innov.Plus

TODAY'S CHALLENGE
TOMORROW'S
INNOVATION

Stand to win up to $200,000 prototype
grant for your learning innovation!

CHALLENGE STATEMENT #04

1. Challenge Owner Index and Pseudonym

#04 – SMILE

2. Challenge Statement

Minimally invasive dental treatment is challenging to teach as the surrounding anatomy is often not obvious (because soft tissues are not cut open) and lies hidden during the procedure. An example would be the insertion of miniscrew implants for the purposes of orthodontic (braces) treatment.

Miniscrew implants are commonly-used temporary anchorage devices in orthodontic treatment that are inserted during a surgical procedure. To insert it successfully and safely in an actual patient, the clinician usually takes a radiograph of the relevant region to have a better sense of the surrounding anatomy and with the correct insertion angle and torque, places the miniscrew into the gums and surrounding bone. Complications like adjacent tooth trauma, nerve injury, sinus perforation, slippage, miniscrew implant fracture or eventual dislodgement can arise which inevitably lead to patient dissatisfaction and undesirable treatment results.

Conventional training involves inculcating theoretical knowledge with lectures and hands-on practice with resin models of dental arches. Training is often focused on building confidence to make the correct judgment of where the correct surgical site is using the appropriate insertion technique. Unfortunately, detailed visualisation of the surgical site anatomy with tactile feedback during screw insertion practice is not possible during training and the competency of trainees also cannot be ascertained before they try the procedure on actual patients.

3. About the Challenge Owner Organisation

We provide multidisciplinary dental services in the following: oral and maxillofacial surgery, orthodontics, prosthodontics, endodontics, periodontics, and paediatric dentistry for the general public in Singapore.

We are also a teaching institution that trains dental specialists, general dentists, radiographers, oral hygiene therapists, dental technicians and dental surgery assistants in collaboration with local tertiary education institutions. Continuing dental education events are also often organised for dentists in Singapore.

4. Define the Challenge

Current Situation
Minimally invasive dental treatment is challenging to teach as the surrounding dental anatomy is often not obvious (because soft tissues are not cut open) and lies hidden during the procedure. The insertion of miniscrew implants for the purposes of orthodontic (braces) treatment is one good

example. Miniscrew implants are commonly used temporary anchorage devices in orthodontic treatment that are inserted during a surgical procedure. It is a fixation device placed in bone for anchorage control using mechanical stability without the intention of osseointegration.

To insert it successfully and safely in an actual patient, the clinician usually takes a radiograph of the relevant region to have a better sense of the surrounding anatomy and with the correct insertion angle and torque, places the miniscrew into the gums and surrounding bone. Complications like adjacent tooth trauma, nerve injury, sinus perforation, slippage, miniscrew implant fracture or eventual dislodgement can arise which inevitably lead to patient dissatisfaction and undesirable treatment results.

Training is focused on building confidence to make the correct judgment of inserting into the right surgical site using the appropriate insertion technique. Unfortunately, detailed visualisation of the surgical site anatomy with tactile feedback during screw insertion practice is not possible during training and the competency of trainees also cannot be ascertained before they try the procedure on actual patients.

Currently, miniscrew implant insertion is taught using a combination of lectures to inculcate theoretical knowledge and then hands-on practice insertion into resin dental models. An experienced clinician will typically demonstrate once or twice and then guide the trainee in the process of insertion on the model. But most trainees will only gain competency after actual clinical experiences with patients.

Past & Current Solutioning Efforts
To visualise the surrounding dental anatomy, resin models with dental anatomy printed on them can be used. But with each miniscrew implant insertion, the screw tip becomes more blunt and there will also be an indentation created at the site of insertion at the resin model. Hence, many of these resin models and miniscrew implants are required which can be quite costly and limit the number of times a trainee can practise with them. Typically, the trainees only get to practise 2-3 times on the same model and will then do it on patients directly subsequently.

Challenge / Gap / Unrealised Potential
No assessment is possible as miniscrew implants are inserted into resin models and impossible to feedback upon as clinical complications like injury of adjacent teeth during the procedure will not occur in an artificial model. Dental anatomy variation between different patients is also not reflected in these models. Trainees thus usually has limited practice before doing it on actual patients and these may affect the success rates of miniscrew implant placement. There is also no way to give constructive feedback during training as it is not possible to see what lies within the resin models that the trainees are practising on.

5. Targeted Learners / Users

General dentists, Periodontists, Oral maxillofacial surgeons and Orthodontists working in our organisation.

Our estimated primary targeted user population is about 80.

Taking into account other dentists in Singapore who may be keen on the training and the potential for the solution to be altered slightly to simulate not just miniscrew implants but also regular dental

implants, our estimated secondary targeted user population can amount to about 2000 since there are about 2500 dentists in Singapore.

6. Solution Partner and Deliverables

The Solution Partner should ideally:
1. Have the expertise to convert digital cone-beam CT radiographic images to three-dimensional dental models
2. Able to produce haptic devices for simulation
3. Able to understand simple dental terminology and procedures

7. Expectations of Solution

It would be useful to leverage on technology to level the learning curve for all dentists interested in inserting miniscrew implants.

Having a cost-effective learning solution that allows repeated practice and assessment is ideal. It should be able to simulate real life insertion of miniscrew implants for trainees. For example, the surrounding dental anatomy should be able to be varied just like how every individual patient is different and the tactile sensation of the screw-driver during the insertion procedure should also be experienced, making learning more impactful and effective. The varying dental anatomy will allow trainees to practise in different scenarios to gain more experience. It will also be useful for the learning solution to allow "add ons" and variations in dental anatomies to expand the number of practice cases provided for trainees.

The solution should also allow a record function for trainees to playback and for trainers to feedback upon (i.e. depth of insertion of miniscrew implant, the torque used or whether the miniscrew implant has contacted any adjacent structures).

8. Measures of Success

Selection criteria:
- Cost effectiveness
- Ease of use
- Similarity to actual insertion procedure

Evaluation criteria:
- Cost of software/hardware
- Amount of time required to master the training software/hardware
- The quality of tactile feedback
- Ability to extract data and develop assessment analytics

Observable outcomes:
- Good trainee feedback from the training programme
- Increase in success rate of surgical procedure
- More effective and realistic training with constructive feedback can be provided

Measurable outcomes:

- Increase in miniscrew implant success rate. Our current miniscrew implant success rate is about 83%[1]. We will like to aim to bring success rates as close to 100% as possible to decrease patient complaints. This is because when a miniscrew fails, it will have to be re-inserted with additional cost and discomfort borne by the patient.
- Increase patient satisfaction
- Better way to assess competency of trainees before they start doing procedures on patients
- To build on learning solution so that it can be scaled up and applied to other minimally invasive dental procedures as well.

---

[1] *Song YL, Yow M, Chew MT, Foong KW, Wong HC. A study of success rate of miniscrew implants as temporary anchorage devices in Singapore. Int J Dent. 2015;2015:294670. doi: 10.1155/2015/294670. Epub 2015 Mar 10.*