The treatment need and associated cost of erosive tooth wear rehabilitation – a service evaluation within an NHS dental hospital

S. O'Toole,*[1] M. Pennington,[2] S. Varma[3] and D. W. Bartlett[4]

Key points

- Provides an overview of the average cost of a tooth wear rehabilitation to an NHS hospital.
- Reports the estimated cost of a tooth wear rehabilitation to a private practitioner
- Highlights the average patient journey time when receiving a tooth wear prosthodontic rehabilitation in an NHS hospital.
- This article will be of interest to those who have patients requiring tooth wear rehabilitation and want to inform patients of the options available to them.

Aim To establish the average treatment need and cost of prosthodontic rehabilitation of severe erosive tooth wear within an NHS hospital setting. **Methods** The clinical notes of patients referred and accepted for treatment to King's College London Dental Institute specialist restorative clinics by their GDP between 1 January 2014 and 1 January 2016 for severe erosive tooth wear were audited. The first 30 patients with completed treatment plans were audited and the following were recorded: age, gender, BEWE score upon presentation, the location and aetiology of the wear, presenting complaint, number of clinical sessions, number of treatment planning sessions, the treatment provided, and materials used. The cost of care including materials and staff costs were estimated. Cost of treatment within a private setting was estimated based on private fees from three practices in the London area. **Results** The average treatment time for patients was 20.8 months (SD 9.6, Range 8–44 months). The average number of clinical visits during this time was 24.3 (SD 12.7; 8–48). The mean total cost per completed treatment plan was £2,371 (SD £1,290: £675–£4,807 which included mean staff costs of £1,333 (SD £697: £439–£2,637) and £1,039 (SD £668: £199–£2,500) for materials and laboratory work. The estimated cost of similar treatment provided by a specialist in private clinic was £13,353 (SD £6,905; £4,737–£31,224) per patient. The only predictor of costs was the presence of wear on both anterior and posterior surfaces. **Conclusion** The prosthodontic rehabilitation of erosive tooth wear is complex, interdisciplinary and costly to the NHS.

Introduction

The treatment of erosive tooth wear is not straightforward. It involves multiple, often inter-disciplinary planning visits, prolonged care and usually changing the occlusal vertical dimension (OVD).

[1]King's College London Dental Institute, Department of Prosthodontics, London, United Kingdom; [2]King's Health Economics, London, United Kingdom; [3]Guys Hospital, Prosthodontics, London, United Kingdom; [4]Kings College London Dental Institute, Prosthodontics, London, United Kingdom
*Correspondence to: Saoirse O'Toole
Email: saoirse.otoole@kcl.ac.uk

Refereed Paper.
Published online 8 June 2018
Accepted 22 January 2018
DOI: 10.1038/sj.bdj.2018.444

Within the UK, patients with severe tooth wear are either referred to secondary specialist care, specialist teaching hospitals or attend a prosthodontist privately, or rely on their general dental practitioner to provide the best care they can. The decision to treat erosive tooth wear is made on relatively arbitrary criteria. A survey of 124 secondary care referrals to a Scottish dental hospital reported that the reasons for patients requesting tooth wear rehabilitation were aesthetics (54%), followed by pain/sensitivity (25%) and then functional problems (12%).[1] Of these referrals, only 8% were accepted for secondary care treatment. On the other hand, severe erosive tooth wear has been shown to impact on quality of life[2,3] with one study reporting that it was equivalent to that of being edentulous.[2] The treating practitioner and patient are faced with difficult decisions juggling the cost, the complexity and commitment to treatment planning. There is also the need to justify possible further removal of tooth structure for placement of long lasting restorations to achieve patient expectations.

The UK is not alone in this difficult decision-making process. Danish colleagues have devised a 'Tooth Wear Evaluation System' which is taught to their dental students to aid in the diagnosis and management planning of the worn dentition.[4] This comprehensive evaluation considers primary factors such as the amount of tooth wear, the surfaces and the number of teeth affected, in addition to secondary factors such as the speed of progression, the age of the patient and the aetiology.

However, the authors repeatedly recognise that no clear cut off criteria can be defined.

Monitoring tooth wear is an appropriate care pathway,[4–6] but there is no objective, quantitative method of measuring erosive tooth wear progression in general dental practice. Often direct composite restorations are seen as non-invasive methods of improving aesthetics and restoring the OVD. However, recent reports have shown that the complication rates can be high as composites are prone to fracture/discolouration; consequently, maintenance levels are high.[6–8]

If a patient opts to undergo a full mouth rehabilitation, they should be informed about the treatment time and commitment involved. Treatment required is likely to be extensive and hence costly. However, there is little data, aside from anecdotal information, to allow the patient to make a fully informed treatment decision. Both the patient and the practitioner should be aware of these costs before commencing an extensive treatment plan.

The aim of this retrospective service evaluation was to establish the average treatment need and cost of prosthodontic rehabilitation of severe erosive tooth wear. We aimed to provide detailed estimates of costs in a primary and tertiary care setting, in addition to estimates of cost had such care been delivered in a private setting.

Methods

This service evaluation was registered with Guy's and St Thomas's Hospital Trust audit bank, project number 7,494. The study population were those who had been referred to King's College London Dental Institute specialist restorative clinics by their GDP between 1 January 2014 and 1 January 2016 for severe erosive tooth wear. The inclusion criteria were: minimum of six teeth in each jaw, referred by their regular general dental practitioner, acceptance for treatment by postgraduate prosthodontic trainees and treatment plans were completed by the 31 August 2017. The exclusion criteria were provision of implants in the treatment planning and underlying dental conditions that would influence severity of wear or long-term prognosis of restorations, eg, amelogenesis imperfecta, hypoplastic enamel, hypodontia. The clinical notes of the first 30 patients identified were audited and the following was recorded: the age, gender and BEWE score upon presentation, the location and aetiology of the wear, the presenting complaint, number of clinical sessions, how many of these were treatment planning sessions, the treatment provided and materials used.

Table 1 Lists of most common treatments provided

Treatments provided	Number of patients requiring treatment	Average number of units (SD)	Min	Max
Study models	30	3.4 (2.2)	2	12
Diagnostic wax ups	30	10.2 (5.0)	4	20
Crown lengthening surgery	12	2.8 (3.9)	1	11
Endodontics	14	2.4 (1.7)	1	7
Direct anterior restorations	25	6.3 (2.5)	2	12
Direct posterior restorations	16	3.4 (1.8)	1	6
Anterior metal ceramic crowns	14	5.6 (2.5)	1	12
Posterior gold crowns	13	4.0 (3.0)	1	12
Anterior metal ceramic crowns	4	4.0 (2.0)	1	8

Costs were estimated from an NHS perspective for the care delivered in a tertiary care setting. Costs included all consumables and the total cost of NHS staff providing dental care (including overheads, training and administrative support). We did not include any costs borne by the patient and they do not make co-payments towards their care. We also did not include the costs of care provided by dental students in the base case analysis, although we did include costs of supervision of students, and an element of overheads associated with the provision of a teaching clinic. Costs of consumables and equipment were obtained from stock managers. Patient contact time with NHS employees providing dental care was estimated and combined with appropriate unit costs per hour taken from the Unit Costs of Health and Social Care, 2016.[9] This authoritative source provides unit costs per hour which include elements for on-costs, capital overheads, training, and where appropriate, administrative support.

The number of consultations and treatments sessions attended by the patients were recorded from our online appointments system and verified in the clinical notes. The clinics are staffed by a consultant supervising six chairs occupied by up to seven postgraduate students during each three-hour clinical session, where an average of two patients per session are treated. We assumed that 14 individual treatment sessions for patients were delivered in each clinic. Clinics were staffed with one NHS consultant dentist at a cost of £135 per hour, and three band-4 nurses, each costing £28 per working hour. An additional university-funded consultant doctor attends the clinic but is excluded in this analysis as their costs are covered by student fees. The resulting staff costs were £46.93 per patient treated. In addition, instrument sterilisation was approximated at £4 per patient, and overheads, such as lighting/cleaning, were approximated at £4 per patient. The total amounted to £143.43 per patient per clinical visit.

Additional costs for direct restorations and root canal treatments were estimated by summing the individual cost per use of materials needed to complete the restoration (material capsules, bonding agents, polishing discs, disposable endodontic files etc) and were provided by the stock managers. The estimates are reported in Table 1.

We also estimated the likely treatment cost to the patient if patients had received the same package of care at a private dental practice. Private fees were estimated using the consultation costs and costs for lab-work as is the typical model for private dental treatment. Consultation and lab-work costs were estimated by averaging practice fees from three mixed NHS/Private clinics based within the Greater London area and two central London private practices. These are provided as a range in Table 2.

We explored the extent of correlation between NHS and private cost estimates and patient characteristics. The characteristics we considered were age; BEWE score; patient concerns regarding progression, aesthetics and tooth shortening; the presence of tooth sensitivity; treatment of one or both anterior and posterior teeth; and diagnosis of more

Official journal of the British Dental Association.

Table 2 Cost of hospital materials and overheads

	Hospital costs (£)
Cost per clinical session	54.93
Study models (n)	15.00
Teeth waxed up (n)	10.00
Crown lengthening surgery per tooth	40.00
Surgical Stent	50.00
Single root endo	70.00
Multi root endo	110.00
Acrylic denture	75.69
Cobalt chrome denture	164.00
Bridge abutments	60.00
Bridge wings	20.00
Bridge pontic	60.00
Anterior glass ionomer	9.20
Anterior composite	18.20
Posterior glass ionomer	9.20
Posterior composite	21.30
Posterior amalgam	8.20
Anterior post core	31.00
Anterior metal ceramic crown	61.50
Anterior ceramic crown	90.00
Gold alloy palatal veneer	51.25
Posterior post cores	30.75
Posterior metal ceramic crown	61.5
Posterior gold crown	51.25
Michigan splint	85.00
Soft splint	20.25

Table 3 Estimated cost of treatment in private practice*

	Private costs (£)	Range (£)
Treatment planning sessions	133.33	100–150
Study models (n)	76.67	30–100
Teeth waxed up (n)	40.00	20–50
Crown lengthening surgery per tooth	316.67	250–450
Surgical Stent	250.00	50–450
Single root endo	650.00	550–1000
Multi root endo	798.33	600–1000
Acrylic denture	816.67	550–1200
Cobalt chrome denture	1,883.33	1350–2500
Bridge abutments	733.33	600–800
Bridge wings	666.67	400–800
Bridge pontic	733.33	600–800
Anterior glass ionomer	73.33	50–85
Anterior composite	343.33	130–600
Posterior glass ionomer	80.00	70–85
Posterior composite	353.33	160-600
Posterior amalgam	101.67	70–150
Anterior post core	450.00	250–800
Anterior metal ceramic crown	733.33	600–800
Anterior ceramic crown	783.33	750–800
Gold alloy palatal veneer	500.00	500
Posterior post cores	300.00	300
Posterior metal ceramic crown	733.33	600–800
Posterior gold crown	816.67	800–850
Michigan splint	533.33	500–550
Soft splint	73.33	60–100

*Based upon the mean costs of three private practices in the Greater London Area. May not be indicative of costs in other practices/locations

than one cause of tooth wear (from abrasion, attrition and erosion). Spearman's rank correlation was used to test for a correlation between two non-normally distributed continuous variables. The Wilcoxon-Mann-Whitney test was used to test for a correlation between a non-normally distributed continuous variable and a dichotomous variable.

We undertook sensitivity analysis on the estimates of cost in an NHS setting in which we assumed a cost of £59 per hour for dental registrars providing care in treatment sessions rather than zero (base case). We based this sensitivity analysis on the cost per working hour for a registrar in the UK NHS.[9]

Results

The clinical notes of 21 males and nine females were evaluated. The average age at first examination was 45.5 years (SD 12.7, Range 24–76) and the average BEWE score was 14.2 (SD 3.2, Range 5–18). The aetiological factors were primarily erosion (n = 13, 43.3%), erosion/attrition (n = 12, 40%), attrition (n = 3, 10%) and erosion/attrition/abrasion (n = 2, 6.7%). The primary source of erosion was diet (n = 13, 43.3%), intrinsic sources (n = 5, 16.7%) or both (n = 8, 26.7%). The most common presenting complaint from the patient was fear of progression or further shortening of teeth (n = 23, 76.7%), aesthetics (n=19, 63.3%), dentine hypersensitivity (n = 8, 26.7%) and reduced function (n = 4, 13.3%).

The average treatment time for patients was 20.8 months (SD 9.6, Range 8–44 months). The average number of clinical visits during this time was 24.3 (SD 12.7; 8–48). Of these an average of 3.8 visits were treatment planning visits, often involving multiple disciplines.

Nine patients received direct composite restorations with no indirect restorations or prosthesis required. For these nine patients, the mean cost of providing direct anterior restorations only was £834 (SD £177; Range £675–£1,247). The mean costs of staff time

Official journal of the British Dental Association.

(excluding postgraduate registrar time) and environment was £580 (SD £165; £439–£989) and materials and laboratory fees were £254 (SD £44; £199–£333). The remaining 21 patients required more extensive treatment. A full list of the most commonly prescribed treatment is presented in Table 1.

In addition, two patients had direct fibre core post restorations placed on three anterior teeth. Eight acrylic partial dentures and seven cobalt chrome partial dentures were provided to ten patients. Eight patients received conventional bridges with a total of 15 pontics. Two patients received gold alloy palatal veneers (total of 11 teeth). All ceramic restorations were placed in two patients, one of whom received 12 ceramic crowns placed and one of whom received a ceramic veneer. One patient had a cast posterior post core made. Finally, 17 participants had either a Michigan (n = 14) or a soft acrylic splint (n = 3) provided.

The average cost per completed treatment plan for all patients in the base case was £2,371 (SD £1,290: £675–£4,807) for each of the 30 patients. This represented a mean of £1,333 (SD £697: £439–£2,637) for staff costs and £1,039 (SD £668: £199–£2,500) for materials and laboratory work. Sensitivity analysis in which dental registrars were assumed to cost £59 per hour generated mean staff costs of £3,481 (SD £1,820: £1,147–£6,885) and mean total costs of £4,519 (SD £2,382: £1,383–£8,254)

The estimated cost of similar treatment provided by a specialist in a private clinic was £13,353 (SD £6,905; £4,737–£31,224) per patient and was 4.1 (SD 1.3) times higher than treatment provided within a hospital setting.

Costs estimated in both NHS and private settings did not follow a Normal distribution. Likewise, patient age and BEWE were non-Normally distributed. Spearman's rank correlations between age and costs (either NHS or private setting) and between BEWE score and costs (NHS or private) were weak (rho <0.3 and p >0.10 in all cases). Wilcoxon-Mann-Whitney tests of the correlation between costs and patients' reporting of concerns around progression; concerns around aesthetics; concerns around shortening of teeth; and sensitivity were also weak. Both NHS and private costs were correlated with the provision of treatment to both anterior and posterior teeth as opposed to treatment of anterior or posterior teeth only (p = 0.006 in both cases). There was a modest correlation between costs estimated in a private setting and multiple aetiological factors for tooth wear (p = 0.07).

Discussion

The breadth of treatments illustrated by this service evaluation demonstrate that the time commitment, cost and scope for erosive tooth wear restorative care is variable. There is no one prescriptive treatment, and planning is driven by patient needs, aiming to maintain functioning for as long as possible. The average patient spent 21 months in treatment requiring a visit at least once a month. Each treatment session was typically 1.5 hours in duration. This required significant patient compliance that was not without cost to the patient and includes taking time off work in addition to travel to and from appointments. Analysis of this was outside the scope of this paper but is worth taking into consideration when planning treatment. Treatment was invasive, often multidisciplinary and requiring appointments with different practitioners.

The mean cost of a tooth wear rehabilitation case was £2,371 (SD £1,290) in the hospital setting, with materials costing a mean of £1,149 (SD £698). These financial estimates are probably conservative. The use of postgraduate training students in a tertiary setting enables provision of care at moderate cost to the NHS. Expanding provision from teaching hospitals would almost certainly entail higher costs. In our sensitivity analysis, costs rose by an average of 1.9 times when the postgraduate registrars' time was accounted for. There are also significant efficiencies of scale possible within a hospital environment which include discounts for materials. However, care may be prolonged in a teaching hospital because of the need for training. Furthermore, we could only estimate cost for treatment written in the clinical notes. Costs of some additional procedures (for example, special trays) or multiple instruments and missed appointments were not captured. Lastly, it is a pre-requisite for patients who are referred for specialist prosthodontic rehabilitation to have good oral hygiene and stable periodontal health. This may not be reflective of those presenting with severe erosive tooth wear to the general dental practitioner and stabilisation of periodontal health may further exacerbate treatment time and costs.

The treatment provided for each patient could range between a direct composite build-up of worn teeth to a full mouth rehabilitation involving multiple anterior and posterior crowns. The interdisciplinary nature of the treatment provided, frequent need for endodontic treatment and extensive treatment planning necessary before direct restorative interventions makes high quality treatment of erosive tooth wear difficult under the current NHS reimbursement scheme.

Nine patients received treatment which might be classified as a Band 2 NHS treatment using the current guidelines. Directly placed plastic restorations remain a treatment option for some but are liable to repeated fractures and maintenance costs are high. In theory, these are possible to deliver in general practice. A patient may prefer crowns which become more challenging to provide. Patient charges for NHS care in the UK are based on a banding system which limits the exposure of patients to very high costs. In principle, the difference in costs and patient co-payments is made up by the state. In practice, remuneration depends on locally agreed payments for dental activity (UDAs) and may not reflect the extent of intensive treatment. Ultimately, if an NHS dentist feels they do not have the experience or confidence to provide the care then they will refer. The reasons for a referral maybe influenced by financial cost and so this is a topic for future evaluation.

It is worth noting that the dental landscape is not simply dichotomised into NHS and private practice. Often advanced treatment can be provided by experienced, non-specialist practitioners who may offer certain treatments under the NHS and other treatments privately. A direct cost comparison to general dental practice using the English banding structure was too complex to calculate. However, the complexity of care, provision of multiple crowns in the same patient, endodontics and milled crowns around metal based partial dentures makes the financial commitment for both NHS and private non-specialist general dental services very challenging.

This study was limited to private practice fees from around London for convenience. Outside London costs may differ, as might any laboratory fees, but variations will always occur as there is no set nationally agreed fee structure. While in principle the NHS costs will be more evenly distributed, practice overheads, salaries and laboratory fees will vary depending on location anywhere in the UK. Nevertheless, the cost of erosive tooth wear rehabilitation in private dental practice is high and reflective of the extensive treatments required. Multifactorial tooth wear resulting from several aetiological factors were correlated with increased costs in NHS and private practice. This is a novel, but not unexpected finding, due to the complexity of treatment. Although the treatment plans will

Official journal of the British Dental Association.

often be similar, the number of visits required in private practice may be reduced compared to a hospital setting as there is no training requirement. It is also recognised that private costs used and listed within this paper may not be indicative of costs for every private practitioner in the UK or overseas. However, the aim of this paper was to provide an estimation and comparison, despite these limitations.

The cost of private treatment is likely to be unaffordable for many patients and is likely to contribute to a gap in service provision for those who do not have access to secondary/tertiary care. It is worth remembering that erosive tooth wear does not always require restorative intervention as erosive tooth wear is not always active and may reflect historical damage. If a convenient measure of progression of tooth wear were possible in general practice, patients may be more likely to accept non-invasive management options. The development of practice based quantitative monitoring tools is urgently required to objectively inform if restorative intervention is indicated. It is interesting to note that progression or further shortening of teeth was the main concern for 73% of the patients in this study. Other symptoms can be managed through non-invasive means using fluoride or similar interventions.[10] There is a lack of evidence on whether extensive prosthodontic treatment improves quality of life for those with severe erosive tooth wear. If the reason for the reduced quality of life is aesthetics and fear of progression, this may or may not be improved with advanced restorative work. Future work could consider investigating if quality of life is improved with prosthodontic rehabilitation, and the extent to which such improvements justify any additional treatment costs.

Conclusion

The prosthodontic rehabilitation of erosive tooth wear is complex, interdisciplinary and costly to the NHS. Patients should be fully informed and involved in the decision to treat and treatment planning stages. For extensive tooth wear cases, the cost to the NHS general dental practitioner makes offering high quality rehabilitation challenging. The option of private care is unaffordable for many. Costs are measured differently within a hospital setting, although access is a limiting factor. Further work should investigate whether prosthodontic rehabilitation improves quality of life for those with erosive tooth wear.

Acknowledgements

The authors would like to thank Dr Pranay Patel for his assistance in the assessment of private dental treatment fees.

1. Ahmed K E, Murray C A, Whitters CJ. A prospective survey of secondary care tooth wear referrals: demographics, reasons for concern and referral outcomes. *Br Dent J* 2014; **216:** E9.
2. Papagianni CE, van der Meulen M J, Naeije M *et al.* Oral health-related quality of life in patients with tooth wear. *J Oral Rehabil* 2013; **40:** 185–190.
3. Li M H M, Bernabé E. Tooth wear and quality of life among adults in the United Kingdom. *J Dent* 2016; **55:** 48–53.
4. Wetselaar P, Lobbezoo F. The tooth wear evaluation system: a modular clinical guideline for the diagnosis and management planning of worn dentitions. *J Oral Rehabil* 2016; **43:** 69–80.
5. Bartlett D W, Ganss C, Lussi A. Basic Erosive Wear Examination (BEWE): a new scoring system for scientific and clinical needs. *Clin Oral Investig* 2008; **12:** S65–S68.
6. Muts E-J, van Pelt H, Edelhoff D *et al.* Tooth wear: A systematic review of treatment options. *J Prosthet Dent* 2014; **112:** 752–759.
7. Bartlett D, Varma S. A retrospective audit of the outcome of composites used to restore worn teeth. *Br Dent J* 2017; **223:** 33–36.
8. Gulamali A B, Hemmings K W, Tredwin C J *et al.* Survival analysis of composite Dahl restorations provided to manage localised anterior tooth wear (ten year follow-up). *Br Dent J* 2011; **211:** 1–8.
9. Curtis L, Burns A. PSSRU Unit Costs of Health and Social Care 2016. Available online at http://www.pssru.ac.uk/project-pages/unit-costs/unit-costs-2016/ (accessed 9 October 2017).
10. Lussi A, Carvalho T. The future of fluorides and other protective agents in erosion prevention. *Caries Res* 2015; **49:** 18–29.