to increase the likelihood that AT will be proposed in appropriate cases.

The results of this study indicate that AT was not a last resort choice for many practitioners, in fact, it was proposed as a treatment option in 20% of all responses. This suggests that the low prevalence of cases in this faculty may be due to other factors aside from dentists not proposing this treatment. To examine this, further studies ought to consider additional factors in order to identify true causal factors. Such factors may include the patient's decision-making process, as well as consideration of the total number of applicable cases.

This study was limited by several factors. First, this was a study concerned with addressing the low prevalence of AT procedures observed in Faculty of Dentistry of Chulalongkorn University. As the faculty comprises a wide range of specialists and facilities, and so as to avoid institutional biases[93], only practicing dentists from the faculty were invited to respond. Due to this restricted sampling technique, it is possible that differences between the sample and the general population of dentists may exist.

In addition, this study may have been limited in adopting an unprimed-primed approach to elucidate changes in proposal style. As the names of the authors of this research were made known to practicing faculty members, it is possible that some respondents may have known that AT was a central topic to the survey before being primed. This, in turn, may have inflated the number of responses choosing to propose AT in unprimed responses.

A final limitation stems from the mean age of respondents, which was found to be 30.84 years. As this research considered all treatments of AT from the past 10 years, it is possible that the respondents may not provide an ideal representation of the collected data as the majority would not have been practicing dentists capable of making proposals during the time period under investigation.

CHAPTER VI

Conclusion

Despite boasting a high success rate, high survival rate, and being a cost-effective treatment option for patients, AT is not popular when compared with other treatments even when considered in a dental school with specialists and facilities. The results of this study indicate that dentist-related factors, such as fields of expertise, knowledge, and the dentist's experience with tooth autotransplantation are significantly associated with the dentist's decision to propose AT in novel cases. To lessen the extent to which AT is disregarded or misunderstood, future educational initiatives should incorporate more experiential and observational opportunities for dental students and post-graduate professionals. This, in turn, will lead to increased usage of AT in appropriate cases.

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