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บทบรรณาธิการ (Editorial Message)

จากงานวิจัย สู่การดูแลสุขภาพช่องปาก

From research to oral health care

เมื่อวันที่ 26 สิงหาคม พ.ศ. 2568 ที่ผ่านมา มหาวิทยาลัยกรุงเทพธนบุรี ร่วมกับมูลนิธิทันตนวัตกรรมในพระบรมราชูปถัมภ์ จัดงานเปิดตัวผลิตภัณฑ์ยาสีฟันและน้ำยาบ้วนปาก BTU Dentistry “เพิ่มความมั่นใจ สู่ความสำเร็จ” จากงานวิจัย...สู่การดูแลสุขภาพช่องปากด้วยพลังธรรมชาติซึ่งประกอบด้วยสารสกัดจากหญ้าแฝกน้ำมันหอมระเหยว่านสาวหลง และสารสกัดจากชะเอมเทศ พืชสมุนไพรจากมูลนิธิแม่ฟ้าหลวง และศูนย์ศึกษาการพัฒนาเขาหินซ้อนอันเนื่องมาจากพระราชดำริ ผลิตภัณฑ์ดังกล่าวอยู่ภายใต้การควบคุมให้เป็นไปตามข้อกำหนดของกองควบคุมเครื่องสำอาง อย. โดยที่โรงงานผู้ผลิตได้รับการรับรองมาตรฐานวิธีการที่ดีในการผลิตหรือ GMP และการรับรองมาตรฐานระบบคุณภาพ ISO 22716 (GMP Cosmetics)

ผลิตภัณฑ์สุขภาพที่สกัดจากธรรมชาติ กำลังได้รับความนิยมเป็นอย่างมาก ทั้งนี้เพราะมีความปลอดภัย นอกจากนี้ยังมีงานวิจัยรองรับว่ามีประสิทธิภาพที่ดี เมื่อใช้ร่วมกับการดูแลสุขภาพช่องปากที่เหมาะสมด้วยวิธีอื่น จะช่วยลดปัญหาฟันผุ โรคปริทันต์ ซึ่งเป็นปัญหาสุขภาพช่องปากที่สำคัญของคนไทยและคนทั่วโลก

สำหรับผลิตภัณฑ์สารสกัดจากหญ้าแฝกนั้น ทางมูลนิธิฯ ได้เป็นผู้ริเริ่มดำเนินงานวิจัยและพัฒนาศึกษาประโยชน์ของหญ้าแฝกในทางทันตกรรม โดยเริ่มจาก “โครงการน้ำยาฆ่าเชื้อจากหญ้าแฝกเพื่อรักษาคลองรากฟัน” ต่อมาได้ศึกษาประสิทธิผลของน้ำยาบ้วนปากผสมสารสกัดจากหญ้าแฝกในเรื่อง การลดเหงือกอักเสบรวมถึงการทดสอบประสิทธิภาพการลดแบคทีเรียก่อฟันผุในอาสาสมัคร ซึ่งทางมหาวิทยาลัยกรุงเทพธนบุรีเป็นหนึ่งในสถาบันการศึกษาที่ได้มีส่วนร่วมในงานวิจัยนี้ ผลการศึกษาพบว่ามีประสิทธิภาพเป็นที่น่าพอใจ มูลนิธิฯ จึงได้ขยายเป้าหมายโครงการ รวมทั้งมีแผนที่จะผลิตผสมสารสกัดจากหญ้าแฝกในระดับอุตสาหกรรม

ความร่วมมือระหว่างมูลนิธิฯ กับมหาวิทยาลัยกรุงเทพธนบุรีไม่จำกัดเพียงเฉพาะผลิตภัณฑ์ดูแลสุขภาพช่องปากเท่านั้น แต่ได้ขยายความร่วมมือไปถึงการวิจัยและพัฒนาอุปกรณ์การแพทย์ รวมทั้งงานวิจัยในระดับเซลล์ ทั้งนี้เพราะทั้งสององค์กรต่างก็มีความมุ่งมั่นที่จะพัฒนาคุณภาพชีวิตของประชาชนชาวไทยให้ดียิ่งขึ้นเช่นเดียวกันครับ

ยสนันท์ จันทรเวคิน

Original Article

Larvicidal and histopathological effects of *Piper sarmentosum* leaf extract against *Culex quinquefasciatus*

ผลของสารสกัดจากใบ *Piper sarmentosum* ในการกำจัดลูกน้ำและพยาธิวิทยาต่อ *Culex quinquefasciatus*

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Abstract The transmitted diseases by mosquitoes are still be classified as one of the serious problems in many countries. The chemical pesticides have been continuously used and affected human health and environments. The objective of this study was to find the alternative to chemical pesticide by evaluate the efficacy of the natural plants. Herb, *Piper sarmentosum* or Cha Phlu in local Thai, was extracted in different interval by using water. The total phenolic content in each interval was assayed and recorded. The results of the total phenolic content after 2, 4, 6, 12 and 24 hours extractions were 8.96, 9.11, 10.8, 12.9 and 17.2 mg/g of dried leaves, respectively. The aqueous extraction of the concentration of total phenolic content was selected for the mosquito larvicidal activity evaluations. Therefore, the 24-hour extract was diluted to the concentrations of 6.25, 12.5, 25 and 50 mg/L and tested individually with *Culex quinquefasciatus* mosquito larvae for 24-h incubation to find the lethal concentrations. The results of the 24-h LC_{50} and LC_{90} values were 32.9 and 61.6 mg/L respectively. The histopathological alterations after incubation with the 50% of the 24-h LC_{50} were observed directly in the midgut tissue. The abnormal lesions were found as swelling enterocytes, separating or lifting from the basement membrane, hyperplasia, blebbing appearance and finally the necrosis of the tissues. The takeaway of this study suggests that using Cha Phlu as mosquito larvicidal herb should be well aspectual consideration.

Keywords Cha Phlu, Histopathology, Larvae, Natural product, Pesticide

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บทคัดย่อ โรคติดต่อที่มียุงเป็นพาหะยังคงจัดเป็นปัญหาที่ร้ายแรงในหลายๆประเทศ สารเคมีกำจัดศัตรูพืชถูกนำมาใช้ในการกำจัดยุงอย่างต่อเนื่องซึ่งส่งผลกระทบต่อสุขภาพของมนุษย์และสิ่งแวดล้อม การวิจัยในครั้งนี้จึงมีวัตถุประสงค์ในการศึกษาประสิทธิภาพของพืชสมุนไพรในการกำจัดยุงเพื่อทดแทนการใช้สารเคมี *Piper sarmentosum* หรือ ชะพลู ในภาษาท้องถิ่นไทย นำมาสกัดโดยใช้น้ำในช่วงเวลาต่าง ๆ และวิเคราะห์หาปริมาณฟีนอลิกทั้งหมดในแต่ละช่วงเวลา ผลการทดลองพบว่าปริมาณฟีนอลิกทั้งหมดหลังจากการสกัดเป็นเวลา 2, 4, 6, 12 และ 24 ชั่วโมงมีค่าเท่ากับ 8.96, 9.11, 10.8, 12.9 และ 17.2 มิลลิกรัมต่อกรัมของใบแห้งตามลำดับ การวิเคราะห์ฤทธิ์ในการกำจัดลูกน้ำยุงจะเลือกใช้สารสกัดในช่วงเวลาที่ให้ปริมาณฟีนอลิกทั้งหมดสูงสุด ดังนั้น สารที่สกัดในช่วง 24 ชั่วโมงจึงถูกนำมาทำให้เจือจางจนมีความเข้มข้น 6.25, 12.5, 25 และ 50 มิลลิกรัมต่อลิตร และนำไปทดสอบกับลูกน้ำยุง *Culex quinquefasciatus* เป็นเวลา 24 ชั่วโมง เพื่อหาความเข้มข้นที่ทำให้เสียชีวิต ผลการทดลองค่า LC_{50} และ LC_{90} ที่ 24 ชั่วโมงมีค่าเท่ากับ 32.9 และ 61.6 มิลลิกรัมต่อลิตรตามลำดับ การเปลี่ยนแปลงทางจุลพยาธิวิทยาหลังจากที่ลูกน้ำยุงสัมผัสกับสารสกัดในระดับความเข้มข้นเท่ากับ 50% ของ LC_{50} ที่ 24 ชั่วโมง พบการเปลี่ยนแปลงในในเนื้อเยื่อลำไส้ส่วนกลาง โดยพบรอยโรคที่ผิดปกติ ได้แก่ เซลล์เยื่อบุลำไส้มีลักษณะบวม พบการแยกตัวหรือยกตัวขึ้นจากเยื่อบุฐาน มีการเพิ่มจำนวนของเซลล์เยื่อบุมากเกิดปกติ พบลักษณะตุ่มพองตัว และสุดท้ายคือพบการตายของเนื้อเยื่อ ข้อสรุปจากการศึกษานี้ชี้ให้เห็นว่าการใช้ชะพลูเป็นสมุนไพรฆ่าลูกน้ำยุงควรได้รับการพิจารณาอย่างรอบคอบ

คำสำคัญ: ชะพลู จุลพยาธิวิทยา ลูกน้ำ ผลิตภัณฑ์ธรรมชาติ สารเคมีกำจัดศัตรูพืช

INTRODUCTION

The mosquito-borne diseases are still been the global health problems including chikungunya, dengue fever, malaria, yellow fever, West Nile virus and Zika virus (Diouf and Nour, 2017; Moreno-Madrinan and Turell, 2018). The use of chemical pesticides has been concerned with health and environmental status such as the resistance, bioaccumulation, and biomagnification (Nicolopoulou-Stamati et al., 2016; Budzinski and Couderchet, 2018). The use of natural pesticides has been popular in worldwide. The efficiency of natural pesticides as an ovicidal, larvicidal, pupicidal and adulticidal substances mean that they have been used to kill or control various stages of several insects (Soonwera and Phasomkusolsil, 2017). The natural pesticides from several plants were studied against *Culex quinquefasciatus* i.e., *Copaifera reticulate* (Leguminosae) from Brazil (Silva et al., 2003); *Cassia occidentalis* (Fabaceae) from India (Kumar et al., 2014); *Cinnamomum verum* (Laurales) from Mexico (Andrade-Ochoa et al., 2018); and *Andrographis paniculata* (Acanthaceae) and *Tinospora crispa* (Menispermaceae) from Thailand (Jiraungkoorskul 2016; 2018). Therefore, the investigation of natural pesticides abilities may be the alternative way for control mosquitoes (George et al., 2014; Damalas and Koutroubas, 2018).

The traditional medicinal plant, *Piper sarmentosuma*, Piperaceae Family used in many countries in Southeast Asia especially in Thailand cuisines. This plant is known as “Cha Phlu” in Thai. The medicinal properties of *P. sarmentosuma* were reported in anti-carcinogenic (Wang et al., 2014), anti-diabetic (Luangpirom et al., 2014), antioxidant (Wang et al., 2016), antimicrobial (Femandez et al., 2012), and antiparasitic activities (Devanthran et al., 2017). It also has the properties for cardiovascular (Thent et al., 2012), hypolipidemia (Kumar et al., 2021), and hypotension treatment (Zainudin et al., 2015). The natural pesticide activities were report against *Aedes aegypti* mosquito vector (Hematpoor et al., 2016), *Brontispa longissima* (Qin et al., 2010), *Rhyzopertha dominica* and *Plodia interpunctella* (Hematpor et al., 2017), and *Sitophilus oryzae* (Vanichpakorn et al., 2017).

The phytochemical compounds in *P. sarmentosuma* are including sesamin, samentine, sarmentosine and samentanide (Tuntiwachwuttikul et al., 2016), alkaloid (Ee et al., 2009), flavonoid (Rahman et al., 2014), phenylpropanoids (Hematpor et al., 2017); and essential oils for the example caryophyllene and myristicin (Chieng

et al., 2008; Qin et al., 2010). No information about the histopathological alteration of insect tissue after the biopesticide treatment. This research was evaluated the efficiency of *Piper sarmentosuma* use as mosquito larvicidal activity by using *Culex quinquefasciatus* as experimental model. The tests had been the lethal concentration bioassay and the histopathological analyses.

MATERIALS AND METHODS

Plant extraction

Fresh *P. sarmentosuma* leaf was dried in 70 degree Celsius for 48 - 72 hours. The 5.0 g of dried leaf was grinding to powder and extracted with 100 mL H_2O. Then, the solution was shaken at 150 rpm room temperature for 2, 4, 6, 12 and 24 hours. After shaking, the solution was centrifuged at 4,000 rpm for 10 min and filtered. The filtered solution was kept as stock solution for further tests. The total phenolic content and the 24-h lethal concentration were performed.

Total phenolic content

The total phenolic contents were used the Folin–Ciocalteu reagent (Mcdonald et al., 2001). The method was done following: the test tube was added with 50 µL Cha Phlu in each extraction time, 250 µL of 10% Folin-Ciocalteus reagent, 200 µL of 0.7M sodium carbonate and 4.5 mL of distilled water. The test tubes were kept at room temperature for 2 hours in dark, and measured OD at wavelength 765 nm. The experiment was repeated three times. The total phenolic contents were reported by using the gallic acid standard curve in the serial concentrations expressed as gallic acid equivalent (GAE) using the following linear equation:

$y = -14.911x^2 + 38.479x - 0.4498$

(y = concentration and x = optical density)

Mosquito larval activity

The filtered solution with the highest total phenolic content was selected for this mosquito larval test. This solution was made to various concentrations: 6.25, 12.5, 25.0 and 50.0 mg/L. The mosquito larval activity was done by following WHO procedure (2005). The mosquito was uninfected laboratory strain and reared by the procedure previously reported (Komalamisra et al., 2005). The late third and early fourth-instar larvae of *C. quinquefasciatus* (n=20, triplicate) were selected for the five groups: control (distilled H_2O) and 6.25, 12.5, 25.0 and 50.0 mg/L of filtered solution. All experiment sample were set in room temperature. The number of larvae death was counted after 24 hours of experiment. Dead larvae showed no movement even after gentle mechanical stimulation. The number of deaths were calculated and reported for the lethal concentration (LC) parameter. The slope of the regression line with its confidence interval ($p<0.05$) was used the probit test from the Statistical Package of Social Sciences software (Finney 1971).

Histopathological alteration

The twenty larvae were exposed with the 50% of 24-h LC_{50} solution through 24 hours. The pathological alteration was analysed (Jiraungkoorskul and Jiraungkoorskul, 2015). The histology protocols were done as following (Presnell and Schreibma, 1997): the experimental specimen was fixed in the neutral buffered formalin for 72 h. Then, the specimen was dipped in the automatic tissue processor step by step: dehydration, clearing, infiltration. The specimen was then embedded in paraffin blocks using an embedding station and was cut by a rotary microtome in 4 µm thick. Finally, the section was stained with hematoxylin and eosin. The stained section was analysed for histopathological alteration using the light microscope. The histopathological report was photographed by a digital camera.

RESULTS AND DISCUSSION

Total phenolic content

The natural antioxidants in herb or medicinal plants are interested in worldwide (Xu et al., 2017). The previous researches have reported the comparative of antioxidant characteristics and total phenolic properties (Dudonne et al., 2009; Faujan et al. 2015). The amount of total phenolic

of *P. sarmentosuma* in 2, 4, 6, 12 and 24 h extractions were 8.96, 9.11, 10.8, 12.9, and 17.2 mg/g GAE, respectively. From this result, the highest total phenolic measurement was the 24-h extraction time. The extraction method and the total phenolic compounds from herb or medicinal plants were previously reported and should be concerned about extracted time and temperature. Moreover, total phenolic amount will be decreased or reduced by extended extraction times. Therefore, the desired extraction time for total phenolic amount should be evaluated (Xu et al., 2017). The present results agreed with earlier studies such as Hafizah et al. (2010) extracted 1:10 of *P. sarmentosuma* leaf dried power by aqueous, methanol and hexane at 80°C for 3 hours and reported that total phenolic content was 90.86 mg/g GAE. Lee et al. (2014) extracted *P. sarmentosuma* leaf with methanol, hexane, chloroform, acetate, butanol and water and reported that total polyphenols were 39, 18, 23, 14, 24 and 18 mg/L, respectively. Rahman et al. (2016) extracted *P. sarmentosuma* leaf with methanol and reported gallic acid was 22.5 µg/g dried weight of plant.

Mosquito larval activity

The abilities of phenolic compounds act as pesticide, insecticide or larvicidal activities were reported (Vimaladevi et al., 2012; Catelan et al., 2015), that is why, in this study, the extraction for 24 hours was evaluated against *C. quinquefasciatus.* No mortality was observed in control group. The averages of mortality rates were 7%, 25%, 53%, and 67% after treated with 6.25 mg/L, 12.5 mg/L, 25 mg/L and 50 mg/L of leaf extract, respectively. There was positive relation between concentration (x) and percent of mortality (y) in this following equation: $y = 1.3933x + 4.2083$, $R^2 = 0.9034$. The present result of 24-h LC_{50} and LC_{90} values with 95% confidence interval (lower – upper confidence limit) of *P. sarmentosuma* extract against *C. quinquefasciatus* were 33.5 (16.9 - 143.4) and 63.0 (40.6 - 438.7) mg/L, respectively. The mosquito larvae activity of *P. sarmentosuma* was reported in agreement with earlier studies. Intirach et al. (2012) reported the essential oil extracts from *P. sarmentosum* against *Anopheles cracens* with LC_{50} value of 16.0 mg/L. Hematpoor et al. (2016) determined the toxicity of 3 chemical substances of phenylpropanoids: asaricin, isoasarone and transasarone from the hexane extract from roots of *P. sarmentosum* toward *Aedes aegypti, A. albopictus* and *C. quinquefasciatus* mosquito larva. They found that these compounds were highly potent against mosquito larva causing up to complete mortality at 15 µg/mL and also showed strong inhibition on acetylcholinesterase. They suggested this plant may be the neuron toxic compounds toward mosquito. Wang et al. (2014) have reviewed that 32 compounds from *Piper* species such as amide alkaloid, phenylpropanoid, lignan, terpene, flavonoid, alkenylphenol and essential oil were studied about cytotoxic effects. The insect larval toxicities of this plant are due to the presence of phenylpropanoids (Hematpor et al., 2017) and essential oils (Chieng et al., 2008). Many researchers studied the efficiency of medicinal plants in various insects such as termite, *Coptotermes sp.* (Chieng et al., 2008), coconut leaf beetle, *Brontispa longissima* (Qin et al., 2010), rice weevil, *Sitophilus* oryzae (Vanichpakorn et al., 2017), wheat weevil, *Rhyzopertha dominica,* and meal moth, *Plodia interpunctella* (Hematpor et al., 2017).

Histopathological alteration

The enterocytes in the midgut of control group revealed a single layer of columnar epithelial cells with a prominent basophilic nucleus, brush border on apex, and acidophilic cytoplasm (Figure 1A). The histopathological alterations were found in the midgut after exposure the extract of this plant. The enterocytes were shown elongated form and found various vesicles in the cytoplasm (Figure 1B). Moreover, some enterocytes were also shown the cytoplasm masses in balloon form which pushed into the lumen, and no observation of brush borders (Figure 1C). The hyperplasia of enterocytes was also found (Figure 1D). These histopathological alterations were reported in agreement with earlier researches. The mosquito uses the brush border of enterocyte for the

absorption. Chaithong et al. (2006) reported the LC_{50} value against *A. aegypti* of ethanolic extracts from *P. sarmentosum* was 4.06 mg/L. They also found that the other organs, except anal papillae, had shown the normal histology look similar to those of control group. They reported the ultrastructural like external damage with atrophy of the cuticle of the anal papillae (Chaithong et al., 2006). The histopathology in midgut of *C. quinquefasciatus* after exposed with *Melia azedarach* were found pale cytoplasm, loss of brush border, mass protruding into the lumen and cell death (Al-Mehmadi and Al-Khalaf, 2010). The similar histopathological appearance such as pale cytoplasm, tearing of epithelial surface and loss of brush border on the midgut after treated with *Matricharia chamomella* (Al-Mehmadi, 2011). The most important things such as the active compounds, the histopathological alterations will be the main properties for natural mosquito larvicidal substances.

CONCLUSIONS

The present study reported the histopathological alteration in the midgut of *C. quinquefasciatus* larvae after treated with *P. sarmentosum*. The aqueous extract of *P. sarmentosum* can be used as a natural larvicidal substance in the mosquito or insect vector control. However, further studies are still need to determine the main active phytochemical substances and mechanism that are responsible for larvicidal activity.

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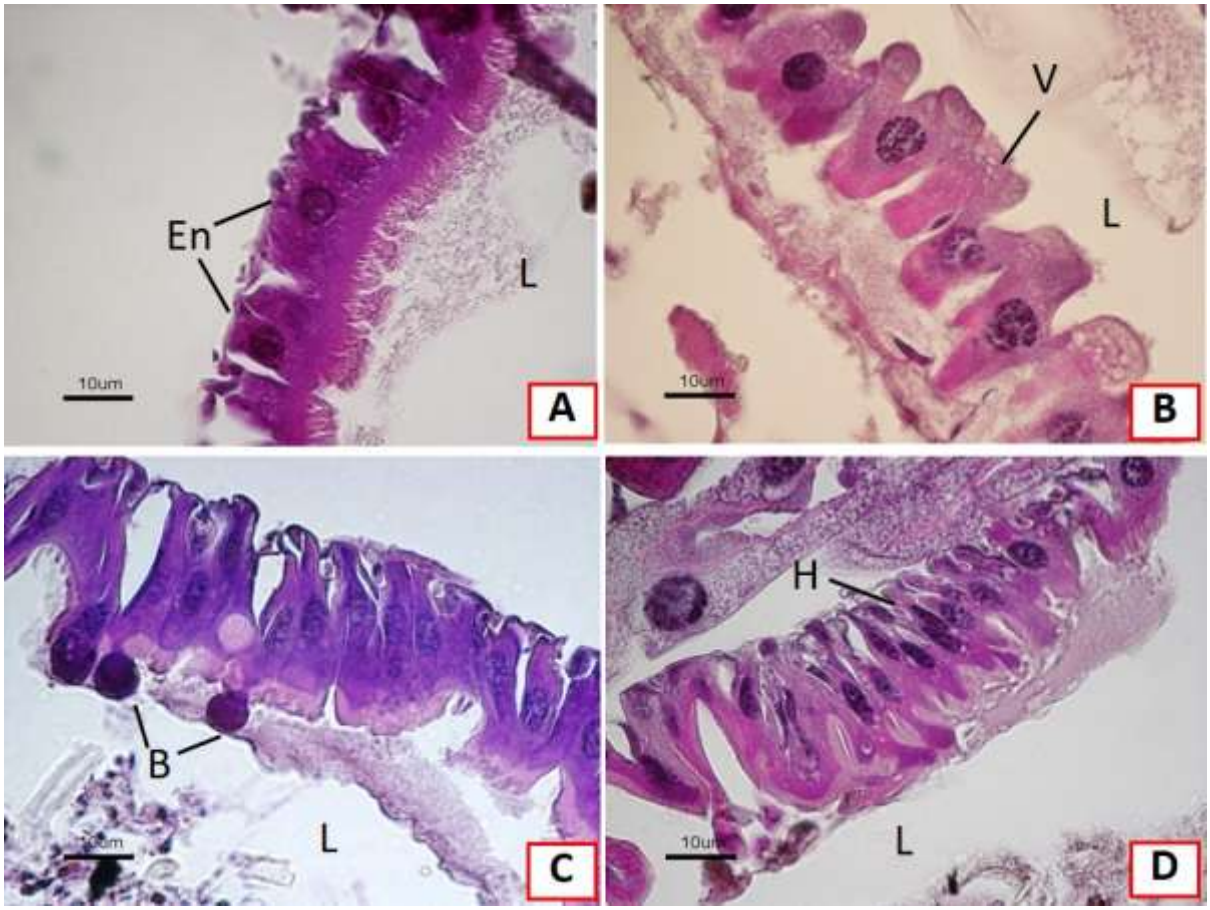

Figure 1. *Culex quinquefasciatus* larvae midgut (A): control larvae midgut with one layer of epithelial cells, the columnar epithelial cell showing the nucleus with basophilic color, brush border on surface, and cytoplasm in acidophilic color: *Piper sarmentosum* groups showing several histopathological alterations such as (B) cytoplasm with numerous pale vesicles, (C) bubble mass push in the lumen, and (D) enterocytes showing hyperplasia appearance. Note: B = bubble; En = enterocyte; H = hyperplasia; L = lumen; V = vesicle.

Original Article

Enhancing dental education through attitude-based analysis: a comparative study of biology achievement among dental students

การยกระดับการศึกษาทันตแพทยศาสตร์ผ่านการวิเคราะห์เชิงเจตคติ: การศึกษาเชิงเปรียบเทียบผลสัมฤทธิ์ทางชีววิทยาในนักศึกษาทันตแพทย์

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Abstract This research aimed to compare academic achievement in biology across two key dimensions: objective scores and subjective scores, between groups of dental students with high and low attitudes toward the subject. The study was grounded in established educational motivation theories. The research utilized comparative research design, employing extreme group selection to identify 40 participants (20 in each group) from students enrolled in the Faculty of Dentistry, Bangkokthonburi University. The primary research instrument was a 19-item attitude scale toward biology, which demonstrated high reliability (Cronbach's alpha = 0.9841) and collected data on student achievement scores. Data analysis involved descriptive statistics and the independent samples t-test. The findings revealed that the high-attitude group achieved significantly higher mean scores in subjective scores (p <.05) compared to the low-attitude group. This outcome supports the Expectancy-Value Theory (EVT) and achievement motivation theory.

Keywords Academic achievement, Student Interest, Motivation

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บทคัดย่อ การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อเปรียบเทียบผลสัมฤทธิ์ทางการเรียนวิชาชีววิทยาใน 2 มิติหลัก ได้แก่ คะแนนแบบปรนัยและคะแนนแบบอัตนัยระหว่างกลุ่มนักศึกษาทันตแพทย์ที่มีทัศนคติต่อวิชาชีววิทยาในระดับสูงและระดับต่ำ โดยใช้พื้นฐานทางทฤษฎีแรงจูงใจทางการศึกษาเป็นกรอบในการศึกษา งานวิจัยนี้ใช้รูปแบบการวิจัยเชิงเปรียบเทียบโดยใช้วิธีการเลือกกลุ่มสุดโต่ง เพื่อคัดเลือกกลุ่มตัวอย่างจำนวน 40 คน (แบ่งเป็นกลุ่มละ 20 คน) จากนักศึกษาที่ลงทะเบียนเรียนในคณะทันตแพทยศาสตร์ มหาวิทยาลัยกรุงเทพธนบุรี เครื่องมือหลักที่ใช้ในการวิจัยคือ แบบวัดทัศนคติต่อวิชาชีววิทยาจำนวน 19 ข้อ ซึ่งมีค่าความเชื่อมั่นสูง (Cronbach's alpha = 0.9841) และทำการเก็บข้อมูลคะแนนผลสัมฤทธิ์ทางการเรียนของนักศึกษา การวิเคราะห์ข้อมูลใช้สถิติเชิงพรรณนาและการทดสอบค่าทีแบบอิสระ ผลการวิจัยพบว่า กลุ่มนักศึกษาที่มีทัศนคติระดับสูงมีคะแนนเฉลี่ยในส่วนของคะแนนอัตนัยสูงกว่ากลุ่มที่มีทัศนคติระดับต่ำอย่างมีนัยสำคัญทางสถิติ ($p<0.05$) ซึ่งผลลัพธ์นี้สอดคล้องกับทฤษฎีความคาดหวังและคุณค่า และทฤษฎีแรงจูงใจใฝ่สัมฤทธิ์

คำสำคัญ: ผลสัมฤทธิ์ทางการเรียน, ความสนใจของนักศึกษา, แรงจูงใจ

INTRODUCTION

Based on classroom observations within the Faculty of Dentistry, a significant disparity in learning engagement has been noted. While dental students generally excel in rote memorization and objective examinations, a challenge arises in tasks requiring higher-order critical thinking and the synthesis of biological principles into clinical contexts. It was observed that this performance gap is often not a result of differing intellectual capabilities, but rather stems from divergent student attitudes toward biology—where some view it as a mere foundational hurdle to be cleared through surface learning, while others perceive it as a vital pillar for their future clinical practice. Consequently, this research was initiated to systematically investigate these observations. Interest and attitude towards a subject are critical psychological factors that strongly correlate with student engagement and the adoption of deep learning strategies. This is particularly true for biology, a discipline that requires critical thinking, self-directed knowledge seeking, and practical laboratory skills. Students with highly favorable attitudes often exhibit increased intrinsic motivation, which is a key predictor of academic success.

The theoretical framework used to elucidate this mechanism is the Expectancy-Value Theory (EVT). EVT posits that achievement is a function of an individual's confidence in their ability to succeed (expectancy) and their perception of the task's importance, usefulness, or enjoyment (value). The attitude and interest measured in this study serve as an element of Intrinsic Value under EVT. It is hypothesized that high-attitude students invest greater effort, leading to higher achievement across all dimensions.

Furthermore, the Self-Determination Theory (SDT) proposes that intrinsic motivation fosters essential psychological needs, namely autonomy and competence. This framework predicts that the high-attitude group should exhibit marked differences in performance dimensions requiring practical skills (activity scores). Finally, the Achievement Motivation Theory emphasizes that individuals driven to overcome obstacles and pursue challenging goals (as reflected in the attitude scale) tend to demonstrate superior overall academic outcomes. This research, therefore, aimed to compare learning outcomes across distinct dimensions (objective, subjective, and activity scores) to understand how subject attitude influenced the nature of student learning among dental students, ultimately informing curriculum development and pedagogical strategies in dental education.

RESEARCH OBJECTIVES

1. To compare the mean objective scores in biology between students with high and low attitudes toward the subject.
2. To compare the mean subjective scores in biology between students with high and low attitudes toward the subject.

RESEARCH METHODOLOGY

Population and samples

The population for this study comprised dental students enrolled in the biology course (HD102) in the Faculty of Dentistry, Bangkokthonburi University. The comparative research sample was selected using the extreme group selection method. This method selected 40 students (20 in each group) from the total cohort of 60 students to maximize statistical power;

1. High interest group: 20 students (top 25% based on total attitude score).

2. Low interest group: 20 students (bottom 25% based on total attitude score).

Basic demographic data, including gender, age, and prior cumulative grade point average (GPAX) from high school, were collected to describe the population characteristics.

Research instrument

1. Attitude toward biology scale
   - 1.1. Type: A 5-point likert rating scale, comprising 19 items divided into 5 dimensions: feeling/ enjoyment, content interest/exploration, value and expectancy, activities and practical work, and effort and determination.
   - 1.2. Qualification: The scale underwent content validity testing by experts with items selected based on an Index of Item objective congruence (IOC) of ≥ 0.70. The internal consistency reliability, calculated using Cronbach's Alpha coefficient from the pilot testing, yielded a high value of 0.9841.
2. Biology academic achievement measures
   - 2.1. Objective scores (MCQ mid): Raw scores (110 points total) measuring foundational knowledge and comprehension.
   - 2.2. Subjective scores (SAQ mid): Raw scores (50 points total) measuring analysis, application of knowledge, and in-depth reasoning (higher-order thinking skills).

Data collection

Achievement scores were retrieved from class records. Attitude data were collected using the developed questionnaire.

Data analysis

1. Descriptive statistics: Mean and standard deviation (S.D.) were computed to describe the attitude and achievement scores in each group.

2. Inferential statistics: The independent samples t-test was used to compare the difference in mean achievement scores across the three dimensions between the high-attitude and low-attitude groups. The significance level was set at α = 0.05.

FINDINGS

The findings were presented in three parts: descriptive analysis of achievement, comparison of attitude dimensions, and t-test results.

1. Descriptive analysis of achievement scores

Achievement dimension	Total score	High interest group (N=20)		Low interest group (N=20)	
		$\overline{x}$	S.D.	$\overline{x}$	S.D.
Total attitude score	95	77.6	4.5	56.40	3.9
Objective scores (MCQ)	110	71.3	10.5	60.8	11.2
Subjective scores (SAQ)	50	30.5	5.1	24.3	6.0

Table 1 Comparison of achievement scores between high-attitude and low-attitude groups (N=40)

The descriptive analysis indicated that the high-attitude group consistently achieved higher mean scores in both examination formats compared to the low-attitude group. Notably, the disparity was evident not only in the objective scores (MCQ), which reflected foundational knowledge, but also significantly in the subjective scores (SAQ). This suggested that students with a more positive attitude toward the subject may possess a superior ability to articulate and synthesize biological concepts, aligning with the "deep learning" characteristic of high-achieving dental students.

2. Comparison of attitude toward biology by dimension

Attitude dimension (theoretical link)	Max score	High attitude group (mean)	Low attitude group (mean)	Mean difference (high–low)
1. Feeling/enjoyment (EVT: intrinsic value)	25	22.9	17.5	+5.4
2. Content interest/exploration (SDT: autonomy/motivation)	20	17.0	12.0	+5.0
3. Value and expectancy (EVT: expectancy & value)	15	12.0	8.5	+3.5
4. Activities and practical work (SDT: competence)	15	14.1	12.8	+1.3
5. Effort and determination (achievement motivation)	20	17.4	15.6	+1.8

Table 2 detailed the comparison of mean scores for the five dimensions of the Attitude toward biology scale, reflecting specific theoretical constructs.

An analysis of the mean scores across the five dimensions of the attitude toward biology Scale, as presented in table 2, revealed distinct variations between the high-attitude and low-attitude groups. The most pronounced discrepancies were observed in the dimensions of feeling/enjoyment (mean difference = +5.40) and content interest/exploration (mean difference = +5.00), indicating that students with a high attitude toward biology exhibited significantly higher levels of intrinsic value and self-directed engagement. Although a notable difference was also identified in value and expectancy (+3.50), the margins were considerably narrower in dimensions associated with achievement motivation and practical application. Specifically, the activities and practical work dimension yielded the smallest mean difference (+1.30), followed by Effort and Determination (+1.80). These findings suggested that while both groups demonstrated relatively comparable levels of persistence and competence in practical settings, the primary factors distinguishing the high-attitude group were their profound emotional affinity for the subject and their autonomous motivation to explore biological content.

3. Results of academic achievement comparison (independent samples t-test)

Achievement dimension	Group	$\overline{x}$	S.D.	t-test	Sig. (*p*-value)	Conclusion
Objective scores	High	71.3	10.5	2.05	0.054	No significant difference ($p>0.05$)
	Low	60.8	11.2			
Subjective scores	High	30.5	5.1	2.15	0.045*	Significantly different ($p<0.05$)
	Low	24.3	6.0			

***0.05 significant level**

Table 3 presented the independent samples t-test results comparing mean achievement scores between the high-attitude and low-attitude groups across two dimensions: objective and subjective scores.

Objective scores (MCQ): The mean of the high-attitude group (mean=71.30) was higher than the low-attitude group (mean=60.80), but the difference was not statistically significant at the 0.05 level (t=2.05, p=0.054).

Subjective scores (SAQ): The mean of the high-attitude group (mean=30.4) was **significantly higher** than the low-attitude group (mean=24.95) at the 0.05 level (t=2.15, p=0.045).

DISCUSSION

The research findings demonstrated that students with a high attitude toward Biology achieved significantly superior academic performance in dimensions requiring deep cognitive processing and analytical synthesis, specifically within Subjective Scores (SAQ). This outcome aligned with the research hypothesis and was substantiated by a robust integration of theoretical frameworks and empirical data:

1. Theoretical alignment with EVT and SDT

The significant disparity in subjective scores validated that a positive psychological disposition and Intrinsic Value led students to invest greater Effort and Determination. This was consistent with the expectancy-value theory (EVT), which posits that achievement behavior is defined by the expectation of success and the value assigned to the task (Eccles and Wigfield, 2024; Wigfield and Eccles, 2023). According to table 2, the high-attitude group exhibited markedly higher mean scores in feeling/enjoyment (+5.40 difference) and content interest/exploration (+5.00 difference). These findings served as critical components of autonomy and

motivation under Self-Determination theory (SDT), suggesting that students who feel autonomous in their learning are more likely to be intrinsically motivated (Deci and Ryan, 2024). Furthermore, this supported Achievement Motivation Theory, where individuals with high motivation are driven to excel in demanding tasks (McClelland, 2023).

2. Nuanced insights on assessment formats

A critical insight emerged from the disparity between assessment types. While the high-attitude group maintained a higher mean score in objective scores (MCQ), the result did not reach statistical significance (p = 0.054). This suggested that while positive attitudes correlated with general proficiency, their true impact was most pronounced in higher-order thinking skills. As noted by Thorndike (2022), measurement and evaluation must distinguish between rote recall and deep understanding. Objective formats might focus on foundational knowledge recognition, whereas subjective assessments (SAQ) better reflected the "deep learning" characteristics and superior ability to synthesize concepts typical of high-achieving students. This aligned with the work of Srirattana (2023), who found that learning achievement is significantly influenced by the specific nature of student interest.

3. The practicality paradox

Interestingly, the smallest difference between groups occurred in the activities and practical work dimension (mean difference = +1.30). This indicated that participation in practical or hands-on tasks alone was not the primary differentiator of student attitude. Instead, the defining characteristic of the high-attitude group was a profound emotional affinity for the subject matter and an autonomous drive for inquiry-based exploration. In curriculum planning, it is essential to move beyond task completion to foster genuine engagement (Willis, 1996).

4. Limitations and future methodological directions

While the current study effectively utilized independent samples t-tests to differentiate between two groups, it was recognized that academic achievement was influenced by multiple variables. To enhance the rigor and evidence-based nature of these findings, future research should employ one-way ANOVA to explore nuances across a broader spectrum of student engagement levels, moving beyond binary classifications (Polit and Beck, 2022). Furthermore, implementing analysis of covariance (ANCOVA)—using prior GPAX as a covariate—was highly recommended. This would provide a more precise validation by statistically controlling for pre-existing academic proficiency, thereby isolating the definitive impact of student attitude on cognitive achievement.

SUMMARY

The comparative study of academic achievement in biology based on student attitude confirmed a strong relationship between intrinsic motivation and academic success in challenging assessment types. Data from Table 3 confirmed that the high-attitude group achieved significantly higher subjective scores ($p < 0.05$), while the difference in objective scores was not statistically significant. This underscored the critical role of student attitude as a vital non-cognitive predictor of academic performance, particularly for tasks requiring synthesis and higher-order application.

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Original Article

Is socket shield technique a reliable technique in immediate dental implant placement

การใช้ส่วนของรากฟันเพื่อเป็นโล่เบ้าฟันในการฝังรากฟันเทียมทันที

ปราโมทย์ สุชนสำราญ, ทองนารถ คำใจ

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Abstract The socket shield technique (SST), or partial tooth extraction (PET), is an intentional leaving a fragment of the tooth being extracted, especially the facial aspect of the root, to preserve of the surrounding hard and soft tissues. The dentist can select the proper size of the implant, and place it in the proper position and angulation. The SST is clinically beneficial but technically sensitive. The objective of the study was to review of literatures studying clinical outcomes of this technique. From selected 12 scientific articles, the clinical outcomes, including success rate, marginal bone loss, pink esthetic score (PES), and patient reported outcome measure (PROM), of this technique were favorable.

Keywords: dental implant, immediate implant placement, partial tooth extraction, Socket-Shield Technique

บทคัดย่อ เทคนิคโล่เบ้าฟันหรือการถอนฟันบางส่วน เป็นการจงใจทิ้งส่วนของรากฟันโดยเฉพาะด้านชิดริมฝีปากโดยมีวัตถุประสงค์เพื่อคงสภาพทั้งเนื้อเยื่อแข็งและเนื้อเยื่ออ่อนบริเวณนั้นและสามารถใช้รากฟันเทียมที่มีขนาด ตำแหน่งและมุมที่เหมาะสมได้ แม้จะเป็นการใช้โล่เบ้าฟันจะมีประโยชน์อย่างมากแต่ก็เป็นเทคนิคที่ละเอียดอ่อน จึงเป็นที่มาของการศึกษาครั้งนี้ที่จะทบทวนวรรณกรรมเกี่ยวกับผลลัพธ์ทางคลินิกของเทคนิคนี้ จากการทบทวนรายงานจำนวน 12 ฉบับ ซึ่งศึกษาทั้งในแง่อัตราประสบความสำเร็จ การสูญเสียกระดูกรอบรากฟันเทียม คะแนนความสวยงามของเนื้อเยื่อเหงือก รวมทั้งผลลัพธ์จากการประเมินของผู้ป่วย พบว่าเทคนิคดังกล่าวให้ผลลัพธ์การรักษาเป็นที่น่าพึงพอใจ

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INTRODUCTION

With the world moving at fast pace, dentistry has been catching up with its trends. This ranges from the recent technologies to new innovations to better serve and live up to today's needs. Dental extraction has been known to cause various volumetric changes to the surrounding tissues. The facial bone on the anterior teeth is thin in nature[1]. In some reports, there is a complete absence of labial bone, causing the surrounding morphology to collapse. This is quite challenging when a clinician attempts to mimic the natural characteristics of a tooth, especially when it involves the esthetic zone.

Various techniques have been suggested in the literature, including selecting the size of the implant, the position of the implant, its angulation, using bone and soft tissue grafting materials and techniques, etc. Another promising technique, which has been introduced since 2010 by Hürzeler et al. is called socket shield technique (SST). This technique features the preservation of the surrounding tissues by intentionally leaving a fragment of the tooth being extracted, especially the facial aspect of the root, so the bone is undisturbed. Socket shield technique goes by various names like partial tooth extraction (PET), root submergence technique (RST), etc[2].

With preservation of the partial root leaves the surrounding soft and hard tissues untouched, hereby maintaining blood supply and postoperative complications. In some circumstances, the chances of additional grafting procedures are greatly reduced. This increases the chances of patient comfort, satisfaction and acceptance and decreases morbidity.

However, SST is technique sensitive. The disadvantages of SST include technical difficulty, risk of root fragment migration, resorption or infection, etc[3]. A skilled clinician with careful planning and case selection is required to increase the chances of success and survival rates. Socket shield technique has also been combined with other techniques to increase successful outcomes like digital planning to increase the precision during implant placement, bone and soft tissue grafts to better mimic natural dental and soft tissue characteristics.

SST has shown promising results when performed on the day of tooth extraction. The tooth is sectioned and prepared to support the facial surrounding structures and an implant is placed immediately. This saves time, cost and reduces patient's morbidity. The minimal change in the overall morphology provides a great advantage, especially in patients with high esthetic demands.

A lot of experiments were done with the size and position of the root remnant. Some suggested to preserve the labial aspect to keep the hard and soft tissues intact. This saved time, cost and reduced patient's morbidity. The minimal change in the overall morphology provided a great advantage, especially in patients with high esthetic demands.

The working of the process following tooth extraction performed by Araújo and Lindhe has shown the activation of osteoclastic activity. This activation causes a resorption of bundle bone. It was found that there was an abundance of bundle bone at the labial aspect when compared to the palatal aspect. Therefore, the loss of bone is more pronounced at the facial surface. The cascade following hard tissue loss is soft tissue defect, whereby various things like apical migration of the gingival margin, loss of interdental papilla and a formation of black triangle, while affecting overall esthetic outcomes. However, some of the factors that affect the volume of bone and soft tissues are the initial bone level, the progression of bone loss and the gingival phenotype.

Following dental extraction or tooth loss, a series of changes occurs at the surrounding soft and hard tissues. A study was conducted on the morphology of the upper anterior zone, where the thickness of the labial bone was measured at different locations. The crest of the alveolar ridge was used as the marker where the measurement was taken beneath at 1, 3 and 5 mm intervals. It was found that the thickness of the bone was less than 1 mm[4]. This coincides with another study where the

maxillary bone thickness of central and lateral incisors was measured 4mm from CEJ. The result showed the bone thickness to be less than 1 mm[4].

Having a limited supply of bone have shown a higher risk in bone loss during and after tooth extraction, which causes the shape of the alveolar ridge to change. This may eventually compromise the success and survival rate of the implant placement.

The introduction of maintaining or compensating the loss of the surrounding hard and soft tissues is an ongoing process. A lot of research has been conducted to attempt to preserve the remaining structures following dental extraction or tooth loss. Grafting of hard tissues, soft tissues or a combination of the two to compensate the loss have shown promising results. The hard tissue substitutes that aid in preservation of the surgical site include autogenous, allogenic, xenogenic and alloplastic grafts. These grafting materials have different properties and are selected according to its properties and clinician's preference. Soft tissue grafting can either come from the patient or widely selected from the manufacturers.

An immediate implant placement following dental extraction can help preserve the alveolar bone and soft tissue contour. Various factors, such as bone volume and quality, soft tissue thickness, and esthetic outcomes should be kept under consideration before deciding on placing implant immediately.

MATERIALS AND METHODS

Although socket shield technique is an acquired skill, which requires learning curve, there have been a lot of experienced clinicians taking on the challenge in coming up with various techniques to section the tooth in such a way that best preserves the neighboring vital structures. The surgical site chosen is a failing tooth with healthy periodontal tissues with an absence of any acute infection and no external or internal root resorption. As suggested by Hürzeler et al. in 2010, the tooth sectioned must have a labial coronal portion supporting the surrounding labial bone structures. The implant immediately placed must be in contact to the tooth fragment. The temporary abutment with crown is then fabricated and immediately loaded. This technique has a major advantage and is widely accepted by a patient.

The crown portion of the tooth is sectioned at bone level (Fig. 1 and 2)[5]. The remaining root remnant's root canal hole is widened with a bur to ease in further sectioning. Then, the tooth is further sectioned in a mesiodistal fashion until the root length (Fig. 3). The palatal portion of the tooth is split from the labial portion and is removed. The periapical portion is curetted, and cleaned thoroughly. The remaining portion of the labial aspect of the tooth is made sure to still be immobile and intact with the labial structures (Fig. 4). The thickness of the root shield should have a labio-palatal thickness of 1.5-2 mm with the length of two thirds of the total root length. The inner surface of the root remnant is then beveled to support the implant platform. Then the socket is prepped apicopalatally for the implant engagement. Once the implant preparation site is ready, the implant is inserted into the socket (Fig. 5). The clinician should be aware to not disturb the root shield to prevent migration. Subsequently, the prepared temporary abutment with attached crown is then inserted (Fig. 6). The illustration of Fig. 7 showed that the inner surface of the root shield is beveled to support the implant platform. The patient should be prohibited from using this tooth, since it can cause failure. After 3 months, the patient is recalled and assessment of the soft and hard tissue is made. Finally, a definitive crown is fabricated and inserted for the patient.

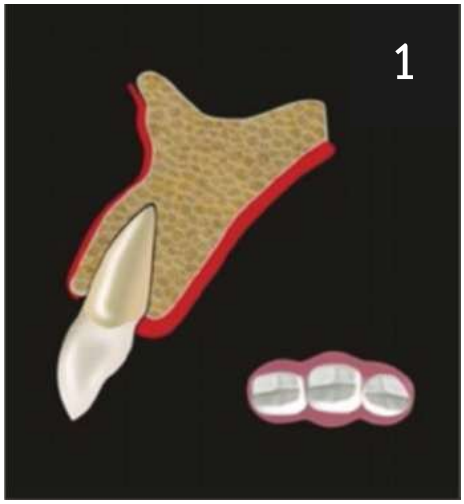

Fig. 1 The tooth is assessed before sectioning.

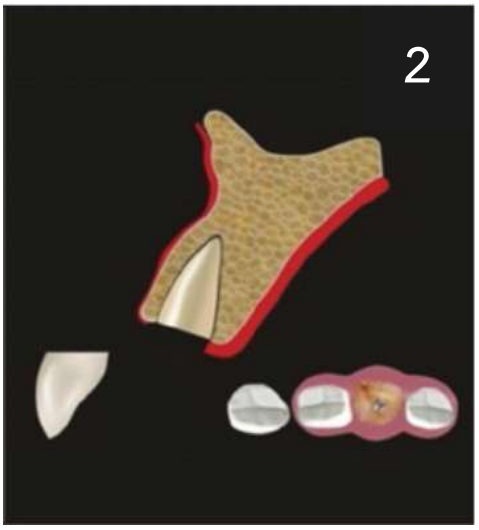

Fig. 2 The crown is sectioned at bone level.

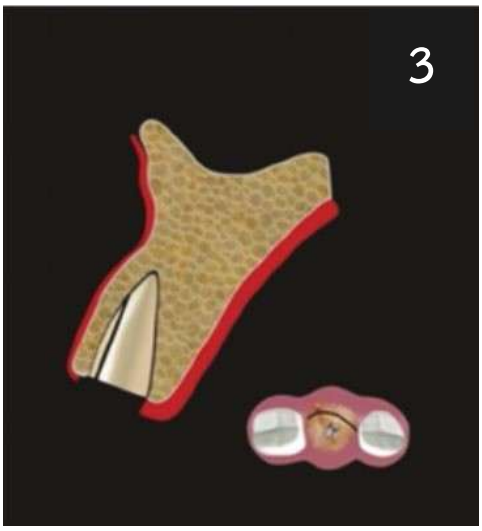

Fig. 3 The tooth is sectioned mesiodistally.

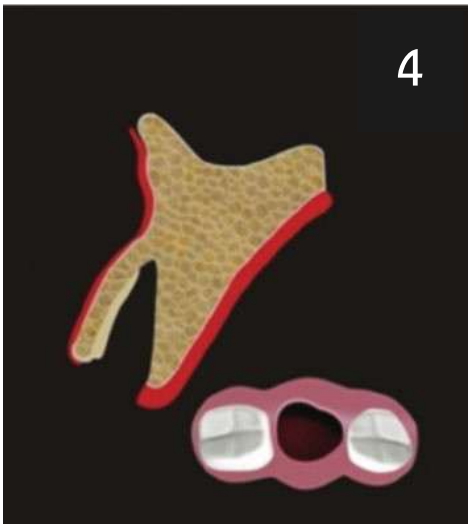

Fig. 4 The split is made and the labial root portion is left intact.

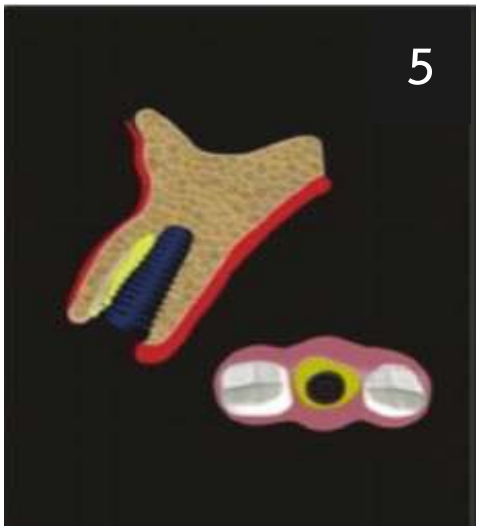

Fig. 5 The implant is placed palatal to the root shield.

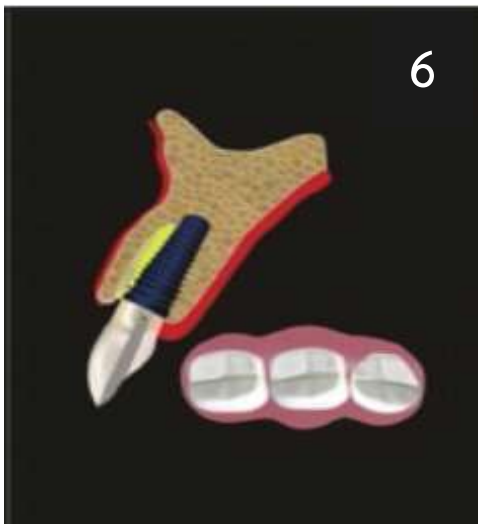

Fig. 6 The temporary abutment and temporary crown are loaded.

Fig. 7 The root shield has an inner bevel chamfer-like finish to take on the implant platform.

Some clinicians have come up with an alternative by changing a few key things. The implant placement leaves a gap between the root remnant and the implant. If the gap is more than 2 mm, then the gap is filled with a biomaterial of choice. If the gap is less than 2 mm, then the clot is expected to aid in new bone formation. Additionally, the types of sectioning have been categorized by Kumar and Kher (2018). It consists of six types, each having its own unique purposes (Fig. 8). Type I is done where the clinician preserves the buccal portion of the root to ensure minimal changes to the surrounding tissues. Type II called the full C preserves the buccal and the interproximal aspect of the root. This procedure is chosen when the clinician intends to preserve the anterior region and the interproximal bone. Type III is called the half C due to its inclusion of the buccal aspect and one of the interproximal faces. This is done with the intention of preserving only one of the interproximal surfaces. This is useful when the adjacent tooth is an implant and the clinician don't want to disturb that particular zone. Next is type IV where only the interproximal root surfaces are preserved. The risk of damaging the thin walls calls for this method of preparation. Type V being called the lingual or palatal can be helpful when there is a thin bone wall on the palatal aspect. It is highly unlikely that this technique is chosen since the buccal walls have more resorption rate. The last type has multiple buccal shields, which is useful when extra measure needs to be taken to prevent buccal morphological change. Several other literatures have suggested other techniques all in favor of preserving the surrounding periodontium.

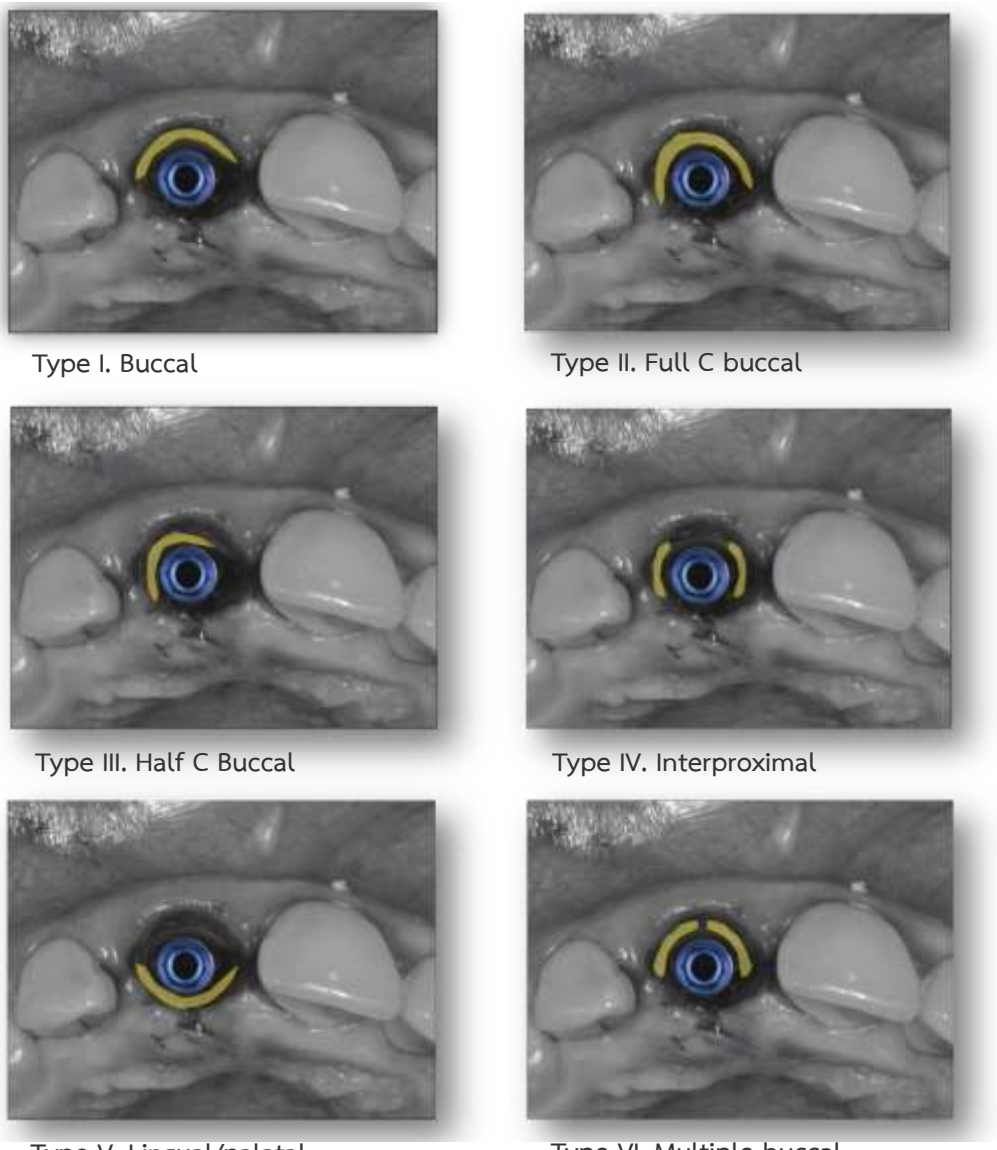

Fig.8 Six techniques of tooth sectioning, described by Kumar and Kher (2018).

Study design

PICO question was used to evaluate the outcomes in soft tissue and bone change. Population was concentrated on the immediate implant placement. The intervention for this study was the socket shield technique for immediate implant placement in esthetic zone. This study compared socket shield technique to the conventional Type I immediate implant placement in esthetic zone. The outcome measures would look into the changes in soft tissues and bone change, which consisted of implant survival /failure rate, marginal bone loss, Pink Esthetic Score (PES) and Patient Related Outcome Measures (PROM).

Inclusion criteria

This study was focused on human findings only. The study included only those implants placed in the esthetic zone with the follow up more than 6 months. The study included prospective clinical trials, randomized controlled trials and retrospective studies.

Exclusion criteria

Studies done on animals were excluded from this study. The implants placed in animals were excluded as well. The posterior teeth had not been included in this study. Any follow up that had not reached 6 months were out of this study.

RESULTS

I. Implant failure rate

Table 1. Implant failure rate

Author/Year	Study type	Sample (n)	F/U time (months)	Implant failure rate
Xu et al., 2019[6]	Prospective clinical trial	24 implants (24 patients)	12	IIP: 0/12 SST: 0/12
Barakat et al., 2017[7]	RCT	20 implants (20 patients 20–50 years old)	7	IIP: 0/10 SST: 0/10
Bramanti et al., 2018[8]	RCT	40 implants (40 patients)	36	IIP: 0/20 SST: 0/20
Tiwari et al., 2019[9]	RCT	16 implants (16 patients)	12	IIP: 0/8 SST: 0/8
Sun et al., 2020[10]	RCT	30 implants (30 patients)	24	IIP: 0/15 SST: 0/15

Five studies with a total of 130 implants with a follow up time ranging from 7 to 36 months were analyzed in this study group. This included prospective clinical trials and randomized controlled trials (RCT). When comparing the immediate implant placement groups to the SST group, none of the groups had implant failure.

Table 2. Implant failure rate in socket shield technique cases

Author/Year	Study type	Sample (n)	F/U time (months)	Implant failure rate
Siormpas et al., 2018[11]	Retrospective study	250 dental implants (182 patients 18–83 years old)	120	SST: 5/250
Siormpas et al., 2014[12]	Retrospective study	46 dental implants (46 patients 28–70 years old)	24–60	SST: 0/46
Baumer et al., 2017[13]	Retrospective study	10 dental implants (10 patients)	51–63	SST: 0/10

Nguyen et al., 2019[14]	Case series	4 dental implants (3 patients 62–87 years old)	24–72	SST: 0/4
Kher et al., 2018[15]	Prospective clinical trial	10 dental implants (10 patients)	12–42	SST: 0/21
Mitsias et al., 2020[16]	Prospective clinical trial	10 dental implants (10 patients)	42	SST: 0/10
Han et al., 2018[17]	Prospective clinical trial	40 dental implants (30 patients 20–82 years old)	12	SST: 0/40

Additional of seven studies conducted only on SST groups ranging from retrospective studies to case series and prospective clinical trials were selected where a total of 324 implants were placed in 245 patients. The patients' age varied from 18 to 87 years. It was found that a study conducted by Siormpas et al. in 2018, where 250 implants were placed, the implant failure rate was at 2% with a total loss of 5 implants.

II. Marginal bone loss

Table 3. The studies with marginal bone loss outcomes

Author/Year	Study type	Sample (n)	F/U time (months)	Marginal bone loss
Barakat et al., 2017[7]	RCT	20 implants (20 patients 20–50 years old)	7	IIP: 1.61 ± 0.78 mm (VBL) SST: 0.44 ± 0.24 mm (VBL)
Bramanti et al., 2018[8]	RCT	40 implants (40 patients)	36	IIP: 1.11 ± 0.13 mm SST: 0.60 ± 0.06 mm
Tiwari et al., 2019[9]	RCT	16 implants (16 patients)	12	IIP: 0.188 ± 0.013 mm SST: 0.030 ± 0.025 mm

Three randomized clinical trial studies were chosen to evaluate marginal bone loss, where 76 implants were placed on 76 patients. the follow up time ranged from 7 months to 3 years. Vertical bone loss was measured in the study conducted by Barakat et al. in 2017. The immediate implant placement group had a mean vertical bone loss (VBL) of 1.61 ± 0.78 mm. SST group had a mean VBL of 0.44 ± 0.24 mm. Bramanti et al. had similar findings where the marginal bone loss measured at IIP group was at 1.11 ± 0.13 mm, whereas SST group had a mean marginal bone loss of 0.60 ± 0.06 mm. Tiwari et al. conducted a study with 0.188 ± 0.013 mm marginal bone loss in IIP group and 0.030 ± 0.025 mm in the SST group.

Three studies that were conducted in SST group only. The report done in 59 patients with a total of 60 implants. All the studies had minimal bone loss, which had no significant difference.

Table 4. Marginal bone loss in SST

Author/Year	Study type	Sample (n)	F/U time (months)	Marginal bone loss
Siormpas et al., 2014[12]	Retrospective study	46 dental implants (46 patients 28–70 years old)	24–60	0.18 ± 0.09 mm mesial and 0.21 ± 0.09 mm distal marginal bone loss
Baumer et al., 2017[13]	Retrospective study	10 dental implants (10 patients)	51–63	0.33 ± 0.43 mm mesial and 0.17 ± 0.36 mm distal marginal bone loss
Nguyen et al., 2019[14]	Case series	4 dental implants (3 patients 62–87 years old)	24–72	0.1 ± 0.2 mm marginal bone loss

III. Pink Esthetic Score

Table 5. The studies with Pink Esthetic Score outcomes

Author/Year	Study type	Sample (n)	F/U time (months)	PES
Bramanti et al., 2018[8]	RCT	40 implants (40 patients)	36	IIP: 10.3 ± 2.53 SST: 12.2 ± 0.76
Sun et al., 2020[10]	RCT	30 implants (30 patients)	24	IIP: 11.3 ± 1.76 SST: 12.1 ± 1.62

The RCT study performed on IIP and SST groups showed that the SST group had higher PES, but there was no significant difference.

Two studies were chosen from year 2017 and 2018 with a total of 20 implants, where the study was conducted on SST groups only. Both achieved PES of 12.

Table 6. Pink Esthetic Score in SST group

Author/Year	Study type	Sample (n)	F/U time (months)	PES
Baumer et al., 2017[13]	Retrospective study	10 dental implants (10 patients)	51–63	12
Kher et al., 2018[15]	Prospective clinical trial	10 dental implants (10 patients)	12–42	12

IV. Soft and hard tissue changes

Table 7. The studies with soft and hard tissue change outcomes

Author/Year	Study type	Sample (n)	F/U time (months)	Soft and hard tissue change
Barakat et al., 2017[7]	RCT	20 implants (20 patients, 20–50 years old)	7	IIP: 2.12 ± 0.64 mm (PD) SST: 1.73 ± 0.28 mm (PD)
Tiwari et al., 2019[9]	RCT	16 implants (16 patients)	12	IIP: Labial bone thickness: 0.988 ± 0.173 mm SST: Labial bone thickness: 1.145 ± 0.277 mm

In two studies, the soft and hard tissues were compared between the IIP and SST groups. The probing depth of IIP group was 2.12 ± 0.64 mm whereas SST group was 1.73 ± 0.28 mm. Labial bone thickness was also measured in both the groups and none had any significant difference. Studies conducted on SST groups alone had a loss of labial tissues ranging from 0 to -0.37mm. The maximum mid-facial recession was measured to be 0.23 mm.

Table 8. Soft and hard tissue changes in SST

Author/Year	Study type	Sample (n)	F/U time (months)	Soft and hard tissue change
Baumer et al., 2017[13]	Retrospective study	10 dental implants (10 patients)	51–63	SST: −0.37 ± 0.18 mm loss of buccal tissue and −0.33 ± 0.23 mm mid-facial recession
Nguyen et al., 2019[14]	Case series	4 dental implants (3 patients 62–87 years old)	24–72	SST: No changes in soft tissue dimensions
Mitsias et al., 2020[16]	Prospective clinical trial	10 dental implants (10 patients)	42	SST: 0.19 mm (0.10 – 0.28 mm) mid-facial recession

V. Implant survival rate

Table 9. The studies with implant survival rate outcomes

Author/Year	Study type	Sample (n)	F/U time (months)	Implant failure (n)	Grafting	Survival rate (%)
Barakat et al. 2017[7]	RCT	10 IIP 10 SST	7	-	No mention	100
Bramanti et al. 2018[8]	RCT	20 IIP 20 SST	36	-	Allograft in control group	100
Xu et al. 2019[6]	Prospective nonrandomized controlled study	12 IIP 12 SST	12	-	Bio-Oss bone powder	100

Two RCT and a Prospective nonrandomized controlled study were chosen to compare the implant survival rate of both the groups. The survival rate was found to be at 100%.

Eleven studies from year 2014 to 2019 were conducted on SST groups with a follow up time ranging from 1 year to 10 years. Gluckman et al. in 2017 had an implant survival rate of 96.1%, whereas Siormpas et al. in 2018 had an implant survival rate of 96.5%. All the remaining studies showed an implant survival rate at 100%.

This section compares PROM mean of IIP with xenograft group versus SST group. The sum total of WES, PES and function had higher values in SST groups, but showed no statistical difference.

Table 10. Implant survival rate in SST

Author/Year	Study type	Sample (n)	F/U time (months)	Implant failure (n)	Grafting	Survival rate (%)
Siormpas et al., 2014[12]	Retrospective study	46 SST	24-60	-	No	100
Lagas et al. 2015[21]	Retrospective study	16 SST	15	-	No mention	100
Abitbol et al. 2016[22]	Retrospective study	23 SST	12	-	Xenograft / allograft	100
Gluckman et al. 2017[23]	Retrospective study	128 SST	48	5	No mention	96.1
Baumer et al. 2017[13]	Retrospective study	10 SST	51-63	-	Enamel matrix protein	100
Han et al. 2018[17]	Prospective study	40 SST 34 max, 6 man	12	-	No	100
Siormpas et al., 2018[11]	Retrospective study	250 implants SST 230 max, 20 man	120	5	No	96.5
Zhu et al. 2018[20]	Prospective study	10 SST	12-48	-	No mention	100
Kher et al. 2018[15]	Retrospective study	21 SST	12-42	-	No	100
Yan et al. 2019[19]	Prospective study	10 SST	12	-	Bio-Oss bone powder	100
Walid and Alkhodary, 2019[18]	Prospective study	18 SST	12	-	Bioactive glass	100

VI. Patient-reported outcome measure (VAS)

Table 11. Patient-reported outcome measure (VAS) comparing between SST and IIP with xenograft groups

PROM	SST group Mean	IIP with xenograft group Mean	*p*-value
WES	9.37 +/- 0.91	9.25 +/- 0.70	0.606
PES	9.62 +/- 0.51	9.25 +/- 0.70	0.263
Function	9.12 +/- 0.99	9.25 +/- 0.70	0.866
Total	9.37 +/- 0.80	9.25 +/- 0.70	0.602

DISCUSSION

This individual study mainly focused on comparing the implant failure rate, marginal bone loss, PES, soft and hard tissue changes, implant survival rate and patient related outcome measures of the conventional immediate implant placement groups versus the proposed socket shield technique. The results showed that there was no statistical difference in both the groups when various comparisons were performed. However, when the implant failure rate in the SST groups was performed alone, Siormpas et. al. (2018) had an implant failure rate of 2%.[11] This study has a strong follow up of 10 years. Of the five failure cases reported, two had failure in osseointegration and three had untreatable peri-implantitis. Three randomized clinical trial studies were chosen to evaluate marginal bone loss, where 76 implants were placed on 76 patients. The follow up time ranged from seven months to three years. Vertical bone loss was measured in the study conducted by Barakat et al. in 2017.[7] The immediate implant placement group had a mean vertical bone loss (VBL) of 1.61 ± 0.78 mm. SST group had a mean VBL of 0.44 ± 0.24 mm. Bramanti et al. (2018) had similar findings, where the marginal bone loss measured at IIP group was at 1.11 ± 0.13 mm, whereas SST group had a mean marginal bone loss of 0.60 ± 0.06 mm. Tiwari et al. (2019) conducted a study with 0.188 ± 0.013 mm marginal bone loss in IIP group and 0.030 ± 0.025 mm in the SST group.[9] Three studies that were conducted in SST group only. The report done in 59 patients with a total of 60 implants. Siormpas et al. in 2014 had a mesial and distal marginal bine loss of 0.18 ± 0.09 mm and 0.21 ± 0.09 mm respectively.[12] Baumer et al. in 2017 had a mesial marginal bone loss of 0.33 ± 0.43 mm and a distal marginal bone loss of 0.17 ± 0.36 mm.[13] Nguyen et al. reported in 2019 to have a marginal bone loss of 0.1 ± 0.2 mm[14]. Two RCT studies conducted by Bramanti et al.[8] and Sun et al.[10] with the follow up ranging from two to three years compared pink esthetic scores in both IIP and SST groups. The PES values for IIP group in the study conducted by Bramanti et al.[8] were 10.30 ± 2.53 and 12.15 ± 0.76 for the SST group. Sun et al. had similar higher values for SST group when compared to the IIP group[10], with the values 12.07 ± 1.62 for SST group and 11.33 ± 1.76 for IIP groups. Although, the SST group had higher values, there was no significant difference among the two groups. In two studies, the soft and hard tissues were compared between the IIP and SST groups. The probing depth of IIP group was 2.12 ± 0.64 mm whereas SST group was 1.73 ± 0.28 mm. Labial bone thickness was also measured in both the groups and none had any significant difference. Three studies were conducted on SST group only. Baumer et al, 2017 performed a retrospective study on 10 patients using 10 implants with a follow up time of 51 – 63 months. There was a 0.37 ± 1.18 mm loss of buccal tissue and 0.33 ± 0.23 mm mid-facial recession. Nguyen et al., 2019 did a case series on 3 patients with age 62-87 years. A follow up was done on for two to six years where they found no changes in soft tissue dimensions.[14]

Mitsias et al., 2020 performed a prospective clinical trial in 10 patients and did a follow up for 42 months and found 0.19 mm (0.10–0.28 mm) mid-facial recession.[16] Two RCT and one Prospective nonrandomized controlled study was conducted to compare the implant failure rate on both IIP and SST groups. All were in agreement where Barakat et al. 2017[7], Bramanti et al. 2018[8] and Xu et al.[6] 2019 had a 100 percent survival rate for both the groups. Studies done solely on SST group to evaluate the implant survival rate by Gluckman et al. 2017 showed a survival rate of 96.1%.[3] The implants failed to osseointegrate and had to be removed. A retrospective study done by Siormpas et al., 2018 had five implants failing, affecting the implant survival rate to 96.5%.[11] The last comparison section for IIP and SST groups was patient related outcome measures. The total mean values for WES, PES and function in SST group was 9.37 +/- 0.80, whereas the total group mean for IIP with xenograft group mean was 9.25 +/- 0.70. The *p*-values was 0.602, showing no statistical difference.

Socket shield technique in the esthetic zone is an

ongoing experimental procedure where clinicians are finding new ways to preserve the natural biological characteristics.

CONCLUSION

The current reports on SST has a wide variety of studies like retrospective studies, case series, case reports and prospective randomized controlled trials with short to long-term follow-ups. Additionally, the indications, contraindications and limitations of PET should be clearly understood and authenticated. SST is a promising technique that offers a chance to preserve the natural biological characteristics as opposed to the conventional implant placement techniques, but more research is needed to establish its clinical applicability and predictability.

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