

# An investigation of the acute management of closed intra-articular fractures of the proximal interphalangeal joint in Ireland

Closed intra-articular fractures

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## Abstract

**Purpose** – Many treatment methods for intra-articular fractures of the proximal interphalangeal (PIP) joint are described in the literature without a consensus on the most effective approach. The purpose of this study was to investigate the methods of treatment of PIP joint fractures being used by trauma surgeons in the Republic of Ireland currently and the timing of referral to therapy.

**Design/methodology/approach** – A cross-sectional descriptive study methodology was used to survey trauma surgeons, occupational therapists and physiotherapists in Ireland. An online platform was used. A total of 21 surveys were returned by surgeons and 37 by therapists. Descriptive statistical analysis was used to present the results.

**Findings** – Buddy strapping was reported as the primary treatment method for stable PIP joint fractures. All levels of fracture severity were reported to be treated using traction constructs, which include static and dynamic fixation and orthoses. Unstable fractures were managed using open reduction with internal fixation by 50 per cent of surgeons. Early timing of referral to therapy is reported by more surgeons than therapists. The majority of therapists indicated that they did not have the resources to see patients at the optimal time.

**Originality/value** – To the authors' knowledge, this study provides the first description of the management of PIP joint fractures across the Irish health service. The findings of this study suggest that additional therapy resources are required within the health service executive to facilitate the desired early referral to therapy and to enable service development for this category of hand fractures.

**Keywords** Survey, Fracture, Finger, Hand therapy, Proximal interphalangeal joint

**Paper type** Research paper

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## Introduction

Intra-articular fracture dislocations of the proximal interphalangeal (PIP) joint of the hand have a complex presentation affecting the bone, cartilage, ligaments and possibly tendon insertions around the PIP joint (Chinchalker and Gan, 2003). They typically occur because of axial loading to the tip of the finger with force being applied to the base of the middle phalanx (Chinchalker and Gan, 2003; Kiefhaber and Stern, 1998). Three different fracture patterns result: fracture of the volar lip, fracture of the dorsal lip and pilon fractures with central depression and both dorsal and volar articular surface fracture (Kiefhaber and Stern, 1998; Haase and Chung, 2014). The most widely cited system to classify intra-articular fractures of the PIP joint is that of Kiefhaber and Stern (1998). They use three groupings: less than 30 per cent articular surface involvement, which is typically stable on reduction; fractures of 30-50 per cent of the articular surface, which have tenuous stability; and >50 per cent involvement, which is unstable on reduction. Intra-articular fractures of the PIP joint are not common (Oak and Lawton, 2013), with an estimated incidence of 11.3 in 100,000 persons per year in the USA (Ootes *et al.*, 2012), and, to our knowledge, there is no published consensus regarding the most effective treatment approach. The range of methods of treatment described in the literature (Haase and Chung, 2014; Caggiano *et al.*, 2018; Janssen *et al.*, 2015; Ng and Oliver, 2009; Morgan *et al.*, 1995) are listed in Table I.

A single randomised study was identified which examined the effectiveness of comparing trans-articular Kirschner wire (K-wire) fixation with open reduction with internal fixation (ORIF) for intra-articular fractures of the PIP joint. The use of ORIF was abandoned following random allocation of 19 of the anticipated 60 participants because of concerns regarding the morbidity and complications associated with all methods of operative fixation, and given that satisfactory short-term outcomes were achieved using trans-articular K wire fixation (Aladin and Davis, 2005). A less invasive method than ORIF for the management of PIP joint fractures is the use of traction. A comparative study by O'Brien *et al.* (2014) examined outcomes of PIP joint fractures of 30-60 per cent articular surface involvement. One group received a dynamic traction orthosis using skeletal traction via K-wire ( $n = 17$ ), the other received operative or conservative treatment without traction ( $n = 14$ ). The study reported the mean combined ROM of the PIP and DIP joint was superior in the swing traction group compared to the no-traction group ( $P = 0.008$ ). Patient ratings of pain level, function and satisfaction were not significantly different between groups ( $p$ -values 0.52, 0.883 and 0.52, respectively) (O'Brien *et al.*, 2014). A 2016 scoping review of the use of traction constructs in the management of intra-articular fractures did not identify the best treatment method because of the paucity of randomised trials and the variation in reporting of fracture classification and outcome measures (Packham *et al.*, 2016). There is insufficient strength of evidence in the literature as to which treatment method is best for the management of intra-articular fractures of the PIP joint. Current practice in Ireland has not been described, with the sole study identified relating to intra-articular fractures in an Irish

**Table I.**

Treatment methods for management of intra-articular fractures of the PIP joint

Closed reduction and buddy strapping	Static traction orthoses
Extension block orthoses	Dynamic traction orthoses
Extension block pinning	ORIF
trans-articular K-wire fixation	VPA
Ex Fix	HHA
may be static or dynamic	
DDEF	Arthrodesis

setting being 20 years old, describing the use of a single method of treatment (Hannen Mullet *et al.*, 1999). Description and understanding of current practice is necessary for service evaluation and development. PIP joint fracture patients are frequently referred for hand therapy intervention. Early motion is recognised as important in the non-operative and post-operative management of closed intra-articular fractures of the PIP joint (O'Brien *et al.*, 2014; Kang and Stern, 2002; Stern *et al.*, 1991; Hirth *et al.*, 2013; Ikeda *et al.*, 2011; MacFarlane *et al.*, 2015; Watanabe *et al.*, 2015). Early motion can be facilitated by timely referral to occupational therapy and physiotherapy. The purpose of this study was to describe the methods of treatment of intra-articular fractures of the PIP joint being used by trauma surgeons in the health service executive (HSE) currently. It also sought to investigate the timing of referral to therapy and therapists' views on current practice relating to timing of referral.

## Methods

### *Study design*

A cross-sectional descriptive survey methodology was chosen to capture current practice in the treatment of closed intra-articular PIP joint fractures (Cresswell, 2014; Fink, 2003). An online survey design was selected as it has been demonstrated to work well in a defined population (e.g. employees of the HSE) where potential respondents are known to have email access (Hicks, 2004). Online surveys are considered less time consuming and costly than other methods and allow participants to complete a self-administered survey at a time and place convenient to them (Sue and Ritter, 2012). The online platform SurveyMonkey<sup>®</sup> was chosen. Purposive sampling was used to recruit both the surgeon and therapy staff working directly in the treatment of intra-articular fractures of the PIP joint in Ireland. This method is useful to recruit participants based on their ability to provide detailed information on the subject being studied (Cresswell, 2014). The consultant surgeons secretaries in each of the twelve Acute Trauma and Orthopaedic Centres in the HSE were contacted and they agreed to forward the survey information via email to the surgeons in each centre. The Irish Hand Surgery Society and the Irish Institute of Trauma and Orthopaedic Surgery were also contacted and agreed to forward the survey to their membership. Therapists were recruited through the Irish Association of Hand Therapists, the Association of Occupational Therapists of Ireland and the Irish Society of Chartered Physiotherapists via an email invitation. Occupational Therapy (OT) and Physiotherapy (PT) Managers at the Trauma Centres were requested to forward the questionnaire to relevant staff. Snowball sampling was also used, with all participants asked to forward the survey to any colleagues known to them who were working with this client group. A reminder email to complete the survey was sent after one month and the survey remained open for a three-month period.

As multiple sources were used to access potential respondents, it was not possible to determine the sample size or response rates. Owing to the varied caseloads of plastic and orthopaedic surgeons it is not possible to estimate how many potential participants from surgery were reached. The Irish Association of Hand Therapists currently has 41 members (64 per cent OTs and 36 per cent PTs) although it is not possible to determine how many members are involved in the management of fractures of the PIP joint.

### *Survey*

Based on published literature and the researcher's practice experience, two separate questionnaires were designed, one for surgeons and one for therapists. Both

questionnaires asked demographic questions including years working with PIP joint fractures. The main body of both questionnaires utilised Kiefhaber and Stern's (1998) three categories of fracture severity. For each category the surgeons were asked for their choice of treatment, the timing of referral to therapy and the primary reason for referral. The therapists' questionnaire targeted the timing of referral to therapy, the reason for referral, and whether participants have the resources to see patients when they think most appropriate. Both questionnaires included comment boxes to allow participants to provide further detail in relation to multiple choice and ranking order questions. The therapists' questionnaire totalled 23 questions and took an average time of nine minutes to complete. The surgeons' questionnaire totalled 20 questions and to an average of 9.5 min to complete. The questionnaires were piloted by a Consultant Orthopaedic and Upper Limb Surgeon with twenty years of experience and a Senior Occupational Therapist working full time in orthopaedic hand therapy. Revisions were made which helped to clarify wording and to reduce the number of questions. The survey information sheet requested that participants respond based on their work in HSE Acute Trauma Centres, and not in their private practice. Ethical approval was granted by the HSE Royal College of Surgeons Ireland (RCSI) Group, Research and Ethics Committee on 5 March 2018. Consent to participate in the study was assumed by return of the completed questionnaire.

#### *Data analysis*

Descriptive statistical analysis was completed via SurveyMonkey® to examine responses to closed questions including analysis of mean, range and ranked scores. Open-ended questions were collated in tables and individual comments were ordered and categorised.

## **Results**

### *Demographic information*

A total of 21 questionnaires were returned by orthopaedic and plastic surgery respondents. Demographic information and numbers of PIP joint fractures seen per month is presented in Table II. Of the respondents, 60 per cent ( $n = 14$ ) reported having worked overseas in the USA, UK, France, India, Pakistan, Australia and New Zealand.

In all, 37 questionnaires were returned by therapists. Table III presents the breakdown of the demographic information reported. Of the therapists, 78 per cent ( $n = 29$ ) had attended hand therapy courses, while 6 of 37 respondents (16 per cent) did not report any post-graduate training in this area.

**Table II.**  
Surgeons'  
demographic  
information

	No. out of 21 respondents	Years of experience mean (range) years	No. who practised overseas	No. of PIP fractures seen per month		
				0-3	4-5	6+
Orthopaedic surgeons	72% ( $n = 15$ )	10 (2-25)	42% ( $n = 9$ )	24% ( $n = 5$ )	38% ( $n = 8$ )	10% ( $n = 2$ )
Plastic surgeons	28% ( $n = 6$ )	10 (2-25)	24% ( $n = 5$ )	28% ( $n = 6$ )	0	0

**Table III.** Therapists' demographic information

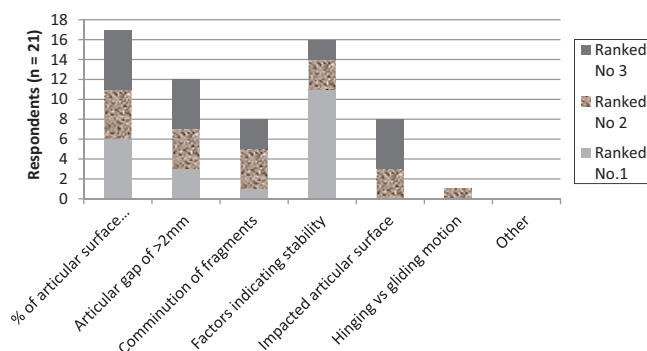
	37 respondents	Years of experience mean (range) years	Accredited/certified	Attended hand therapy courses	Practised overseas
Clinical Specialist OT	8% ( <i>n</i> = 3)	20 (11-25)	8% ( <i>n</i> = 3)	8% ( <i>n</i> = 3)	0% ( <i>n</i> = 0)
Senior OT Staff	49% ( <i>n</i> = 18)	9 (4-20)	8% ( <i>n</i> = 3)	46% ( <i>n</i> = 17)	18% ( <i>n</i> = 7)
Clinical Grade OT	3% ( <i>n</i> = 1)	7	0% ( <i>n</i> = 0)	3% ( <i>n</i> = 1)	3% ( <i>n</i> = 1)
Clinical Specialist PT	0% ( <i>n</i> = 0)	0	0% ( <i>n</i> = 0)	0% ( <i>n</i> = 0)	0% ( <i>n</i> = 0)
Senior PT Staff	30% ( <i>n</i> = 11)	10 (6-25)	3% ( <i>n</i> = 1)	16% ( <i>n</i> = 6)	13.5% ( <i>n</i> = 5)
Clinical Grade PT	10% ( <i>n</i> = 4)	2 (1-3)	0% ( <i>n</i> = 0)	5% ( <i>n</i> = 2)	5% ( <i>n</i> = 2)

### Surgeon respondents

#### Treatment approach

The surgeon respondents were asked to rank the primary three fracture characteristics that determine selection of management technique. This is outlined in Figure 1. Factors indicating stability of the joint was ranked as the primary consideration by 52 per cent (*n*=11) of respondents. The percentage of the articular surface fractured was ranked in the first three choices by 80 per cent (*n* = 17) of respondents.

The treatment methods used are presented in Figure 2. For stable fractures buddy strapping was rated as the treatment of choice by 76 per cent (*n* = 16) of respondents. Selection of treatment for unstable fractures presents a more complex picture, with five different techniques reported for fractures of tenuous stability (30-50 per cent). The more invasive methods of ORIF and volar plate arthroplasty (VPA) were selected by 25 per cent of surgeons (*n* = 5) for fractures of 30-50 per cent articular surface involvement. Two respondents commented that they have used all forms of fixation for complex intra-articular fractures and that it was difficult to specify just one treatment method. Dynamic traction orthoses/constructs is the only treatment method which was reported by surgeons to be used across all levels of severity of fracture (*n* = 11). Two out of six plastic surgeons (33 per cent) compared to 11 out of 15 orthopaedic surgeons (73 per cent) selected traction constructs. Methods of traction are presented in Figure 3 and include surgically applied



**Figure 1.** Criteria which inform surgeons' decisions regarding management

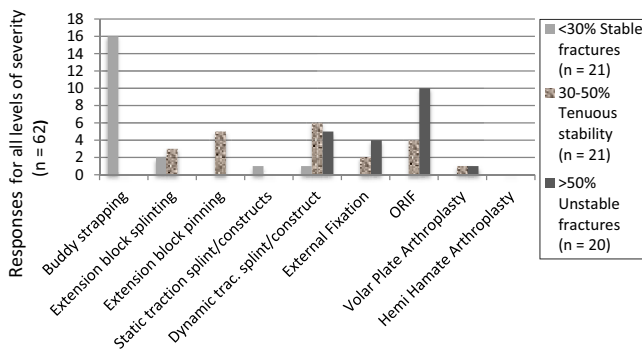
dynamic digital external fixation (DDEF), e.g. the Ligamentotaxor, as well as therapist-applied orthoses.

*Timing of referral to therapy*

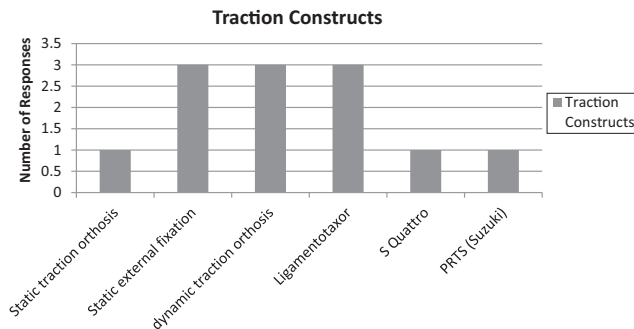
The timing of referral to therapy is outlined in Figure 4 according to the treatment method selected by the surgeon. Variance in timing of referral was seen for seven treatment methods; however, 52 per cent ( $n = 31$ ) of responses for all methods indicated that they refer to therapy within the first week. Plastic surgeons were most consistent (100 per cent  $n = 6$ ) in reporting referral to therapy within the first week for all levels of severity of fracture.

*Reason for referral to therapy*

The surgeon respondents were asked to rank their primary three reasons for referral to therapy for all severity categories. This is presented in Figure 5. Mobilisation of the PIP joint was ranked the primary reason for referral for all levels of fracture severity by 55 per cent of respondents ( $n = 11$ ). Traction orthoses were the least ranked reason for referral to therapy ( $n = 2$ ).

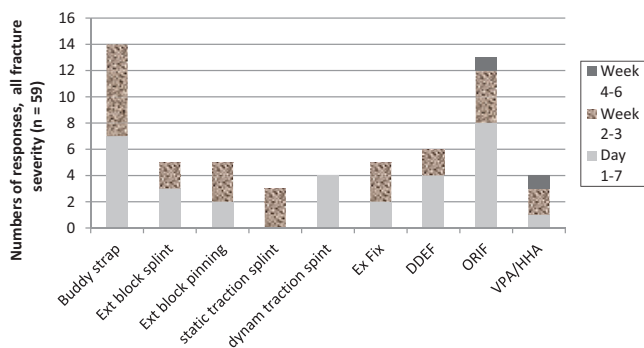


**Figure 2.** Surgeons' choice of management for closed fractures of the PIP joint



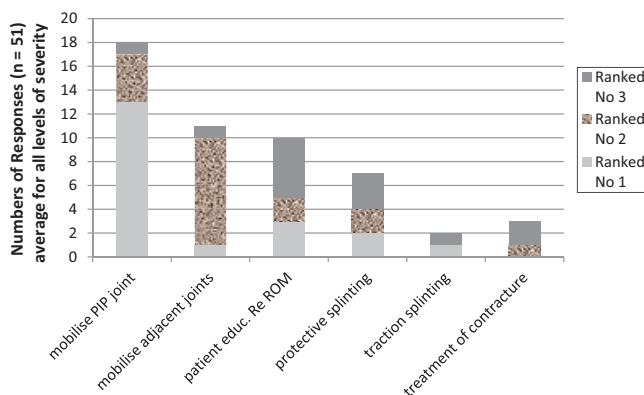
**Figure 3.** Surgeons' choice of traction method

**Sources:** Ligamentotaxor; MacFarlane *et al.* (2015), S Quattro (Stockport Serpentine Spring System); (Mullet *et al.*, 1999; Khan and Fahmy, 2006), PRTS Pins and Rubber Traction System; (Haase and Chung, 2014; Oak and Lawton, 2013)



**Notes:** Ext: extension, Ex Fix: external fixation, DDEF: dynamic digital external fixation, ORIF: open reduction internal fixation, VPA: volar plate arthroplasty, HHA: hemi-hamate arthroplasty

**Figure 4.** Surgeons' reporting of timing of referral to therapy according to treatment method



**Figure 5.** Surgeons' ranking of reason for referral to therapy, all fracture severity

### Availability of therapy services

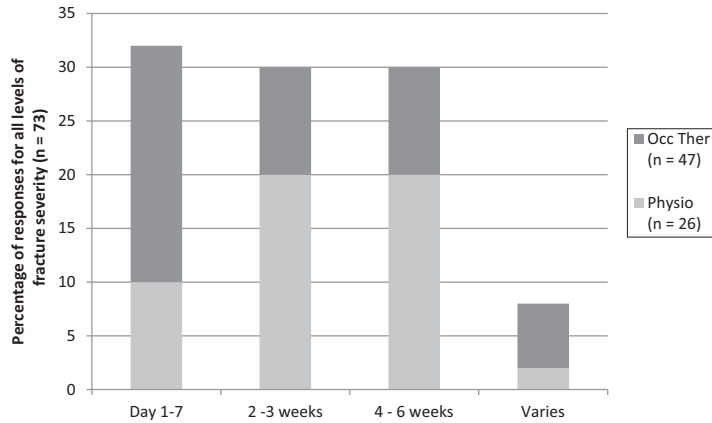
Access to a full time therapy service for the treatment of intra-articular fractures was reported by 60 per cent of surgeons ( $n = 12$ ), 35 per cent ( $n = 7$ ) reported a part time service and 5 per cent ( $n = 1$ ) responded "don't know". When asked if access to therapy services is sufficient to meet demand, 75 per cent ( $n = 15$ ) reported no. Four respondents commented that access to therapy is dependent on the patient's proximity to the Trauma Centre; e.g. "I have patients coming a long way and arranging local therapy is difficult".

### Therapist respondents

#### Therapists' reporting of timing of referral to therapy

Therapists reporting of timing of referral varies from the reporting of surgeons. This is outlined in Figure 6. When asked if therapists would prefer to receive referrals for these patients at a different time than they currently do, 33 per cent responded no ( $n = 12$ ), and 64 per cent ( $n = 24$ ) reported that they would like earlier referral of patients, 58 per cent of

**Figure 6.**  
Therapists' report of  
timing of referral to  
therapy



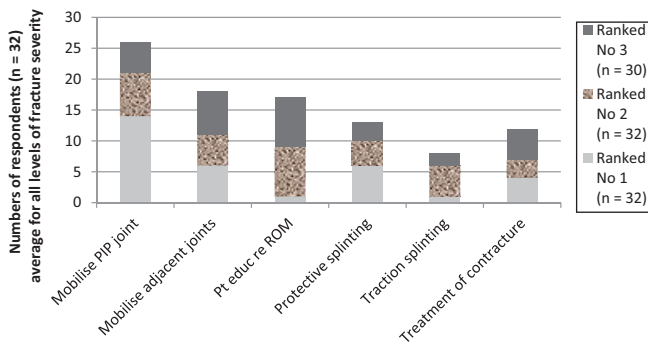
respondents ( $n = 21$ ) stated they would prefer to receive referrals within the first week. The preference for earlier referral was most widely reported for fractures of tenuous stability, 30-50 per cent surface involvement, by both physiotherapists and occupational therapists. Eleven therapists reported referral at four to six weeks across all levels of severity of fracture; eight reported they would prefer to see these patients earlier, ranging from immediately post-operatively ( $n = 4$ ) to two to three weeks post-operatively ( $n = 2$ ). Therapists were asked if they have the resources to see patients at the time they think optimal to commence therapy; of 36 respondents 61 per cent ( $n = 22$ ) reported no. Of the respondents, 39 per cent ( $n = 14$ ) reported they did with half of these ( $n = 7$ ) commenting that these patients were prioritised.

*Reason for referral to therapy*

Therapist respondents were asked to rank the principal three reasons for referral to their service. The results are outlined in Figure 7. Referral for treatment of contracture of the PIP joint was reported in 12 per cent of therapist responses ( $n = 9$ ) whereas this reason was reported by only 3 per cent of surgeon responses ( $n = 2$ ).

Therapists were asked if there were any interventions they would like to be doing that is not currently part of their practice. A total of 28 people responded; 43 per cent said yes ( $n = 12$ ) and 57 per cent said no ( $n = 16$ ). Comments from those who said yes include that they

**Figure 7.**  
Therapists' ranking  
of reasons for referral  
to therapy





“would like Clinical Specialist Physiotherapist protocols” ( $n = 1$ ); “early mobilisation” ( $n = 3$ ) and to “introduce (Poole) traction orthoses” ( $n = 5$ ).

## Discussion

### *Methods of treatment*

In line with previous studies (Ootes *et al.*, 2012; Janssen *et al.*, 2015) the results highlighted that the numbers of PIP intra-articular fractures seen are low, with only two of the surgeons indicating that they see more than five of these fractures per month. There was also a broad variation in treatment methods utilised across all levels of fracture severity, again reflective of international practice (Oak and Lawton, 2013; Caggiano *et al.*, 2018; Janssen *et al.*, 2015; Ng and Oliver, 2009). For the treatment of stable fractures buddy strapping was reported as the primary intervention by most surgeons. Buddy strapping is more widely proposed in the literature for PIP joint dorsal dislocation without fracture (Freiberg *et al.*, 2006; Roh *et al.*, 2018) than with fracture (Ng and Oliver, 2009; Calfee and Sommerkamp, 2009). Extension block orthoses or pinning are identified in the literature as alternative methods (Haase and Chung, 2014; Oak and Lawton, 2013; Caggiano *et al.*, 2018; Calfee and Sommerkamp, 2009) and these were indicated as the treatment of choice by five of the surgeons for stable fractures and five for tenuous injuries. ORIF management was reported to be used by more than half of the surgeons, particularly when the percentage of articular surface fractured was greater than 50 per cent. It is not possible to determine why this method was chosen as data related to justification of method was not sought. As outlined in the introduction with reference to the study by Aladin and Davis, the literature proposes that less invasive treatment methods are preferable (Aladin and Davis, 2005; Deitch *et al.*, 1999). However, rotation of the fracture fragment, volar plate entrapment or irreducible fractures may necessitate ORIF (Ikeda *et al.*, 2011; Calfee and Sommerkamp, 2009; Seno *et al.*, 1997). ORIF has been recommended as a treatment of choice to ensure stability of fixation to commence early motion (Haase and Chung, 2014; Ikeda *et al.*, 2011; Watanabe *et al.*, 2015).

The use of traction constructs was reported across all levels of severity of PIP joint fracture, the only treatment with this broad an application, although the percentage of use was relatively low in comparison to the use of ORIF. O'Brien *et al.* (2014) did not solely compare dynamic traction to ORIF; however, they reported superior range of motion in the traction group in comparison with the non-traction group ( $n = 14$ ) of whom nine underwent ORIF. Complications of swan-neck deformity, cold sensitivity, mal-union, infection or adhesions occurred to the same extent in the traction group as in the no-traction group. Traction constructs are the highest ranked choice of management for fractures of 30-50 per cent articular surface involvement in this survey, however traction constructs encompass a range of techniques and methods of application including static or dynamic options and both surgeon and therapist-applied options (Morgan *et al.*, 1995; Packham *et al.*, 2016; Hirth *et al.*, 2013; MacFarlane *et al.*, 2015; De Kesel *et al.*, 2006). The application of traction constructs is less invasive than open reduction, utilising percutaneous insertion of two to three K-wires (Morgan *et al.*, 1995; O'Brien *et al.*, 2014; MacFarlane *et al.*, 2015). Nail hook traction can be used with dynamic traction orthoses which avoids the complication of pin site infection, although use of a single K-wire to provide skeletal traction is more widely described (O'Brien *et al.*, 2014; Packham *et al.*, 2016; Hirth *et al.*, 2013; MacFarlane *et al.*, 2015; Dennys *et al.*, 1992; Schenck, 1994). Therapists' comments in this study indicated that dynamic traction orthoses are an intervention that some are introducing in their practice. Introduction of dynamic traction orthoses may have the benefit of being more cost-effective than surgical interventions (O'Brien *et al.*, 2014; Hirth *et al.*, 2013; Poole Hospital NHS Foundation Trust, 2015). A qualitative study of the patient experience of traction orthosis

use reported pain and dissatisfaction with the confronting appearance of the orthosis as adverse aspects of traction orthosis use (O'Brien and Presnell, 2013).

#### *Referral to therapy*

A finger injury can impact on a person's occupational engagement and lead to a reduced quality of life. It can have an adverse effect on their functional performance and participation in work which negatively impacts financial security (Kingston *et al.*, 2010). Referral to therapy following a finger injury can ameliorate these adverse outcomes. The reporting of the reason for referral to therapy showed similarity in the responses of occupational therapists and physiotherapists and between surgeons and therapists. There is consensus that mobilisation of the hand is the primary reason for referral across all levels of fracture severity: the top three rated reasons featured mobilisation; of the PIP joint, of adjacent joints and patient education regarding mobilisation. Current evidence supports the use of early motion for extra-articular hand fracture. Miller *et al.* found that the only characteristic that significantly predicted ROM at six weeks post injury was time to commencement of active exercise (Miller *et al.*, 2017). Watanabe *et al.* in his study of factors affecting the functional results of ORIF of the PIP joint reported that "the time after surgery until starting active motion exercise was the most significant factor influencing PIP joint ROM" (p.112) (Watanabe *et al.*, 2015) Maximising range of motion facilitates hand function in the areas of self-care, work and leisure activities. There is similarity between surgeons and therapists in reporting traction orthoses as the least common reason for referral, whilst referral for treatment of contracture of the PIP joint shows fewer surgeons ( $n = 2$ ) reporting this compared to therapist responses ( $n = 9$ ). Extensor lag/PIP joint contracture is widely reported in outcomes for many methods of PIP joint fracture management and therefore is expected to commonly form part of therapy management (Aladin and Davis, 2005; Packham *et al.*, 2016; Ikeda *et al.*, 2011; Watanabe *et al.*, 2015).

Referral to therapy within seven days of injury is reported more consistently in this study by plastic surgeons than by orthopaedic surgeons. Variance is also seen between the responses of surgeons and that of therapists. More than half of the surgeons (52 per cent) reported referring within the first seven days. Only 32 per cent ( $n = 24$ ) of therapists report this timing in current practice. A possible explanation for this difference may be the location of respondents in an acute setting or in the smaller hospitals within the catchment area of the Acute Trauma Centre. As the surveys were anonymous it was not possible to determine the work setting of participants. Across all levels of fracture severity, 64 per cent of therapist responses reported that they would prefer an earlier timing of referral with 62 per cent of therapists ( $n = 23$ , 8 PTs and 15 OTs) specifying Days 1-7. Early motion for intra-articular fractures is recommended in the literature and is described as within the first week (Kiefhaber and Stern, 1998; Haase and Chung, 2014; Hastings and Carroll, 1988). Joint motion increases circulation of synovial fluid which enhances nutrition and thus healing of articular cartilage (Salter, 1994; McKee *et al.*, 2012).

Later referral to therapy (four to six weeks) is reported in greater numbers by therapists (30 per cent  $n = 11$ ) than surgeons (9 per cent,  $n = 2$ ). Waiting until removal of external fixation, typically at four to six weeks (Watanabe *et al.*, 2015; Schenck, 1994), provides a rationale for referral at this time; however, dynamic external fixation allows early range of motion of the PIP joint and this study reports referral as early as one to seven days for fractures managed using external fixation. All occupational therapists (total seven responses) who reported receiving referrals at four to six weeks indicate that they would prefer earlier referral. Three physiotherapists (four responses) reported referral at four to six weeks who did not prefer earlier referral. These responses were further analysed because of

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the importance of early active motion for finger fractures (Watanabe *et al.*, 2015; Miller *et al.*, 2017; Feehan and Bassett, 2004). Two of these questionnaires identify a lack of resources to see patients at a time the therapists consider optimal. It is possible the other response is associated with a lack of post-graduate training. The BSSH recommends that hand injuries should be treated by therapists with expertise in hand therapy (p. 15) (British Society for Surgery of the Hand, 2017).

### *Capacity of the current service*

This study identified both surgeons and therapists reporting a lack of resources as impacting on patients' access to service and on therapists' ability to commence treatment in the timeframe indicated in the literature to give the best outcomes. The majority of therapists reported a preference for earlier referral of patients, and some commented that they would like to introduce new practices, but the findings of this study are that therapists are largely under-resourced to do so. Two surgeons commented that they do not refer fractures of <30 per cent because of the lack of therapy resources. The HSE publication:

National Model of Care for Trauma and Orthopaedic Surgery 2015 states that 'It is nevertheless recognised that physical capacity for treating trauma and orthopaedic patients is limited, and the geographical location of services does not always match the distribution of patients presenting. Therefore, plans to add more capacity should be developed (p. 59) (Health Service Executive 2015).

The findings of this study support the need to add more capacity to therapy services for hand trauma patients within the HSE. The British Society for Surgery of the Hand in a report of a Working Party 2017 states that a population of 500,000 requires a minimum of six whole time equivalent hand therapists. (p. 17) (British Society for Surgery of the Hand, 2017) Guidelines such as these could be used to estimate the hand therapy capacity required for Ireland's growing population.

### **Limitations**

As the exact numbers of potential participants were not available it is not possible to calculate the sample size representative of the population. The survey may contain bias in that responses received may differ to those of non-respondents, and this limits the generalisability of results (Curtis and Drennan, 2013). In spite of this, the survey offers relevant information regarding current methods of treatment of closed intra-articular fractures of the PIP joint in Ireland. Although piloted, the questionnaires were original and not validated. However information was gathered from a number of sources during the literature review to inform the generation of items for the questionnaire and the survey was piloted by two experienced practitioners. In spite of using a classification of fracture severity, the variance in presentation of fracture patterns made reporting of treatment selection difficult to describe in general terms. More accurate information may have been obtained if the survey focused on just one level of severity of fracture, or if one presentation of intra-articular fracture, complete with lateral radiographs was given for which surgeons could outline their choice of management.

### **Conclusion**

This study provides the first description of the management of intra-articular PIP joint fractures across the Irish health service, and provides a foundation for service analysis and development. There is a wide range of treatment techniques used within the HSE in the

management of closed PIP joint fractures and this reflects the lack of specific evidence-based recommendations for the management of these fractures internationally. The findings of this study suggest that additional hand therapy resources would be required within the Irish health service to facilitate desired early referral to therapy and/or to enable service development for this category of hand fractures.

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