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Identifying important prognostic factors and outcomes for autotransplantation of developing teeth: Clinicians' perspectives

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Abstract

Background/Aim: Variability in the outcome measures used to assess the success of tooth autotransplantation presents challenges for combining data to examine the success of the technique. Reaching agreement on the most important outcomes will enable routine procedural and follow-up data to be collected in a standardised way. In turn this will promote greater data synthesis to evaluate outcomes and examine which procedural techniques influence outcome. The aim of this study was to identify which prognostic factors and outcomes are most important to clinicians with experience in autotransplantation of developing teeth.

Methods: The Delphi method was used to build consensus on the most important prognostic factors and outcomes. Item identification involved a systematic literature review and review of current clinical datasets in use. A two-round Delphi questionnaire was undertaken with clinicians providing tooth autotransplantation, followed by a consensus meeting to finalise the most important items.

Results: Outcomes and prognostic factors were identified from the systematic review (82 studies and eight reviews), one guideline and three existing clinical datasets. Patient interviews and a clinician survey added a number of items that would not have been identified from the literature only. A total of 56 outcomes and 93 prognostic factors were included for rating in the Delphi questionnaire. The Delphi questionnaire was completed by 15 respondents in round one and 13 respondents in round two. The consensus meeting was attended by nine participants. The final items that were judged to be most important included 29 outcomes (25 clinical, three patient-reported and one service delivery) and 49 prognostic factors (18 patient characteristics, four presurgical, 17 surgical and 10 postsurgical). Clinical outcomes were consistently rated higher than patient-reported outcomes.

Conclusions: The clinical outcomes rated as the most important were transplant survival and reason for failure, outcomes relating to pulp health, different types of resorption and evidence of infection (suppuration). Important patient-reported outcomes were

satisfaction with overall treatment experience, and outcome and quality of life related to function of the transplanted tooth. Procedural information rated as being the most important related to the donor tooth: stage of root development, method for surgical removal and storage and condition of the donor tooth root surface following removal.

KEYWORDS
child, prognosis, record, treatment

1 | INTRODUCTION

Tooth autotransplantation in humans was first reported in the 1950s in relation to impacted third molars and there have since been numerous publications about the technique. Tooth autotransplantation can be used to manage tooth absence following dental trauma or pathologies, or to replace one or more teeth as a result of traumatic injury, pathologies or developmental anomalies.[1] The use of a natural tooth replacement has benefits in regenerating and maintaining the supporting periodontal tissues, allowing physiological eruption to optimise alveolar bone volume and maintenance of existing alveolar bone.[2] Developing or immature teeth, that is those teeth with an incomplete root and open apex, can be transplanted in growing patients where there is the additional advantage of continued development of hard and soft tissues.

Tooth transplant survival is the ongoing presence of the tooth in the mouth; however, definitions of success vary. Based on clinical and radiographic examination, success can include outcomes such as pulp and periodontal healing, continued root development, satisfactory aesthetics and function.[3–9] A number of biological complications have been also been identified including replacement resorption (ankylosis), inflammatory or invasive resorption, pulp necrosis, loss of periodontal attachment and arrested root development. Examination of potential prognostic factors that may influence the outcome of tooth autotransplantation suggests characteristics relating to the donor tooth (tooth type and stage of root development), recipient site (bone volume, proximity to adjacent structures and ankylosis of primary molar) and surgical factors (socket preparation, gentle extraction technique and extra-alveolar time) may be important.

The volume of literature related to tooth autotransplantation demonstrates the interest in this technique and the ambition to further improve outcomes. Randomised controlled trials (RCTs) are considered the gold standard for evaluating the effectiveness of one treatment modality compared to alternatives[10]; however, RCTs are challenging in tooth autotransplantation due to the specific and multifactorial clinical indications for tooth autotransplantation which make equipoise, and subsequently ethical randomisation, difficult. Good quality observational data may therefore be a necessary alternative for evaluating tooth autotransplantation if sufficient prospective, standardised, complete datasets can be obtained.[11] Currently, there are challenges with synthesising reported observational data arising from variability in reporting of procedural details and the use of different outcomes and outcome measures.

Two previous Expert Meetings held during the 2016 and 2018 Tooth Transplantation Congresses revealed marked differences in opinions about how tooth transplantation should be performed and evaluated. The need for a more systematic approach to reaching consensus was noted, which led to the design of this study as a first step to developing a minimal clinical datasets (MCDs). MCDs are defined as 'an essential or pertinent set of data elements related to a single clinical condition, procedure, specialty, or healthcare process', which are applied in practice as the minimum clinical information that should be collected from each patient as part of routine clinical care.[12] MCDs promote collection of pre-agreed standardised data for every patient, which in turn allows greater evaluation of processes and outcomes. It is important to stress that MCDs do not dictate how a procedure should be performed, nor do they prevent collection of other additional data which individual clinicians or teams may feel is important. MCDs are differentiated from core outcomes sets (COS), which represent the minimum outcomes that should be measured and reported in all clinical trials of a specific condition,[13] because MCDs are intended to be used in routine clinical care.

The aim of this study was to reach consensus about which prognostic factors and clinical outcomes are important in autotransplantation of developing teeth. This is a fundamental first step for establishing a MCD for this treatment modality. The Delphi method was chosen to give a robust and evidence-based approach to reaching consensus in an area where there is recognised uncertainty and no existing guidelines about the important procedural information and outcomes to record. It is recognised that the Delphi methods is constructivist in nature, that is it relies on expert knowledge to negotiate a shared reality and to co-construct knowledge and the outcome from the method (median importance ratings for prognostic factors and outcomes) is only as reliable as the available evidence and the participating experts.[14]

2 | MATERIALS AND METHODS

This was a cross-sectional survey involving:

1. Item identification through a systematic review of literature, clinical guidelines and existing clinical datasets, review of

transcripts from previous interviews with stakeholders and a questionnaire to clinicians
2. Reaching agreement on the most important items using the Delphi method, consisting of a two-round questionnaire followed by a consensus meeting.

The perspective of interest was dental professionals involved in providing autotransplantation of developing teeth. This included clinicians from different dental specialities working in different healthcare systems worldwide. A separate study is in progress to establish important outcomes from a patient perspective.

Evidence-based best practice guidance for minimum clinical datasets and core outcome set development was used to inform the methods.[15–17] The research team included recognised world experts in tooth autotransplantation (EC and PP), which encouraged participation and interest in the study, but it was recognised these individuals could have potentially influenced the Delphi process through their established position and known beliefs. To avoid this risk of bias, the research was led by two researchers who had topic knowledge but no existing reputation or influence. One researcher (KK) has experience in both the Delphi methods and nominal group technique. An independent facilitator developed materials and led the consensus meeting.

2.1 | Identification and recruitment

Due to the multicountry approach, there was no obvious single route for identifying all people who are interested and experienced in tooth transplantation. Invitations were sent to the participants of the preconference Expert Meetings held during the 2016 and 2018 Tooth Transplantation Congresses and to personal contacts of the research team and corresponding authors on tooth transplantation research publications. Invitees were also asked to recommend other people with clinical and research expertise in transplantation of developing teeth. Representation from different countries and specialties was sought. In total, 30 potential participants were identified and invited. Invitations were sent to all potential participants to request participation in stage 1 (Item identification survey). Invitation were resent to all participants to invite participation in the Delphi method. The group who participated in the Delphi method were referred to as the 'Expert Clinician' group. To try to minimise dropouts it was emphasised that the Delphi method is relatively burdensome but it is important that people who do take part are able to complete both rounds and ideally, attend the consensus meeting.

2.2 | Stage one: Item identification

The item identification process was used to generate a preliminary list of items from different sources:

1. Systematic literature review to identify studies examining the outcome from autotransplantation of developing teeth in humans were included. The systematic review methods are described in full in Table S1.
2. Guidelines published by the International Association for Dental Traumatology, International Association of Paediatric Dentistry, British Society of Paediatric Dentistry and American Association of Endodontics were searched to identify any recommendations or guidance relating to tooth autotransplantation or management of tooth avulsion.
3. Review of transcripts from interviews with people with experience of tooth autotransplantation, including young people, parents and dental professionals, which were undertaken in the Leeds Dental Institute for another study.[18]

Patient and procedural characteristics and outcomes were extracted and synthesised into categories:

- Prognostic factors: Patient-related; presurgical; surgical; postsurgical
- Outcomes: Clinical; patient-reported; health service

The outcome measurement instruments (how to measure) and the timing of information collection (when to measure) were extracted from the literature review for use in subsequent work but werenot included in the Delphi questionnaire. Patient-reported outcomes are any outcomes that are measured from the patient perspective, such as satisfaction, pain or self-confidence. These were included to assess whether clinicians feel these are important to elicit.

Following the systematic review, existing datasets were requested from the clinician group. Datasets were defined as any type of clinical record that collects standardised data, such as forms or templates. These were translated into English then checked for accuracy by the person who provided it. Items in the datasets were reviewed against the items already identified, and any additional items were identified and added to the list of items. The comprehensive list of items was then reviewed by the research team to remove duplicate items, clarify terminology and agree on definitions. Finally, an online questionnaire was created using OnlineSurveys (www.onlinesurveys.co.uk) and distributed to the clinician group to identify any additional items and to ensure the items were adequately defined (Supplemental questionnaire). The research team reviewed the results of the questionnaire to finalise the list of items.

2.3 | Stage two: Item rating

The Delphi study was developed, administered and reported using the guidance on Conducting and Reporting Delphi Studies (CREDES) standards.[14] The methods are summarised in Figure 1.

The Delphi questionnaire components are summarised in Table S2. Specialist software (DelphiManager v5.0) was purchased from the COMET Initiative and used to design the questionnaire and to collect and analyse responses. Ratings for each item were

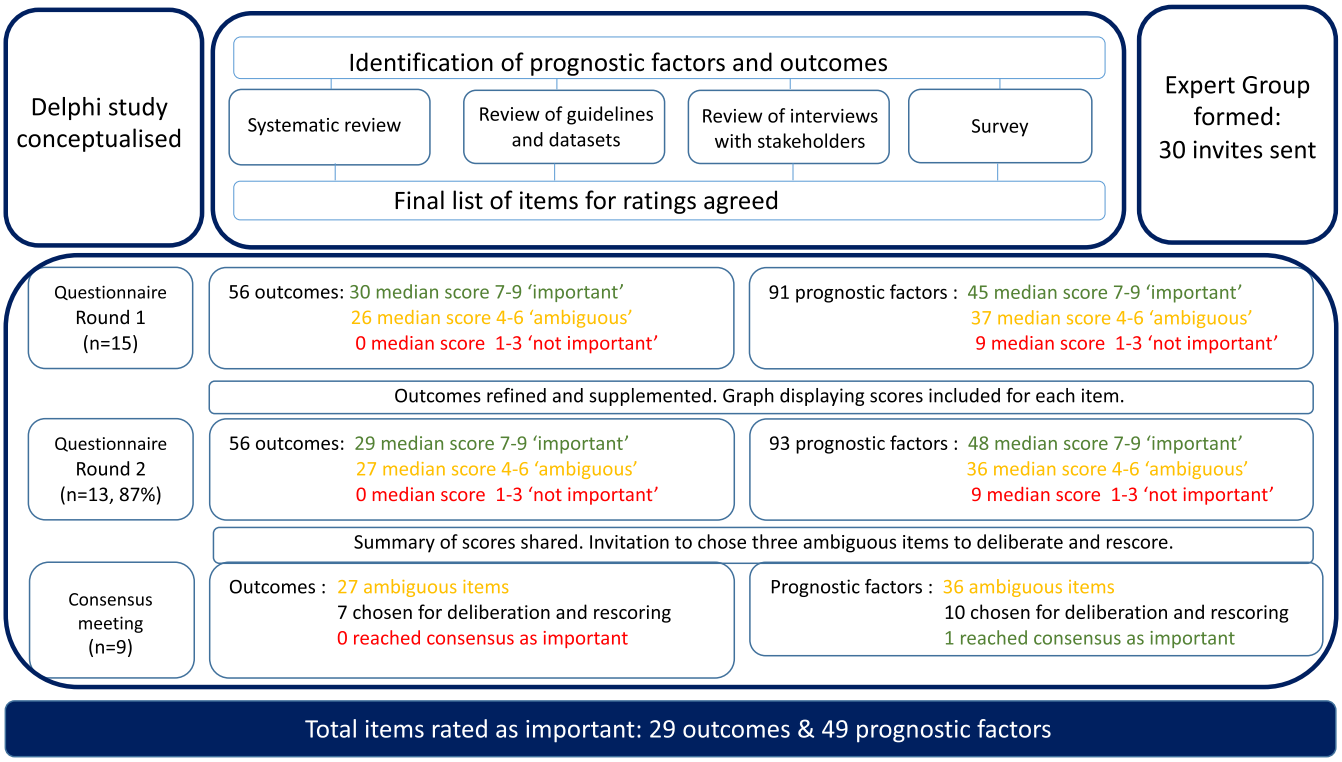
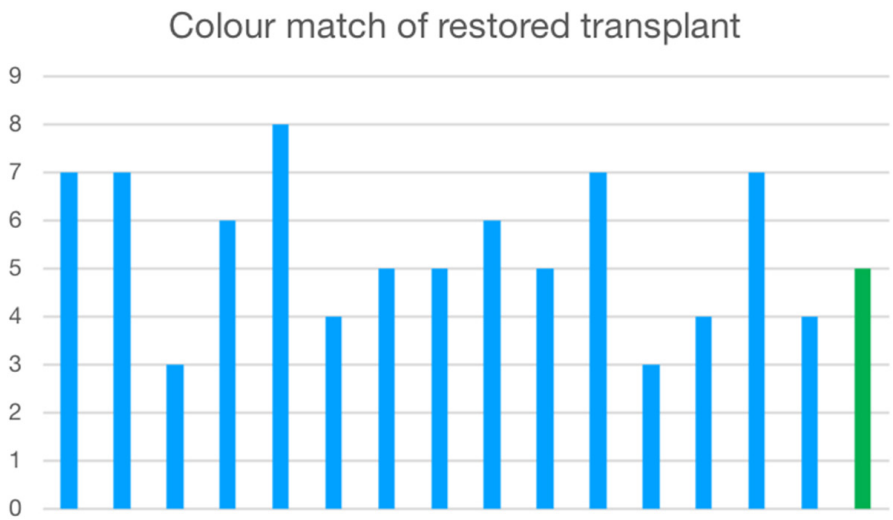


FIGURE 1 Summary of methods and progression of prognostic factors and outcomes through the study.

FIGURE 2 Example of bar chart used in the report after round one of the Delphi questionnaire. This showed the anonymised participant scores and the median score for each item.



given on a traditional 9-point Likert scale,[14] where 1 = 'Definitely not important' and 9 = 'Definitely important'. Consensus was defined by median rating for each item, with a median score of 7–9 judged to be important, 4–6 as ambiguous and 1–3 as not important. No items were removed between the questionnaire rounds to allow for a change in individual and median ratings. The consensus meeting was used to confirm that participants accepted those judged to be important (median score 7–9) and unimportant (median score 1–3). There was then an opportunity to discuss items that were scored as ambiguous and then to revote in order to reach a final consensus score for these items. In the final vote the participants were asked whether the ambiguous items were important (yes/no) and the item required seven out of nine participants (78%) to vote yes for the item to be included.

After each round, the ratings were collated, and the distribution of ratings and the median score for each item was calculated. A summary report was created after the first and sent to the participants prior to the invitation to participate in Round 2. The report included a summary of the Delphi method and the purpose of the research. A bar chart with the median score for each item, grouped by category was included in the report (Figure 2). Graphs showing median scores from the first round were uploaded into the system for the second round for respondents to see when rescoring items. All items were included in the second round and any new items suggested

by respondents were added. A similar report was created after the second round.

The consensus meeting included a sample of the participants who had completed both rounds of the Delphi questionnaire. A professional independent facilitator with expertise in the nominal group technique was employed to plan and deliver the consensus meeting workshop. All materials used for the consensus meeting were written by the independent facilitator to promote unbiased and clear explanations, then checked by the research team to ensure accuracy. Due to the Covid-19 pandemic, the consensus meeting was held virtually using Zoom. A report of the outcomes of the two rounds of the Delphi questionnaire and instructions for the meeting were sent to the participants one week prior to the meeting to allow time for review. Participants were asked to select up to three items (if they wished) that were scored <7 but that they felt were important. Inviting each participant to choose up to three items to discuss ensured each person had equal opportunity to speak and the independent facilitator managed the group conversation to ensure no single voice dominated the group. These items were deliberated and then rescored individually and anonymously using an online questionnaire during the meeting (www.SurveyMonkey.co.uk).

Results of the Delphi process were presented at the 3rd Tooth Transplantation Congress in Prague in May 2022, and anyone interested who had not taken part in either the Delphi questionnaire or the consensus meeting was invited to review the Delphi report. Ratification of the report was sought from both Delphi participants and all who expressed an interest in reviewing the results.

3 | RESULTS

3.1 | Item identification

The systematic review search was performed on 24th September 2018. Electronic database and grey literature searches identified 3726 records, of which 393 were excluded as duplicates. Of the 3333 records reviewed, 2990 were excluded by title and a further 343 by abstract. Full text articles were reviewed for 90 records and from these, 82 studies and eight systematic reviews were included for full data extraction (Figure S1).

The search for guidelines found one relevant guideline, the International Association of Dental Traumatology *Guidelines for the Evaluation and Management of Traumatic Dental Injuries: 2: Avulsion of permanent teeth*,[19] which has since been superseded by the 2020 version. A number of other guidelines linked to this. No specific guidelines for tooth autotransplantation were identified. Three current datasets in routine use were provided by teams involved in providing tooth autotransplantation from three different European countries, who reported these datasets were based on the original clinical dataset used by Professor Jens Andreasen.

The literature review and datasets provided the majority of the prognostic factors and clinical outcomes while the interviews were important for identifying a number of additional patient-reported items such as treatment burden, dental appearance immediately after surgery, physical and emotional pain and impact on daily activities, such as eating. The questionnaire to identify any additional items was completed by 22 participants (Table 1). The items that were identified from the mixed methods and subsequent questionnaire are listed in Table S3; this comprehensive list of items was used for the Delphi questionnaire, which included 56 outcomes and 93 prognostic factors.

3.2 | Item rating

Of the 30 people invited to take part in the Delphi questionnaire, 15 completed round one (50%). Of these, 13 completed the second round (87%). The two who withdrew reported to have insufficient time to complete the second round due to personal circumstances. Specialty and country of those who participated are summarised in Table 1. The median scores for the importance of the outcomes and prognostic factors from questionnaire rounds one and two are reported in Figure S2.

The consensus meeting was attended by nine participants who had taken part in the Delphi questionnaire. Following discussion of the items scored as highly important (7–9), no items were downgraded. Of the ambiguous items chosen by the participants for further discussion and rescoring, only one was scored as important which was 'Bone volume at recipient site' (Table S4).

The final items that were judged to be most important included 29 outcomes (25 clinical, three patient-reported and one service delivery) and 49 prognostic factors (18 patient characteristics, four presurgical, 17 surgical and 10 postsurgical) (Table 2). Clinical outcomes were generally rated as more important than patient-reported outcomes. These are the items that are suggested for use in the future minimum clinical dataset.

4 | DISCUSSION

The clinical outcomes that were rated as most important (scored 9) were transplant survival and reason for failure, those relating to pulp health and resorption and evidence of infection (suppuration). These are all outcomes which have been widely used in the literature and are recognised markers of success. The procedural information that was rated as being most important relates to the donor tooth: stage of root development, method for surgical removal and storage and condition of donor tooth root surface following removal. Stage of root development and surgical technique have both previously been identified as an important prognostic factors for predicting successful pulp healing.[20]

The literature review identified a considerable number of clinical outcomes that have been used to evaluate success and, in addition, there were several outcome measurement tools used across the studies. This presented challenges for the Delphi method because inclusion of all items made the questionnaire somewhat onerous to

TABLE 1 Summary of participants involved in item identification and selection.

Stage of research	Specialty (*n*)		Country (*n*)	
Item identification questionnaire (*n* = 22)	Endodontics	1	Belgium	1
	General dentist	3	Brazil	1
	Implants/oral surgery	1	Czech Republic	5
	Oral maxillofacial surgery	2	Denmark	1
	Orthodontics	5	Iceland	1
	Paediatric dentistry	5	Japan	1
	Periodontology/surgeon	5	the Netherlands	2
			Poland	2
			UK	3
			USA	5
Delphi questionnaire Round 1 (*n* = 15)	General dentist	2	Czech Republic	3
	Implants/oral surgery	1	Denmark	1
	Oral maxillofacial surgery	3	Iceland	1
	Orthodontics	4	the Netherlands	1
	Paediatric dentistry	4	Poland	2
	Periodontology/surgeon	1	UK	4
			USA	3
Consensus meeting (*n* = 9)	General dentist	1	Czech Republic	1
	Implants	1	Denmark	1
	Oral maxillofacial surgery	1	Iceland	1
	Orthodontics	3	Poland	1
	Paediatric dentistry	2	Singapore	1
	Periodontology/surgeon	1	UK	2
			USA	1

complete and analyse; however, there was generally good agreement about which items were judged to be important. The final list of 25 clinical outcomes and three patient-reported outcomes may be challenging to record for every patient; so this requires some careful consideration to ensure the minimum clinical dataset is feasible. While clinical outcomes were dominant in the existing literature and the final list of important outcomes, there is growing emphasis on the inclusion of patient-reported outcomes when evaluating success.[21] Three outcomes relating to satisfaction and quality of life were judged as being important; however, these were only scored as seven compared with scores of nine for the clinical outcomes. Patient-reported outcomes are by nature subjective and careful consideration will need to be given to how and when they are measured, and how clinicians can be supported to capture this data.

The high number of procedural items that were judged to be important is likely to present less challenge for the minimum clinical dataset because many will be routinely recorded throughout treatment as part of existing clinical record keeping. The value of standardised recording of procedural information is considerable because this will help answer many long-standing questions about the most effective protocol for performing tooth transplantation.

Whilst this study indicates which prognostic factors and outcomes are most important from clinicians' perspectives, it does not identify when and how to record this data, how to define success and failure of autotransplantation, nor does it capture the patient and family's perspective of what is important. The next stage of this research is to examine which outcomes are most important to young people undergoing tooth autotransplantation and their parents. This will involve interviews with young people and parents to explain and discuss all possible outcomes, followed by individuals independently rating the outcomes. Once important prognostic factors and outcomes have been agreed, clinicians will be engaged again to agree on the most appropriate measurement tools.

4.1 | Strengths and limitations

The Delphi method is a well established method to achieve consensus based on an iterative process with anonymous consultation and controlled feedback.[17] The COMET handbook[15] considers Delphi to be an excellent method for gaining information about opinion from a wide group of participants and gives guidance on optimising this approach. This guidance was followed to ensure transparent, reproducible and robust methodology for choosing the outcomes to be included in the minimum dataset. The Delphi method assumes experts will allow their judgements to be shaped by understanding the opinions of others.[22] However, there is evidence in this study that opinions did not significantly change. This may be because there was

TABLE 2 Final items that were rated as important.

Prognostic factors ($n=48$)	
Patient-related ($n=17$)	Donor stage root development
	Patient age
	Patient's cooperation with dental treatment
	Donor tooth type
	Position of donor tooth
	Donor tooth coronal and root dimensions
	Location of recipient site
	Presence and status of tooth in recipient site
	Intercoronal and interradicular space at recipient site
	Relevant medical conditions
	Patients oral health status
	Patients smoking status
	Reason for tooth transplantation
	Number of teeth transplanted
	Previous surgical exposure of donor tooth
	Inflammation at recipient site
	Bone volume at recipient site
Presurgical ($n=4$)	Presurgical orthodontics to create space in recipient site
	Preparation of edentulous recipient site
	Preoperative antibiotics to manage infection at the recipient site
	Timing of bone grafting at recipient site
Surgical ($n=17$)	Method for removing donor tooth
	Condition of donor tooth root surface following removal
	Storage medium for donor tooth
	Experience of operator
	Donor tooth root form
	Donor tooth extraoral time
	Vertical position of donor tooth in socket after transplantation (occlusal contact on transplant tooth)
	Exposure and method of bone removal for donor tooth
	Ease of donor tooth removal
	Postpreparation donor root coverage (buccal and lingual)
	Quantity of bone at recipient site
	Number of times donor tooth tried in socket during socket preparation
	Closure of wound
	Additional procedures required in recipient site (e.g. sinus lift)
	Splinting method
	Immediate post-operative advice to maintain excellent oral hygiene
	Immediate post-operative advice to avoid possible trauma
Postsurgical ($n=10$)	Post-operative cooperation and attendance
	Timing of endodontic treatment
	Evidence of surgical wound healing
	Use of post-operative antibiotics
	Timing of splint removal
	Post-operative oral hygiene
	Timepoint when orthodontic force first applied to transplant
	Forced orthodontic extrusion (e.g. corticotomy)
	Type of endodontic treatment
	Enamel/dentine grinding while restoring the transplant

TABLE 2 (Continued)

Outcomes ($n=29$)	
Clinical ($n=25$)	Transplant survival
	Reason for loss of transplant
	Pulp chamber and canal obliteration (for vital transplants)
	Internal inflammatory resorption
	External inflammatory resorption
	External cervical resorption
	Osseous replacement resorption (ankylosis)
	Pulp necrosis (vital transplants)
	Completion of endodontic treatment (nonvital transplants)
	Suppuration associated with transplant
	Surface resorption
	Repeat endodontic treatment (nonvital transplants)
	Mobility of transplant
	Transplant response to orthodontic traction
	Stage of root development of transplant
	Gingival inflammation around transplant
	Transplant sound on percussion
	Spontaneous eruption of transplant (vital transplant)
	Further transplant root development following transplantation
	Probing depths around transplant
	Gingival recession associated with transplant
	Status of papilla around transplant
	Presence of plaque around transplant
	Appearance of supporting tissue around transplant
	Occlusal contact on transplant
Patient-reported ($n=3$)	Satisfaction with overall treatment experience
	Satisfaction with outcome from tooth transplantation
	Quality of life related to function of transplant
Service delivery ($n=1$)	Team involved in delivering treatment

generally good agreement from the outset on broad item ratings and perhaps more importantly, no limit was given for how many items could be included in the final list.

It is recognised that the Delphi process can be influenced by the panel expertise and composition, as well as the number of respondents and attrition.[22] No monetary incentive was offered for taking part but despite this, the attrition rate was low. It was challenging to assess the panel expertise objectively, but the majority of those who took part are considered to be experts through their clinical experience and research in the field. It is likely there was an element of self-selection bias in those who agreed to take part. It is likely these are individuals who are very interested in this technique or who have specific beliefs about how the procedure should be performed and evaluated. However, is not possible to quantify how this may have altered results.

It is suggested that diversity in the panel of Delphi participants may allow a wider range of alternatives and perspectives to be included, leading to a better performance.[23] For this reason, participants from different specialities and countries were sought. In keeping with other healthcare-related Delphi studies, a relatively small sample (10–12) was accepted because the need to include participants with particular knowledge of tooth autotransplantation meant the potential sample was relatively limited and homogeneity was unavoidable. Inviting more participants may have increased the variety of expertise, but evidence suggests eventually there are diminishing returns on increasing sample size[24] and a group of more than 12 does not insignificantly increase reliability.[25] The discussion in the consensus meeting suggested differences in opinion exist about the tooth transplantation procedure and how and when to measure outcomes, but generally there was good agreement about which items are judged to be most important. Furthermore, no concerns about the results were expressed following presentation at the 3rd Tooth Transplantation Congress to people who had not taken part in the study. For this reason, repeating this research with other participants is unlikely to lead to significantly different results.

It is recognised that the Delphi process can be sensitive to questionnaire administration and question clarity.[24] The description of items and explanations included in the questionnaires were discussed extensively by the research team, which included people whose first language was not English, to ensure the definitions and explanations were clear. However, no piloting was undertaken to test the validity of the materials. It is acknowledged that some of the members of the research team are recognised experts in this treatment modality so they knew many of the participants who took part in the consensus meeting but this was actually considered to be a benefit because the existing relationship and known differences in opinion resulted in extensive and open discussion.

A key strength of consensus methods is the balanced participation from group members, unlike a focus group, whereby the facilitator must control for and minimise the risk of a dominant participant influencing the discussion.[24] Furthermore, participants have the opportunity to consider the views of others before rerating each item and can, therefore, change their initial response based on the feedback from the previous rounds.[15] In this study, the Delphi method successfully engaged a range of experienced clinicians from across the world and the response rate was good. A professional independent facilitator with expertise in the nominal group technique planned and delivered the consensus meeting workshop, which reduced the potential for bias that would have occurred from facilitation by clinician-researchers.

Although the Covid-19 pandemic prevented the consensus meeting being undertaken in person, this proved advantageous because it allowed a greater number of people to take part. The nominal group technique (NGT) is a facilitated and structured face-to-face group interaction which aims to empower participants by providing an opportunity to have their voices heard and opinions considered by other members. This enables equal participation among members in generating information and achieving outcomes. It comprises four key stages: silent generation, round robin, clarification and voting.[24] The experienced facilitator and use of the nominal group technique (NGT) provided a structure to the consensus meeting and enabled all voices to be heard. This quality assured the results of the Delphi process by permitting a more in-depth discussion of any ambiguous items.

5 | CONCLUSIONS

- Agreement has been reached on 25 clinical, three patient-reported and one service-related outcome that are important for autotransplantation of developing teeth.
- The clinical outcomes that were rated as most important were transplant survival and reason for failure, those relating to pulp health and resorption, and evidence of infection (suppuration).
- Important patient-reported outcomes were satisfaction with overall treatment experience and outcome, and quality of life related to function of transplant but these were not rated as highly as the important clinical outcomes.
- The procedural information that was rated as being most important related to the donor tooth: stage of root development, method for surgical removal and storage and condition of donor tooth root surface following removal.
- The Delphi method and the nominal group technique consensus meeting proved successful methods for reaching agreement on which outcomes and procedural details are important to record.

AUTHOR CONTRIBUTIONS

All authors contributed to concept, design, recruitment, data analysis, manuscript preparation and final review. Sophy Barber and Kate Kenny were responsible for delivery and data collection.

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CONFLICT OF INTEREST STATEMENT

The authors confirm they have no conflicts of interest.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

1. Andreasen JO, Andersson L, Tsukiboshi M, Czochrowska EM. Autotransplantation of teeth to the anterior region. In: JO A, Andreasen FM, Anderson L, editors. Textbook and colour atlas of traumatic injuries to the teeth. 5th ed. Hoboken: Wiley-Blackwell; 2018. p. 853–87.
2. Waldon K, Barber SK, Spencer RJ, Duggal MS. Indications for the use of auto-transplantation of teeth in the child and adolescent. Eur Arch Paed Dent. 2012;13(4):210–6.
3. Ahmed N. Outcome of tooth autotransplantation: a systematic review, MSc thesis. Hoboken: The University of Leeds; 2015.
4. AImpani K, Papageorgiou SN, Papadopoulos MA. Autotransplantation of teeth in humans: a systematic review and meta-analysis. Clin Oral Investig. 2015;19(6):1157–79.
5. Akhlef Y, Schwartz O, Anderasen JO, Jensen SS. Autotransplantation of teeth to the anterior maxilla: a systematic review of survival and success, aesthetic presentation and patient reported outcome. Dent Traumatol. 2018;34:20–7.

6. Atala-Acevedo C, Abarca J, Martinez-Zapata MJ, Diaz J, Olate S, Zaror C. Success rate of autotransplantation of teeth with an open apex: systematic review and meta-analysis. Am Asssoc Oral Maxillofac Surg. 2017;75:35–50.
7. Chung W-C, Tu Y-K, Lin Y-H, Lu H-K. Outcomes of autotransplanted teeth with complete root formation: a systematic review and meta-analysis. J Clin Periodontol. 2014;41:412–23.
8. Rohof EC, Kerdijk W, Jansma J, Livas C, Ren Y. Autotransplantation of teeth with incomplete root formation: a systematic review and meta-analysis. Clin Oral Investig. 2018;22:1613–24.
9. Machado LA, Do Nascimento RR, Ferreira DM, Mattos CT, Vilella OV. Long-term prognosis of tooth autotransplantation: a systematic review and meta-analysis. Int J Oral Maxillofac Surg. 2016;45(5):610–7.
10. Hariton E, Locascio JJ. Randomised controlled trials – the gold standard for effectiveness research: study design: randomised controlled trials. BJOG: Int J Obs Gynae. 2018;125(13):1716.
11. Bondemark L, Ruf S. Randomized controlled trial: the gold standard or an unobtainable fallacy? Eur J Orthod. 2015;37(5):457–61.
12. Svensson-Ranallo PA, Adam TJ, Sainfort F. A framework and standardized methodology for developing minimum clinical datasets. AMIA Jt Summits Transl Sci Proc. 2011;2011:54–8.
13. Webbe J, Sinha I, Gale C. Core outcome sets. Archives Dis Childhood Educat Pract. 2018;103:163–6.
14. Jünger S, Payne SA, Brine J, Radbruch L, Brearley SG. Guidance on conducting and reporting Delphi studies (CREDES) in palliative care: recommendations based on a methodological systematic review. Palliat Med. 2017;31:684–706.
15. Williamson PR, Altman DG, Bagley H, Barnes KL, Blazeby JM, Brookes ST, et al. The COMET handbook: version 1.0. Trials. 2017;18(3):280.
16. Williamson PR, Altman DG, Blazeby JM, Clarke M, Devane D, Gargon E, et al. Developing core outcome sets for clinical trials: issues to consider. Trials. 2012;13(1):132.
17. Sinha IP, Smyth RL, Williamson PR. Using the Delphi technique to determine which outcomes to measure in clinical trials: recommendations for the future based on a systematic review of existing studies. PLoS Med. 2011;8(1):e1000393.
18. Albalooshy AM. The Experiences and Outcomes of Tooth Auto-Transplantation at Leeds Dental Institute. UK: The University of Leeds. 2021 Integrated PhD and MSc Thesis.
19. Fouad AF, Abbott PV, Tsilingaridis G, Cohenca N, Lauridsen E, Bourguignon C, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. Dent Traumatol. 2020;36:331–42.
20. Andreasen JO, Paulsen HU, Yu Z, Bayer T, Schwartz O. A long-term study of 370 autotransplanted premolars. Part II. Tooth survival and pulp healing subsequent to transplantation. Eur J Orthod. 1990;12(1):14–24.
21. Tsichlaki A, O'Brien K, Benson PE, Marshman Z, Johal A, Colonio-Salazar FB, et al. Development of a core outcome set for use in routine orthodontic clinical trials. Am J Ortho Dent Orth. 2020;158(5):650–60.
22. Donohoe HM, Needham RD. Moving best practice forward: Delphi characteristics, advantages, potential problems, and solutions. Int J Tour Res. 2009;11(5):415–37.
23. Powell C. The Delphi technique: myths and realities. J Adv Nurs. 2003;41(4):376–82.
24. McMillan SS, King M, Tully MP. How to use the nominal group and Delphi technique. Int J Clin Pharm. 2016;38:655–62.
25. Waggoner J, Carline JD, Durning SJ. Is there consensus on consensus methodology? Descriptions and recommendations for future consensus research. Acad Med. 2016;91:663–8.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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