RCS ADVANCING SURGICAL STANDARDS

UPPER LIMB

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Three-dimensional assessment of hand outcome

RA Pearl, HJCR Belcher

Queen Victoria NHS Foundation Trust, East Grinstead, UK

ABSTRACT

INTRODUCTION Patient reported outcome measures are central to National Health Service quality of care assessments. This study investigated the benefit of elective hand surgery by the simultaneous analysis of pain, function and appearance, using a three-dimensional (3D) graphical model for evaluating and presenting outcome.

METHODS A total of 188 patients scheduled for surgery completed pre- and postoperative questionnaires grading the severity of their pain, dysfunction and deformity of their hand(s). Scores were plotted on a 3D graph to demonstrate the degree of 'normalisation' following surgery.

RESULTS Surgical groups included: nerve compression (*n*=53), Dupuytren's disease (*n*=51), trigger finger (*n*=20), ganglion (*n*=17) or other lump (*n*=21), trapeziometacarpal joint osteoarthritis (*n*=10), rheumatoid disease (*n*=5) and other pathology (*n*=13). A significant improvement towards normality was seen after surgery in each group except for patients with rheumatoid disease.

CONCLUSIONS This study provides a simple, visual representation of hand surgery outcome by plotting patient scores for pain, function and appearance simultaneously on a 3D graph.

KEYWORDS

Hand surgery – Outcome – Three-dimensional assessment

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CORRESPONDENCE TO

Robert Pearl, Department of Plastic Surgery, Queen Victoria Hospital, Holtye Road, East Grinstead, West Sussex RH19 3DZ, UK
E: robert.pearl@talk21.com

Patient evaluation of the results of surgery are central to quality of care assessments.[1] Patient reported outcome measures (PROMs) are measurements of health status or health related quality of life that come directly from patients. The success of a clinical intervention can thus be determined by comparing a patient's self-reported health status at two points in time (for example, before and after a surgical procedure). PROMs are used to determine the effectiveness of clinical care and form an integral part of the Department of Health report *High Quality Care for All*.[1]

Since April 2009, NHS hospital trusts performing certain elective surgical procedures (unilateral hip or knee replacements, varicose vein surgery and groin hernia surgery) have been required to invite patients to complete pre- and postoperative evaluation questionnaires. Ultimately, such questionnaires are likely to become mandatory for all elective surgical procedures, to provide continuous patient feedback on the quality of service provision. The Department of Health report also indicates that PROMs and other patient satisfaction assessment tools will help determine hospital funding allocation in the future.[1] In other words, quality of clinical work, as well as volume, will affect hospital trusts' payments. In the current climate of healthcare rationing, such subjective outcome measurements will play an important role in deciding which elective operations are funded by the National Health Service (NHS).

Patient assessment questionnaires are well established in hand surgery but have relied invariably on sample surveys (representing a particular patient cohort) at one point in time rather than allowing continuous feedback from an entire patient population. Furthermore, questionnaires in current usage tend to be long and time consuming for patients to complete, and are not uniform in the data they generate. It is well recognised that there is a significant amount of subjectivity in the evaluation of surgical outcome, which does not necessarily follow a linear relationship with objective clinical measurements.[2]

Analysis of the main pre-existing questionnaires of hand disability (Disabilities of the Arm, Shoulder and Hand [DASH], Patient Evaluation Measure [PEM], Michigan Hand Outcomes Questionnaire [MHQ]) shows that patients' reported hand problems can be split into three key elements: pain/tenderness, dysfunction and deformity/appearance. Different conditions will vary in their presentations in terms of severity of each of these variables. For example, patients with trapeziometacarpal joint (thumb base) osteoarthritis (TMCJ OA) may report severe pain scores albeit with little deformity whereas late stage rheumatoid patients may mark higher scores for deformity but with relatively less pain.

The aim of this study was to design a method of patient-based assessment to investigate the outcome of different hand operations. It employed a short, easy-to-use question-

Severity (score)	None (0)	Minor (1)	Moderate (2)	Major (3)
Function:	Normal	Minor difficulties	Moderate difficulties	Major difficulties
How well do your hand(s) work?	• My hand(s) work and move normally	• Occasional or minor problem • Some weakness, stiffness or numbness • Clumsy or slower to perform some tasks	• Restricted use • Unable to perform some tasks • Substitution of other hand for some tasks	• Hand(s) have little or no useful function • Other hand used for most or all tasks • Assistance required
Pain and tenderness:	Normal	Minor discomfort	Moderate discomfort	Major discomfort
How much pain or tenderness do you have in your hand(s)?	• No pain or tenderness	• Minor pain or tenderness • Occurs only during heavy work or activities (sport, gardening, DIY)	• Moderate pain or tenderness • Occurs during normal daytime activities (driving, writing, cooking, dressing)	• Severe pain or tenderness • Occurs when resting and/or disturbs sleep
Appearance:	Normal	Minor deformity	Moderate deformity	Major deformity
Do your hand(s) look normal?	• My hand(s) look normal	• Not obvious to others in social situations • Minor self-consciousness	• Deformity visible in social situations • Occasional glances or comments • Moderate self-consciousness	• Obvious deformity visible in any situation • Frequent glances, comments or teasing • Prefer to keep hand hidden

Figure 1 Pre/postoperative questionnaire

naire that evaluated patients' hands in terms of pain, function and appearance. This could then be presented in a simple, visual, three-dimensional (3D) graph representing the impact of surgery. Such a tool could be used for audit, PROMs or to provide clinical information to general practitioner commissioners, insurance companies or others purchasing clinical services.

Methods

Overall, 252 patients scheduled for elective hand surgery were invited to complete a preoperative questionnaire on the severity of their pain, functional disability and appearance of their hand(s) prior to surgery (Fig 1). Patients graded each variable on a four-point scale (0–3) based on which descriptions best met their symptoms.

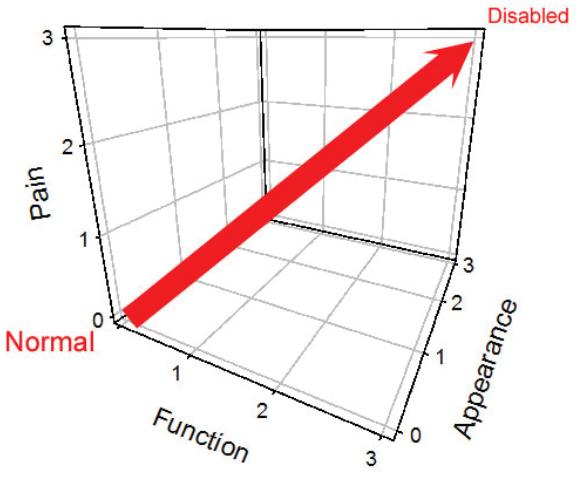
Eight months following surgery, patients were contacted by post and asked to complete the same questionnaire. This was followed up with a telephone reminder for patients who had not responded to the postal questionnaire.

Patients having operations that involved bilateral surgery (eg bilateral carpal tunnel decompression) or more than one surgical procedure on the same limb (eg simultaneous cubital tunnel and carpal tunnel decompression) were classified as having one intervention. These patients were asked to complete the questionnaire on the basis of an overall assessment of their hand or hands. Those having surgery on different hands on separate occasions were classified as having two interventions, and were therefore invited to complete two preoperative and postoperative questionnaires.

Responses were entered into Access® database (Microsoft, Redmond, WA, US). Two-tailed probability tests of the null hypothesis were used to assess statistical significance. Results with a p-value of <0.05 were considered to be significant. Effect size (r) was calculated for each surgical group interpreted using Cohen's 'rules of thumb' ($r>0.50$ = large effect , ie effect responsible for >25% of total variance). A 3D graph was constructed that plotted patient scores for each variable (pain, function, appearance) simultaneously to assess degree of 'normalisation' of their hands following surgery (Fig 2).

Results

A total of 252 patients undergoing 254 elective hand procedures were enrolled in the study when scheduled for surgery at their initial outpatient consultation. However, 21 patients did not go through with their surgery, leaving 231 patients who were went sent postoperative questionnaires. Of these, 188 patients completed 190 questionnaires, giving a response rate of 81.4%. The male-to-female ratio of respondents was 1:1.1 with a mean age of 60.2 years (range: 18–91 years). No patients who completed both questionnaires (prior to and following surgery) were excluded from the study. Surgical groups in this cohort were: nerve compression (n=53), Dupuytren's disease (n=51), trigger finger (n=20), ganglion (n=17) or other lump (n=21), TMCJ (thumb



Disability score: 0 = normal; 1 = minor; 2 = moderate; 3 = major

Figure 2 Three-dimensional graphical representation of outcome

Table 1 Miscellaneous procedures for other pathology

Procedures	Number
Finger fusion (DIPJ)	3
Release of web space	2
DeQuervain's release	1
Tenolysis	1
Neurolysis	1
Burial of neuroma	1
Ligament repair	1
Scapholunate stabilisation	1
Repair of sagittal band	1
Release joint contracture	1
Total	**13**

DIPJ = distal interphalangeal joint

base) OA (n=10), rheumatoid disease (n=5) and other pathologies (n=13) (Table 1).

Plotting scores for each parameter (pain, function and appearance) simultaneously on a 3D graph before and after surgery for each diagnostic group are shown in Figures 3 and 4. Marked improvements, demonstrated on the 3D graph by movement of plotted points towards the origin of the three axes (ie normalisation), were seen following surgery. These were statistically significant in each group except for rheumatoid disease (Table 2). Surgery for TMCJ OA and trigger finger release demonstrated the greatest 3D improvement (normalisation) postoperatively although only patients having lumps (other than ganglia) removed reported complete 'normalisation' of their hands following surgery (Fig 4).

Table 3 details the median scores prior to and following surgery, plus the effect size (r) for each parameter, for each operation. Patients undergoing surgery for TMCJ OA reported the most severe preoperative pain scores. Rheumatoid patients and those with ganglia were the most affected by the appearance of their hands. Patients with nerve compression, rheumatoid disease, trigger finger and TMCJ OA all scored highest functional impairment (moderate).

Trigger finger release demonstrated the most improvement in function (r=0.75) and patients having excision of 'other lump' from their hands showed the most improvement in cosmetic deformity (r=0.70). In terms of pain reduction, surgery for TMCJ OA had the greatest impact (r=0.88). Following ganglion removal, patients reported only limited improvements in pain (r=0.38) and function (r=0.32) and a residual cosmetic deformity, albeit improved (r=0.68).

Discussion

Assessment of outcome following hand surgery can be split into objective clinical measurements and subjective patient assessments. Objective measurements can be determined by quantitative parameters such as grip strength, pinch grip strength, sensory testing, degree of joint contracture (eg in Dupuytren's disease) and radiographic measurements (eg amount of radial shortening following distal radial fracture).[3] Standardised hand function tests have also been employed to provide objective functional outcome scores. The Sollerman hand function test and Jebsen hand function test are such tools.[4,5] They involve observing activities of daily living, which are timed and compared with standardised measurements. Sollerman scores were originally described to evaluate hand function in tetraplegic patients but they have been used in other clinical situations. Changes in Sollerman scores, for example, have been related to improvements in joint contractures following Dupuytren's surgery.[6]

Nevertheless, such objective measurements often have little relevance to patients. There is good evidence that quantitative measurements of joint contracture, grip strength and others do not necessarily correlate with subjective patient scores of hand and wrist function.[2,3,7] In developing the Brigham and Women's Hospital symptom severity scale (SSS) and functional status scale (FSS), a patient questionnaire for carpal tunnel syndrome, Levine *et al* noted there was 'no universally accepted measurement of the severity of symptoms or functional status of the hand'.[8] They reported that grip, pinch strength, median nerve sensory conduction, two-point discrimination and Semmes–Weinstein monofilament testing did not correlate well with patient reported symptom (SSS) and functional (FSS) improvements in carpal tunnel syndrome. FSS and SSS scores did, however, correlate well with patient satisfaction.

Following this, Ozyürekoğlu *et al* studied patients having steroid injection for carpal tunnel syndrome and described the 'minimal clinically important difference' (MCID).[9] The

Table 2 Significance of normalisation following surgery by operative group; comparative additive scores, Mann–Whitney U test

Group	Preoperative vs postoperative
Nerve compression	***p*<0.001**
Dupuytren's disease	***p*<0.001**
Trigger finger	***p*<0.001**
Ganglion	***p*<0.02**
Other lump	***p*<0.001**
TMCJ OA	***p*<0.01**
Other pathology	***p*<0.05**
Rheumatoid disease	*p*>0.05

TMCJ OA = trapeziometacarpal osteoarthritis

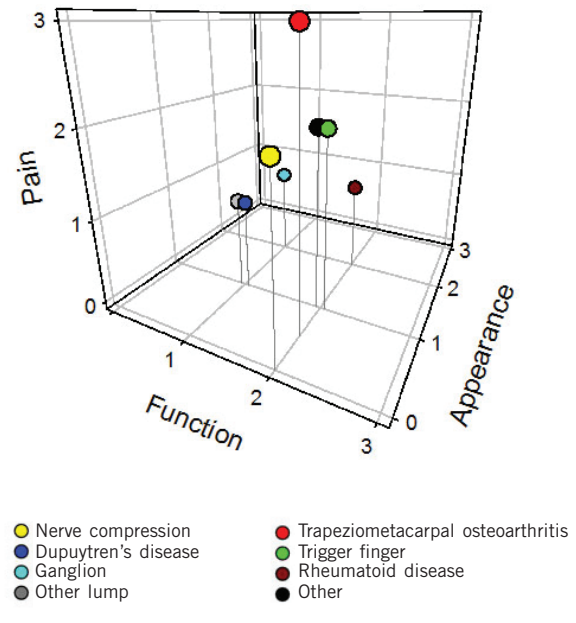


Figure 3 Three-dimensional graph demonstrating preoperative scores for each diagnostic group

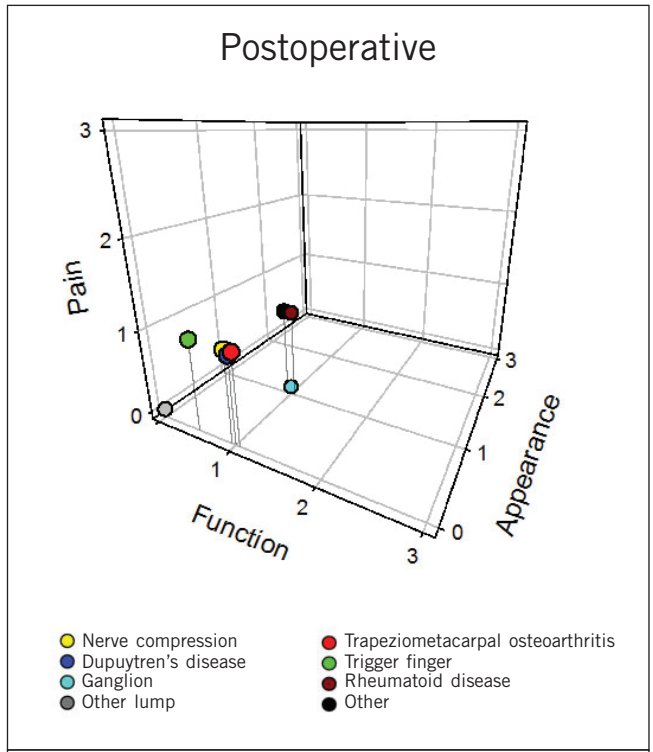


Figure 4 Three-dimensional graph demonstrating postoperative scores for each diagnostic group

MCID was defined as the smallest amount of change between two outcome measure scores that had clinical relevance to the patient.

There is a panoply of patient assessment questionnaires for the hand and upper limb, ranging in complexity. Some are disease specific, (eg the Brigham and Women's Hospital carpal tunnel score, the Cochin scale for rheumatoid disease,[10] and the patient rated wrist evaluation (PRWE) described by MacDermiad *et al*[11] to evaluate wrist pain and disability following distal radial fractures). Others are generic assessments of hand function and disability (eg DASH, PEM and MHQ).[12–14] These generic assessments give a better indication of overall hand function but can be complex and time consuming to complete and their validity has been questioned for certain specific conditions, such as nerve disorders.[15]

Disease specific outcome assessments such as Brigham and Women's carpal tunnel questionnaire and PRWE are, unsurprisingly, a more sensitive tool for their respective diagnostic groups.[16] However, they are not applicable beyond this and do not allow comparison between different patient operative groups or take into account coexisting pathologies.

As a result, studies into hand surgery often include a range of assessment tools (eg DASH for overall functional use, visual analogue scale for postoperative pain, Likert scale for patient satisfaction) in addition to any objective measurements that might be relevant to that specific operation. All this generates a large amount of rather unwieldy data and a difficulty in comparing different conditions as different assessment tools are more suited to different procedures or pathologies.

The task of continually measuring standards/outcome (ie of all surgical interventions in all patients in a hand unit) as the Department of Health has indicated will become mandatory and requires, we believe, a different tool. Our prospective study investigated the three core elements of patient hand assessment: pain, function and appearance.

Table 3 Median pre and postoperative scores for function, pain and appearance by patient group

Group	Demographics			Preoperative			Postoperative (effect size, *r*)		
	n	Male-to-female ratio	Mean age (range)	Function	Pain	Appearance	Function	Pain	Appearance
Nerve compression	53	23:30	62 (31–91)	2	2	0	1 (0.67)	1 (0.80)	0 (0.28)
Dupuytren's disease	51	39:12	65 (19–86)	1	1	1	1 (0.60)	1 (0.34)	0 (0.69)
Trigger finger	20	4:16	67 (36–88)	2	2	1	0.5 (0.75)	1 (0.79)	0 (0.59)
Ganglion	17	6:11	59 (18–81)	1	1	2	1 (0.32)	0 (0.38)	1 (0.68)
Other lump	21	11:10	47 (31–88)	1	1	1	0 (0.45)	0 (0.63)	0 (0.70)
TMCJ OA	10	2:8	67 (51–80)	2	3	0.5	1 (0.55)	1 (0.88)	0 (0.40)
Other pathology	13	4:9	46 (19–77)	2	2	1	1 (0.44)	1 (0.53)	1 (0.19)
Rheumatoid disease	5	1:4	78 (49–80)	2	1	2	1 (0.67)	1 (0.28)	1 (0.62)
Total	**190**	**90:100**	**60.2 (18–91)**	**1**	**2**	**1**	**1**	**1**	**0**

TMCJ OA = trapeziometacarpal osteoarthritis

Appearance is often not included in assessment tools (eg DASH, PRWE) and yet physical deformity of the hand is an important factor from the patient perspective, both in terms of their perceived disability and the impact of surgical intervention.[17,18] By plotting each variable simultaneously, a simple, visual representation of surgical outcome can be produced on a single 3D graph, covering all aspects of hand disability, at specific times during the treatment process.

All diagnostic groups except for rheumatoid disease demonstrated significant improvements or 'normalisation' following surgery. (The exception for rheumatoid patients may be explained by the small sample size.) The 3D assessment generates an overall score, like other questionnaires, but also illustrates differences between conditions on the 3D graph. For example, the overall scores for patients with nerve compression and ganglion are the same before and after surgery but the differences are clearly seen as the two conditions occupy different territories three dimensionally (Figs 3 and 4).

Nerve compression scores for pain and function both improved following surgery without completely normalising. Conversely, in ganglion patients, cosmesis improved but dysfunction remained virtually the same. This is important as it can demonstrate visually to both those purchasing clinical services and prospective patients what surgery can and cannot achieve. Some operations are effective for pain relief while for others the main benefits are cosmetic. Interestingly, pain was a significant issue for Dupuytren's patients, contrary to common perception.

It was decided to include patients having concurrent operations on the same limb (two patients with simultaneous carpal and cubital tunnel decompressions, and one patient having TMCJ OA surgery who had his carpal tunnel decompressed in the same hand as a preventative measure) as this best reflects a hand surgeon's practice. Many of these patients will have varying degrees of concurrent hand pathology and, moreover, PROMs are intended to obtain outcome data from all who undergo surgery.

Conclusions

The NHS is coming under increasing pressure to provide patient-based outcome measures as a basis of quality of care assessments. In the future, it is likely that hospital funding allocation will be based, in part, on subjective patient measures of surgical success. In the current climate of healthcare rationing, the burden of proof has fallen on clinicians to demonstrate that procedures being reduced to 'low priority' status are in fact extremely beneficial to patients. This study has provided a simple tool that can visually depict the relative benefits of different hand surgical procedures to those purchasing clinical services. Furthermore, it can provide hospital staff with a quick, efficient means of generating outcome data.

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Duplicate publication – never acceptable

Recently our copy-editor detected a case of attempted duplicate publication. In preparing a paper for publication and as part of our routine process, she discovered an identical paper already published online in another journal. The previous online publication had four authors: a senior fellow and three consultants from a trust in England. The paper we were about to publish had the same four authors plus a registrar as first and corresponding author. Our enquiries suggest that a number of mistakes were made by various authors.

After publication of the first version, the senior fellow asked the registrar to prepare a presentation and suggested that it might be adapted for a print publication. The registrar made minimal changes to the text so that the two versions were almost identical and submitted it for consideration. In doing so, he certified that the work was original and submitted with the approval of all authors, who were, in fact, unaware of the submission.

Potential authors should be aware of publication ethics and their responsibilities to adhere to accepted standards (http://publicationethics.org/international-standards-editors-and-authors). In the submission process, the request for provision of email addresses for all authors must be complied with, the certification of originality applies to *all previous publications* in any format (print/online, peer reviewed or not), and the statement that all authors are aware of the submission and approve the final version of the manuscript is definitely not a 'tick box exercise'. The failure to respect these requirements calls into question the probity of the person responsible.

In this case, following a thorough enquiry, the editors have ordered the paper to be withdrawn, and have officially notified the chair of the relevant training committee and the medical director of the senior author's trust, who are well placed to decide whether further action is necessary.

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Chair of the Editorial Board

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