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Implant-based dental rehabilitation after fibula free-flap reconstruction: a national survey of Restorative Dentistry practice in the United Kingdom

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Key points

- Implant-based rehabilitation after fibula free-flap reconstruction depends on close joint working between Restorative Dentistry and oral and maxillofacial surgery, yet evidence to guide practice is limited.
- This national survey found wide variation across UK units in the timing of implant placement, use of virtual surgical planning, soft-tissue management, consent processes and outcome recording.
- Agreed national pathways, a minimum outcome dataset that includes patient-reported outcomes, and prospective multi-centre data collection are needed to reduce unwarranted variation and inform service development.

Abstract

Aims: To describe current UK practice, service organisation and perceived challenges in implant-based dental rehabilitation of fibula free-flap reconstructions.

Methods: A cross-sectional online survey (Microsoft Forms) was distributed to Consultants in Restorative Dentistry through the Restorative Dentistry UK Head and Neck Cancer Clinical Excellence Network between September 2025 and January 2026. Closed responses were summarised descriptively, and free-text responses were analysed qualitatively.

Results: Sixteen Consultants from 14 NHS Boards and Trusts responded. Almost all planned fibula reconstructions jointly with oral and maxillofacial surgery (OMFS) teams. Primary or case-dependent implant placement was preferred in 79% of centres and secondary placement after healing in 21%. Virtual surgical planning was used routinely for cases in 57% of centres. Restorative Consultants usually placed implants and OMFS surgeons usually debulked flaps. Fixed prostheses predominated and immediate loading was generally not used. Soft-tissue problems were the most frequently reported complication. Approaches to implant timing when adjuvant radiotherapy was anticipated was divergent. Outcome recording was inconsistent and published patient-reported outcome measures were rarely used.

Conclusions: Prosthodontic rehabilitation pathways of fibula free flaps vary considerably in UK hospitals. Agreed national pathways, a minimum outcome dataset that includes patient-reported outcomes, and prospective multi-centre data collection are needed to reduce unwarranted variation and inform service development.

Introduction

Ablative surgery for head and neck cancer (HNC), benign jaw pathologies (such as ameloblastoma), and osteoradionecrosis (ORN) frequently necessitates segmental resection of the mandible or maxilla, with resultant functional and aesthetic deficits that can profoundly affect patient quality of life.[1] The vascularised fibula free-flap has become the established reconstructive standard for mandibular defects, offering reliable bone stock of adequate length and cortical quality to restore skeletal continuity and support implant-based dental rehabilitation.[2,3] It is also widely used to reconstruct maxillary defects.[4] Osseointegrated implant-retained prostheses are widely regarded as the optimal rehabilitative option in this setting, facilitating restoration of occlusal function, nutritional adequacy, and patient-reported outcomes. UK multidisciplinary guidelines recommend that osseointegrated implants be considered for all patients undergoing resection for HNC.[5] However, evidence that implant-retained prostheses improve quality of life in patients with intraoral maxillofacial defects remains limited,[6] and only around half of patients are reported to receive dental prosthetic rehabilitation after fibula reconstruction of the jaws.[7]

The delivery of implant-based oral rehabilitation following fibula free-flap reconstruction is a technically demanding, resource-intensive process necessitating coordinated multidisciplinary input across oral and maxillofacial surgery (OMFS), Restorative Dentistry, and allied clinical specialties. Critical decision points include the timing and operator responsibility for implant placement, the application of virtual surgical planning (VSP), soft-tissue management strategies, prosthodontic design, and the sequencing of adjuvant oncological treatment.

Implants may be placed as part of ablative surgery (primary placement), or placement may be delayed until after healing (secondary placement). The likelihood of adjuvant radiotherapy may favour primary placement, avoiding later implant surgery in irradiated bone, which is associated with reduced implant survival and a risk of ORN.[7,8,9] Conversely, implants placed at primary surgery will be irradiated if adjuvant radiotherapy is given, and comparative evidence on the optimal timing is limited.[10,11]

VSP can be used for the dental rehabilitation of fibula reconstructions for both primary and secondary implant placements. It has been associated with shorter operating times and greater accuracy for some measures of reconstruction, although study methods have been heterogeneous.[12,13] The Alberta Reconstructive Technique is an occlusally driven technique that uses VSP to fully guide the reconstruction and primary implant placement.[14,15]

Soft tissue management is regularly required for dental rehabilitation of fibula reconstructions as after surgery the tissues are often bulky or unsuitable for implant emergence. Soft tissue management may involve debulking of the tissues, sulcoplasty,

or grafting to establish keratinised mucosa around the implants. Skin grafts, or free gingival grafts with apically repositioned flaps,[16] may be used for this.

Prosthodontic design depends on numerous factors including the restorative space, which tissues require replacement, requirements for cancer surveillance of the underlying tissues, the number of implants placed, and trismus and access to restore and maintain implants. Patients who have had fibula reconstructions often require replacement of gingival and dental tissues, so prostheses that replace both teeth and soft tissues (Misch FP-3, RP-4 or RP-5 designs) are usually indicated.[17]

Robust evidence to guide standardised, best-practice approaches across these domains remains limited.

Within the United Kingdom, provision of this highly specialised care is distributed across a small number of NHS centres, with potential for considerable inter-institutional variation. Previous UK national surveys of oral and maxillofacial surgeons and restorative dentists have characterised broader patterns of service delivery, reporting increasing use of dental implants after cancer surgery, and substantial variation in dental input to oncology pathways, pre-radiotherapy dental assessment, and the timing, operator and funding of implant rehabilitation.[18,19,20] Internationally, Wiedenmann *et al*. conducted a patterns-of-care survey across German-speaking countries, examining prosthetic rehabilitation of HNC patients following radiotherapy, identifying variation in treatment concepts by specialty and work setting, and concluding that patients might benefit from centralisation in larger multidisciplinary institutions.[21] More recently, a French national survey of reconstructive surgeons found that dental implant rehabilitation after free bone flap reconstruction remained uncommon, with patient irradiation and lack of funding the most frequently cited obstacles.[22] No published survey has specifically examined practice variation within the fibula free-flap reconstruction pathway in the UK, or from the perspective of Restorative Dentistry. This constitutes a substantive evidence gap, particularly given the complexity of this care pathway and the imperative to reduce unwarranted clinical variation in specialist HNC services.

To address this gap, a national cross-sectional survey of Consultant practice was undertaken by the Restorative Dentistry UK (RDUK) Head and Neck Cancer Clinical Excellence Network (CEN). The primary aim was to characterise current service provision and clinical practice across UK centres delivering fibula free-flap implant rehabilitation, identify perceived barriers and clinical challenges, and provide a baseline to inform service improvement and future research in this field.

Methods

Study design

A national cross-sectional survey was conducted to evaluate current practice, variations in the delivery of care, and challenges to the use of dental implant rehabilitation in fibula free-flap reconstructions for patients undergoing treatment for HNC or benign pathology.

Survey

NHS Consultants in Restorative Dentistry with experience providing dental implant rehabilitation in fibula free-flap reconstructions within an HNC surgical team developed a structured questionnaire using Microsoft Forms (Microsoft Corporation, Redmond, WA, USA). The survey was designed collaboratively by members of the CEN following discussion at network meetings where the fibula free flap was identified as a shared area of clinical interest . These were integrated into the survey instrument and further refined through research team discussions to optimise comprehensibility. The survey was piloted across four NHS Health Boards/Trusts where Restorative Dentistry was embedded within the multidisciplinary team. Comments and suggestions on the pilot survey supported question refinement and development of the finalised survey. The final survey was reviewed by the authors chairs prior to distribution. The survey was distributed by email to members of the RDUK Head and Neck Cancer CEN (n=40) and was open from 26 September 2025 to 31 January 2026.

The final survey contained 25 questions comprising closed and free-text items covering:

- NHS organisation;
- experience in restoring fibula flap reconstructions;
- timing and planning of dental implant placement;
- virtual surgical planning (VSP) usage;
- implant type and operator responsibility;
- soft-tissue management;
- prosthodontic rehabilitation approaches;
- outcome recording and use of patient-reported outcome measures (PROMs);
- perceived complications and clinical challenges;
- influence of adjuvant therapy on decision-making; and
- consent processes.

The full questionnaire is provided as Supplementary Information.

Participants and ethical considerations

Participation was voluntary and the form permitted optional anonymity. No identifiable patient data were collected. Respondents were asked to confirm their involvement in planning dental implants in fibula reconstructions and to name their NHS organisation.

Formal ethical approval was not required, as surveys of this kind form a core function of the Restorative Dentistry UK Head and Neck Cancer Clinical Excellence Network. The data will removed from Microsoft Office after one year.

Data Extraction and Analysis

Raw data were exported to Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and summarised as counts and percentages. Sixteen responses were received from 14 NHS Boards and Trusts. Responses to questions about an individual clinician's own practice are therefore reported as a proportion of the 16 responding Consultants, and responses to questions about the organisation of the service as a proportion of the 14 responding Boards and Trusts; both denominators are given in the text as n/N. For the complications question, respondents could select up to three options. A qualitative analysis of free-text responses was carried out using keyword frequency, open coding, and grouping into dominant clinical themes. Given the small sample, no inferential statistical analysis was undertaken.

Results

Respondents

A total of **16 responses** were received from Consultants in Restorative Dentistry in 14 NHS Boards and Trusts. Responding organisations, in England and Scotland, were Barts, Plymouth, Leeds & Mid-Yorkshire, Manchester, Newcastle, South Tees, Sheffield, Bristol & Weston, Tayside, Leicester, York & Scarborough, Torbay & South Devon, Gloucestershire, Birmingham Community, and Lancashire Teaching Hospitals. Respondents varied in experience, reporting restoration of **0–50 fibula flap implant cases** within the past five years.

Implant Planning and Surgical Integration

Multidisciplinary Collaboration

Almost all respondents (15/16) reported working collaboratively with OMFS teams when planning fibula free-flap reconstructions, with one respondent not currently planning implant placement in fibula free flaps but with immediate plans to develop such a service.

Timing of Implant Placement

Preferred timing varied:

- **Primary placement during ablative surgery** (43% of centres, 6/14);
- **Case-dependent approaches** (36% of centres, 5/14);
- **Secondary placement after healing** (21% of centres, 3/14).

Use of Virtual Surgical Planning (VSP)

Use of VSP to plan the bony and implant-based reconstruction varied between centres:

- Some centres reported **routine VSP use for all benign and malignant cases (57%, 8/14);**
- A minority reported no access to VSP **(14%, 2/14).**
- In free-text responses, one respondent raised concerns about the quality and accuracy of commercially supplied surgical guides.

Implant Placement, Types, and Surgical Responsibilities

Operator Performing Implant Placement

Restorative dentistry consultants were usually responsible for placing implants into the fibula with 86% of respondents reporting that this was the case in their unit. One

respondent reported that this was normally undertaken by OMFS colleagues, while one reported that it was shared responsibility but dependent on practicalities like surgical time available on the list.

Implant Type

Most respondents reported that **bone-level implants (12/14)** were the type most commonly used in their unit; for a minority, **tissue-level (2/14)** implants were most commonly used.

Flap Debulking and Second-Stage Surgery

- **Flap debulking:** normally undertaken by OMFS consultants, mostly under general anaesthesia (13/14 units). One centre reported that it was undertaken by OMFS colleagues under local anaesthesia.
- **Second-stage surgery:** usually undertaken by restorative dentistry consultants (10/14 units), although in a minority of centres it was undertaken by OMFS consultants, under general (2/14 units) or local anaesthesia (2/14 units).

Outcome Measurement and PROMs

Patient-Reported Outcome Measures

Use of PROMs was limited: only two centres (2/14) reported using a published PROM to assess patient-based outcomes.

Outcome Recording

Overall, 57% of centres (8/14) reported that they record **implant and/or prosthodontic outcomes for this patient group**.

In centres that recorded outcomes, measurements included:

- implant survival and failure rates,
- prosthesis success,
- peri-implant health (e.g., probing depths, bleeding on probing, implant mobility),
- time from placement to loading or restoration,
- radiographic assessment,
- number of occluding units,
- complications, including peri-implant disease,
- aesthetic outcomes.

Definitions and methods of recording varied, from implant presence or failure alone to structured databases; one respondent applied adapted published criteria for peri-implant soft-tissue health and prosthetic success.

Prosthodontic Approach and Occlusal Goals

Loading Strategy

Immediate loading was generally **not used** in the responding centres with no units reporting that they did.

Prosthesis Type

- **Fixed prostheses** predominated with 12/14 centres aiming for this approach.
- A minority of centres generally aimed for a removable prosthesis, retained by studs (1/14) or a bar (1/14).

Occlusion Targets

Most centres aimed for **8–10 occluding units (7/14)**, while several aimed for **>10 units (6/14)**. The remaining centre did not set clear criteria and this may reflect a more nuanced, case-dependent approach.

Extent of Reconstruction

Accepting the variation in clinical situations, several centres (36%) stated that they aimed to **extend prostheses onto native bone** when feasible for cross-arch splinting. Others restricted the prosthesis to implants within the fibula or described a case-dependent approach. Some respondents commented that healthy teeth were rarely, if ever, extracted to facilitate cross-arch splinting, although one reported sometimes doing so in the maxilla.

Complications and Clinical Challenges

Most Frequently Reported Complications

Responses to the multiple-choice question (up to three selections) and free-text comments identified the following themes:

- **Soft-tissue problems** 13/14): bulky soft tissue requiring debulking, hyperplastic or inflamed peri-implant tissue, the need for tall healing abutments, and trauma where the cheek contacts the implants or prosthesis were all reported.
- **Inability to restore implants**: (6/14) attributed to trismus and limited access, or to unfavourable implant position.

- **Flap-related complications,** (4/14) including flap failure.
- **Patient-related factors:** (6/14) such as declining further treatment, intercurrent illness or further cancer treatment, and death.
- **Osteoradionecrosis:** (3/14) selected by a minority of respondents.
- **Peri-implant disease:** (4/14) a minority of centres reported that peri-implant disease had compromised the surgical reconstruction on at least one occasion.
- **Planning and technical factors:** free text responses identified conflict between the fibula position required for the bony reconstruction and the optimal position for implants, flexure of the reconstruction affecting the occlusion, and difficulty securing a fixed provisional splint at the time of surgery.
- **Service factors:** free text responses revealed limited access to theatre time; one respondent suggested that these complex cases should be managed by a small number of experienced teams, as for cleft lip and palate care.

Soft-Tissue Grafting

The reported proportion of cases in which soft-tissue grafts were placed after healing varied:

- 0% (three centres, 3/14);
- 1–10% (seven centres, 7/14; the most common response);
- 10–25% (three centres, 3/14);
- 50% or more (one centre, 1/14).

Techniques included:

- split-thickness skin grafts,
- free gingival grafts,
- xenogeneic collagen matrix (Mucograft),
- secondary intention healing following debulking,
- collagen-based dermal matrices (Integra or Matriderm) under a fixed cover plate after removal of the skin layer.

One respondent observed that soft-tissue problems could persist even when several of these techniques had been used.

Responsibility for grafting varied between OMFS and Restorative Dentistry Consultants, and was sometimes shared or determined by the extent of grafting required.

Influence of Adjuvant Treatment

Responses on how the likelihood of adjuvant radiotherapy influenced implant planning were heterogeneous. Several respondents reported that anticipated radiotherapy

increased the priority given to placing implants at primary surgery (4/14); one explained that implants would not later be placed in the high-dose field. Others reported that it had little or no influence on their approach (2/14), or that implants were placed after completion of cancer treatment, including radiotherapy, in some cases after reviewing the radiotherapy fields or dose plan. One respondent reported that implants were not offered to patients who had received adjuvant radiotherapy. Another noted that most complications in their unit had been related to radiotherapy toxicity affecting the flap or implants.

Consent Processes

Consent processes varied:

- In three centres, treatment was discussed or consent obtained at a joint OMFS–Restorative Dentistry appointment or planning meeting;
- Two centres used separate consent episodes for ablative surgery (OMFS) and implant rehabilitation (Restorative Dentistry);
- In other centres, consent for the whole procedure, including implants, was obtained by the OMFS team, in one supplemented by a letter detailing the options, risks and benefits;
- Practice in sharing virtual plans with patients also varied: some centres routinely showed patients digital plans or planning images, others did so when final plans were available in time, and others did not share them.

Discussion

This survey indicates that collaboration between Restorative Dentistry and OMFS is established in almost all responding units for this cohort of highly complex patients. Primary implant placement, either routinely or on a case-by-case basis, was preferred in 79% of centres (11/14), and secondary placement after healing in 21% (3/14). A cross-sectional survey cannot establish whether joint working leads to greater prioritisation of oral and dental rehabilitation, but this pattern is consistent with UK guidance that implants should be considered for all patients undergoing resection for HNC.[5] Routine use of VSP was reported more often than a preference for primary placement, suggesting that some units use VSP to plan the bony reconstruction even when implants are placed secondarily.

The variation observed is consistent with an earlier UK survey of Consultants in Restorative Dentistry, which found wide variation in the timing, operator and funding of implant rehabilitation for head and neck cancer patients,[20] and with an international patterns-of-care survey in which treatment concepts differed by specialty and work setting.[21] More recently, the second British Association of Oral and Maxillofacial Surgeons Quality and Outcomes in Oral and Maxillofacial Surgery report found that primary oral rehabilitation or implant assessment was standard care in six of the 13 participating units that perform reconstruction and was offered to selected patients in a further six; the remaining unit cited a lack of expertise and/or reliable access.[23] The present survey extends this work by describing practice within the fibula free-flap pathway specifically.

Responses on adjuvant radiotherapy were among the most divergent, ranging from prioritising primary placement to placing implants only after radiotherapy or not offering them to irradiated patients. Patient irradiation was also the joint most frequently cited obstacle to implant rehabilitation in the French national survey.[22] Irradiation adversely affects implant survival,[8] and a systematic review of rehabilitation after fibula reconstruction reported markedly lower survival for implants placed after radiotherapy than in non-irradiated fibulae.[7] Meta-analyses comparing primary with secondary placement have reported similar or slightly higher implant survival with primary placement,[10,11] and a small comparative study reported less ORN when implants were placed at the time of reconstruction,[9] but these data come from small and heterogeneous studies. Given its implications for patient safety and for timely rehabilitation, this question warrants prospective multicentre evaluation.

If primary implant placement becomes more widespread, Restorative Dentistry teams will need to develop protocols and pathways to maximise the benefit of early implant placement by delivering prosthetic rehabilitation in a more timely manner. The authors anticipate that digital approaches, such as photogrammetry, digital smile design, three-dimensional printing and intraoral scanning at the time of surgery (as suggested by one

respondent), will increasingly be incorporated into these protocols and pathways. Immediate dental rehabilitation at the time of fibula reconstruction has been reported in malignant disease without delaying adjuvant radiotherapy,[24] although a recent scoping review found the evidence to be limited to small, predominantly single-centre series.[25] As with the zygomatic implant perforated (ZIP) flap for low-level maxillary defects,[26,27] some of the authors in this group aspire to deliver provisional prosthetic rehabilitation prior to radiotherapy in malignant cases, assuming primary stability of implants can be secured. In this survey, immediate loading was generally not used, and the authors consider it should be a focus of quality improvement and service development over the coming years.

Soft-tissue problems were the most frequently reported complication, and a minority of centres reported that peri-implant disease had compromised a reconstruction. This is consistent with a published series in which the incidence of peri-implantitis around implants in vascularised free-flap reconstructions was 32% despite soft-tissue management.[16] Grafting practice ranged from none to half or more of cases, with no consensus on technique or operator. Comparative studies of soft-tissue management, and structured supportive peri-implant care for this group, are needed.

Outcome recording was inconsistent, with heterogeneous measures and definitions, and published PROMs were rarely used. Although, to the authors' knowledge, no PROM has been developed specifically for fibula reconstruction, instruments designed to assess oral rehabilitation after treatment for oral cancer exist, such as the Liverpool Oral Rehabilitation Questionnaire,[28] and a recent scoping review of immediate dental rehabilitation with free-flap reconstruction found that no included study had used validated PROMs.[25] Evidence that implant-retained prostheses improve quality of life in patients with intraoral maxillofacial defects also remains limited.[6] A nationally agreed minimum dataset covering implant and prosthesis survival, peri-implant health, time to functional dental rehabilitation and PROMs would enable benchmarking and support future research.

Most respondents had restored 25 or fewer such cases in five years. One respondent suggested that these complex operations and rehabilitations should be concentrated in a small number of experienced teams, as for cleft lip and palate care, echoing the suggestion by Wiedenmann *et al.* that patients may benefit from centralisation in larger multidisciplinary centres.[21] Consent processes also varied, including who obtained consent for implant treatment and whether virtual plans were shared with patients. Since *Montgomery v Lanarkshire Health Board*,[29] clinicians must take reasonable care to ensure that patients are aware of any material risks of recommended treatment and of any reasonable alternative or variant treatments; implant-related risks and prosthodontic options may be best explained by the restorative clinician, supported by joint consultations, shared virtual plans and written information.

Strengths and limitations

To the authors' knowledge, this is the first UK survey to focus specifically on implant rehabilitation of fibula reconstructions. It has several limitations. The sample was small (40%), no responses were received from Wales or Northern Ireland, and units with a particular interest may have been more likely to respond. Practice was self-reported rather than audited. Because the 16 responses came from 14 Boards and Trusts, some organisations are represented by more than one Consultant, and the clinician-level and unit-level proportions reported here are not directly comparable. Although piloted, the questionnaire was not formally validated, and some items were ambiguous; for example, the grafting categories overlapped, the occluding-units question did not match its response options, and one respondent did not understand the question on extending the prosthesis. Most items did not distinguish between maxillary and mandibular reconstruction or between benign and malignant disease, and the free-text analysis was descriptive.

Conclusions

Implant-based rehabilitation of fibula reconstructions in the UK is delivered through joint working between Restorative Dentistry and OMFS, but practice varies in the timing of implant placement relative to adjuvant radiotherapy, the use of virtual planning, soft-tissue management, consent and outcome recording. National consensus on care pathways, a minimum outcome dataset that includes PROMs, and prospective multicentre data collection are needed to reduce unwarranted variation and to inform service development. Further research should also explore patient perceptions of primary implant placement to better support the consent process.

Declarations

Ethics: Formal ethical approval was not required, as surveys of this kind form a core function of the Restorative Dentistry UK Head and Neck Cancer Clinical Excellence Network.

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Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- FibulasurveyCROSSchecklist.docx