



## Patient perception on fracture healing

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Effective communication skills are an extremely important aspect of good medical practice. Fractures are common with over 1 million fractures occurring each year in the UK; of which 5-10% may have problems with healing. Patient perceptions of factors harmful to the fracture healing process are unknown and our study investigates this.

A total of 418 responses were collected from participants in a single centre in our survey based study. We collected our data using a questionnaire we developed set to determine patient perception on factors potentially affecting bone-healing.

The patients and relatives attending our fracture clinic who completed the questionnaire showed that 84% and 73% of patients believed tobacco and alcohol to be harmful to bone-healing. 31% thought that there was a harmful effect to bone-healing with ibuprofen and 25% perceived the same regarding caffeine. Paracetamol, vinegar and chocolate were considered to be least harmful to bone-healing with 20%, 15% and 11% responses respectively.

The majority of patients believed that there was a harmful association with tobacco and alcohol with regards to bone-healing. This harmful relationship is well understood in modern literature with documented association of bone delayed and non-union. However we believe for the benefit of patients, they should all be aware of these detrimental effects. There was no clear consensus regarding all the remaining substances and their effect on bone-healing. A clear possibility has been identified to improve fracture outcomes by empowering patients to take ownership of their injury by lifestyle modifications which are within their remit.

**Keywords** : fracture ; healing ; patient perception ; non union ; risk factors.

## INTRODUCTION

Fractures are one of the most common bone problems affecting the population across all age groups and genders. Most fractures are the result of accidental injury. A fracture is defined as a breach or disruption in the structural continuity of bone with associated soft tissue injury. Patients sustaining fractures from trauma are often faced with injuries of which they have no prior experience and may have little or no knowledge of the healing process. Effective communication skills are one of the main domains of good medical practice (1) and essential for developing meaningful and trustworthy relationships between patients and doctors, that can be used to drive healthy lifestyle choices.

Over 1 million fractures occur each year in the United Kingdom of which 5-10% are considered to have problems in healing (2). Annual fracture incidence has been estimated at 3.6% and fracture prevalence as 38.2% (3). Fracture healing is described as a continuous process of replacing

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injured bone divided into 3 phases I) inflammation II) repair and III) remodelling. It is considered essential for surgeons to be aware of factors which inhibit fracture repair. Our study set out to explore the patient’s understanding of the influence of common substances on fracture healing. The impact of some substances is theoretical and warrants further investigation ; whilst for others there is published evidence. Factors considered outside of the patients control were not studied.

**PATIENTS AND METHODS**

To select the substances we performed a Medline OVID Pubmed search using the following terms to identify all papers providing evidence for delay to fracture healing. The <search term> used were Factors AND Healing AND/OR non union AND/OR delayed union. This yielded a total of 134 relevant papers which were used to identify key descriptive terms relating to fracture healing ; Alcohol, Infection, Open reduction, Open fracture, Fracture pattern, Fracture site, Compartment syndrome, Osteoporosis, Diabetes (metabolic disease), Peripheral vascular disease, Chronic inflam-matory disease, Renal insufficiency, Insulin, Opiates, Steroids, Antibiotics, Anticoagulants, Chemotherapeutics, Age, Smoking, NSAIDs, Paracetamol and Caffeine. We decided to exclude any factors in our study which we considered potentially outside of the patient’s control. We included two artificial terms not identified from our database search ‘vinegar’ and ‘chocolate’. No literature exists to consider them as harmful to bone healing and we decided to use these as our control to stratify the significance of our results. We repeated the search terms using the individual factors Chocolate (no papers) ; vinegar/acetic acid (5 papers) ; alcohol/ethanol (295 paper) ; Smoking (274 papers) ; Caffeine (1 paper) ; NSAIDS (255 papers) and finally paracetamol (11 papers).

We performed a survey-based study between the dates of June and October 2018. A total of 418 responses were collected from patients from fracture clinic in a single centre. 61 questionnaires did not record a gender however their responses were still included. All patients and relatives were eligible to

participate in the survey. We collected our data using a questionnaire we developed to determine patient’s perception on factors potentially affecting bone healing. Responders were asked several multiple choice questions assessing their understanding of potentially harmful agents to bone healing. They could record their answers by choosing “yes”, “no” and “don’t know”. This study had no set exclusion criteria.

**RESULTS**

Our primary outcome was patient perception for specific substances and their effect on bone healing. From the total of 418 responses, there were 145 (41%) males with a median age of 45 years and 212 (59%) females with a median age of 52 years. Table I and Figure I shows a summary of our results. The results from the questionnaire revealed that 84% and 73% believed tobacco and alcohol to be harmful to bone healing respectively. 31% perceived a

Table I.

<b>Does it harm bone healing? (Total 418 responses)</b>			
	Yes	No	Don't Know
Caffeine	25%	33%	42%
Tobacco	85%	9%	6%
Vinegar	16%	40%	44%
Paracetamol	20%	51%	29%
Alcohol	73%	16%	11%
Chocolate	12%	55%	33%
Ibuprofen	31%	46%	23%

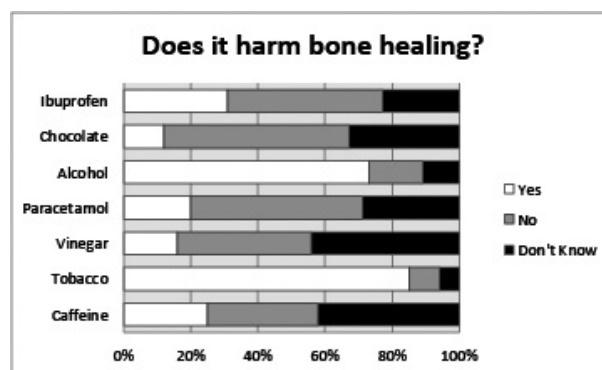


Figure 1.

Table II.

Comparison between substances and control group				
	Yes	No	Don't Know	P-value*
Caffeine	106	139	173	<0.001
Tobacco	353	38	27	<0.001
Paracetamol	84	213	121	0.002
Alcohol	306	66	46	<0.001
Ibuprofen	131	192	95	<0.001

\*chi-squared test with 2 degrees of freedom (3 decimal places).

harmful effect to bone healing with ibuprofen and 25% perceived the same in regards to caffeine. Paracetamol, vinegar and chocolate were considered to be least harmful to bone healing with 20%, 15% and 11% responses respectively. Our control group was determined by the responses for vinegar and chocolate, both of which are perceived as innocuous substances and with no current literature regarding harm to bone healing. Statistical analysis was conducted for our data. Means were used to describe the control group data. We used chi-squared test to compare our results for the remaining substances against the control group (Table II). P-values of <0.05 were considered statistically significant.

## DISCUSSION

Patient perception regarding bone healing following fractures is not known in current literature. Patient's understanding of their injury and their healthcare beliefs are an essential component of patient centred care (4). They can impact behaviours such as medication adherence, use of healthcare services and lifestyle choices (5) which can have a financial impact on the use of health care resources (6). There seems to be a general lack of understanding in patient's knowledge of fractures. One study reported only 45-84% of patients understood the term 'fracture' (7,8). This lack of understanding is a concern. Interventions to improve self-efficacy and health literacy are consistently related to positive outcomes in patient self-care and management (9). Randomised controlled trials have already demonstrated improvements in quality of life and financial cost effectiveness after self-management

or lifestyle intervention were integrated as key aspects in the patient's management (10,11).

Healthcare providers hold the view that education is required for patients to understand the consequences of their actions concerning their health (12). Interventional studies improving knowledge on osteoporosis in patients has consistently shown improved levels of self-efficacy, health beliefs and dietary intakes following said interventions (13,14). A systemic review investigating nine randomised controlled trials showed intervention in the form of patient education positively affected osteoporosis treatment in patients following fragility fractures (15). Educational handouts designed for patients sustaining ankle fractures requiring open reduction internal fixation in a randomised controlled trial demonstrated them as being a valuable tool in improving patient satisfaction with the potential to improve outcomes (16). Holistic patient journey allows patients engagement and empowerment to positively impact their health. Communication throughout this process can vary in the form of visual aids, information leaflets and most importantly in the doctor-patient consultation. The surgeon should adopt inclusive key communication. This can be in the way to help support patients by improving accessibility to resources for example found in primary care and the community or by lifting other barriers to self improvement. This type of communication should help educate the patient by sharing information and exploring ideas with them. It should also acknowledge the individual as a focus in their care and the importance their lifestyle changes can have. The role of the surgeon in driving this process is of paramount significance. Fracture healing is a complex process in which bone heals for the purpose of transferring mechanical load (17). Different substances can affect one or multiple stages of this healing process. Patient perceptions in regards to these factors are overlooked.

Our study shows that the majority of patients surveyed were aware of the harmful effects of tobacco to bone healing. A review of multiple studies looking at the relationship of tobacco and fracture healing demonstrated adverse effects on bone mineral density, lumbar disc disease, rate of hip fractures and dynamics of bone and wound

healing (18). Current and previous smokers were 37% ( $P=0.01$ ) and 32% (0.04) less likely to achieve union than non-smokers (19). Smoking is thought to affect fracture healing by reducing the blood supply, increasing levels of reactive oxygen intermediates and lowering concentration of anti-oxidant vitamins (20). In vivo animal studies in rats displayed tobacco extracts free from any nicotine significantly reducing the mechanical strength of femoral fractures (21). It has been consistently shown that patients who smoke were more at risk of non-union and delayed union (22,19,23). All patients should be aware of the effects of tobacco on fracture healing and those who are smoking encouraged to stop.

In comparison, a smaller majority contributed alcohol as harmful to bone healing. In a study examining the dose dependent effects of ethanol on bone repair in a rat model showed that the chronic consumption of excess alcohol is associated with an osteopaenic skeleton and delayed healing when compared with rats receiving an ethanol-free diet. Alcohol is thought to suppress ossifiable matrix. Furthermore, removal of ethanol from the diet after bone injury completely restored normal bone healing, concluding an alcohol dose dependent toxic effect on osteoblast activity (24). Animal models have shown that alcohol decreases fracture callus volume, diameter and biomechanical strength. The authors demonstrated alcohol to inhibit osteopontin dependent transforming growth factors- $\beta$ 1 levels interfering directly with the signalling pathways in mesenchymal stem cells (25). This is an area for further patient education.

Non-steroidal anti-inflammatory drugs (NSAID) such as ibuprofen inhibit cyclooxygenase (COX) activity and therefore prostaglandin production in providing analgesia and relief of musculoskeletal pain. There is conflicting evidence in literature about the harmful effects of NSAIDs on fracture healing (26). Several hypotheses for potential modes of action of NSAIDs are proposed regarding their effect on fracture healing. COX-2, a type of COX enzyme found at specific sites is induced at fracture sites and produces pro-inflammatory prostaglandins. A study in which murine models were treated with COX-2 selective inhibitors, radiographic and histological findings suggested that COX-2 is required for normal

endochondral ossification during fracture healing (27,28). Secondly, COX-2 inhibition reduces blood flow across the fracture site resulting in improper repair due to lack of angiogenesis (29). Molecular studies have suggested prostaglandins control the expression of bone morphogenetic proteins (30,31). However conflicting data from a relatively recent histometric study of rats showed no negative effect of COX inhibitors or NSAIDs on bone healing (32). On the balance of literature, it should be considered to avoid NSAID use during fracture repair. Only 31% of respondents in fracture clinic considered ibuprofen to be harmful to bone healing. However paracetamol on the other hand has generally been considered either safe to use in fractures (32,33) or their exact effects not fully understood.

Caffeine was considered to be relatively safe in regards to its effect on bone healing. Ten studies on the effect of caffeine or coffee on bone health show varying results. They are summarised in a meta-analysis showing a 3.5% increase in fracture risk for an increment of one cup of coffee per day, however their current data is insufficient to reach a convincing conclusion (34).

The lowest perceived harmful agents for bone healing were vinegar and chocolate. Limited literature exists and there has been no established link between the use of vinegar or chocolate with bone healing. Cross sectional analysis from a study has shown older women with daily chocolate consumption had lower bone density and strength, however stated further data was still required (35).

## CONCLUSIONS

There is no literature on patient's knowledge of specific agents and their perceived effects on bone healing. Numerous studies have shown patient education and self-efficacy helps improve outcomes. The majority of patients believed that there was a harmful association with tobacco and alcohol in regards to bone healing. This is well known from modern literature with direct association of bone delayed and non-union. This is significant and we believe all patients should be aware of these effects. There is no clear consensus on the harmful effects of the remaining substances. There is some

evidence to suggest the negative role of NSAIDS during fracture healing of which only a minority of patients were aware of. Our study has identified a significant area in need for further patient education. We also emphasise the role of the surgeon in delivering effective communication to address this. A clear possibility has been identified to improve fracture outcomes by empowering patients to take ownership of their injury by lifestyle modifications which are within their remit.

## REFERENCES

- Council, General Medical.** Domain 3 : Communication partnership and teamwork. <https://www.gmc-uk.org>. [Online] <https://www.gmc-uk.org/ethical-guidance/ethical-guidance-for-doctors/good-medical-practice/domain-3---communication-partnership-and-teamwork>.
- Johansen A, Evans RJ, Stone MD, Richmond PW, Lo SV, Woodhouse KW.** Fracture incidence in England and Wales : a study based on the population of Cardiff. *Injury*. 1997 Nov-Dec ; 28(9-10) : 655-60.
- Donaldson LJ, Reckless IP, Scholes S, Mindell JS, Shelton NJ.** The epidemiology of fractures in England. *J Epidemiol Community Health*. 2008 Feb ; 62(2) : 174-80
- Street RL Jr, Haidet P.** How well do doctors know their patients? Factors affecting physician understanding of patients' health beliefs. *J Gen Intern Med*. 2011 Jan ; 26(1) : 21-7
- Godin G, Kok G.** The theory of planned behavior : a review of its applications to health-related behaviors. *Am J Health Promot*. 1996 Nov-Dec ; 11(2) : 87-98.
- Hak DJ, Fitzpatrick D, Bishop JA, Marsh JL, Tilp S, Schnettler R, Simpson H, Alt V.** Delayed union and nonunions : epidemiology, clinical issues, and financial aspects. *Injury*. 2014 Jun ; 45 Suppl 2 : S3-7
- Ghorbanhoseini M, Riedel M, Gonzalez T, Hafezi P, Kwon J.** Is It "Fractured" or "Broken"? A Patient Survey Study to Assess Injury Comprehension after Orthopaedic Trauma. *Arch Bone Jt Surg*. 2017 Jul ; 5(4) : 235-242.
- RJ Kampa, J Pang and R Gleeson.** Broken Bones and Fractures - An Audit of Patients' Perceptions. *Ann R Coll Surg Engl*. 2006 Nov ; 88(7) : 663-666
- A, Bandura.** Self-efficacy : toward a unifying theory of behavioral change. *Psychol Rev*. 1977 Mar ; 84(2) : 191-215
- Wens J, Vermeire E, Hearnshaw H, Lindenmeyer A, Biot Y, Van Royen P.** Educational interventions aiming at improving adherence to treatment recommendations in type 2 diabetes : A sub-analysis of a systematic review of randomised controlled trials. *Diabetes Res Clin Pract*, 2008 Mar ; 79(3) : 377-88.
- Katon W, Unützer J, Fan MY, Williams JW Jr, Schoenbaum M, Lin EH, Hunkeler EM.** Cost-effectiveness and net benefit of enhanced treatment of depression for older adults with diabetes and depression. *Diabetes Care*. 2006 Feb ; 29(2) : 265-70.
- Kennedy BM, Rehman M, Johnson WD, Magee MB, Leonard R, Katzmarzyk PT.** Healthcare Providers versus Patients' Understanding of Health Beliefs and Values. *Patient Exp J*, Vols. 2017 ; 4(3) : 29-37.
- Gaines JM, Marx KA.** Older men's knowledge about osteoporosis and educational interventions to increase osteoporosis knowledge in older men : a systematic review. *Maturitas*. 2011 Jan ; 68(1) : 5-12
- Park K, Yoo J, Kim H, Jang S, Park J, Ha Y.** Education and exercise program improves osteoporosis knowledge and changes calcium and vitamin D dietary intake in community dwelling elderly. *BMC Public Health*, 2017, Vol. 17 : 966.
- Little EA, Martin P.** A systematic review of the effectiveness of interventions to improve post-fracture investigation and management of patients at risk of osteoporosis. *Implement Sci*. 2010 Oct 22 ; 5 : 80.
- Mayich DJ, McCormick W, Tieszer C, Lawendy A, Sanders DW.** Do educational handouts work after ankle fracture? Results of a randomised controlled trial. *The British Editorial Society of Bone & Joint Surgery*, 2018 Feb
- Einhorn TA.** The cell and molecular biology of fracture healing. *Clin Orthop Relat Res*. 1998 Oct ; (355 Suppl) : S7-21
- Porter SE, Hanley EN Jr.** The musculoskeletal effects of smoking. *J Am Acad Orthop Surg*, 2001, Vols. Jan-Feb ; 9(1) : 9-17.
- Castillo RC, Bosse MJ, MacKenzie EJ, Patterson BM.** Impact of smoking on fracture healing and risk of complications in limb-threatening open tibia fractures. LEAP Study Group. *J Orthop Trauma*, 2005, Vols. 19 : 151-7.
- Gullihorn L, Karpman R, Lippiello L.** Differential effects of nicotine and smoke condensate on bone cell metabolic activity. *J Orthop Trauma*, 2005, Vols. 2005 ; 19 : 17-22.
- Skott M, Andreassen TT, Ulrich-Vinther M.** Tobacco extract but not nicotine impairs the mechanical strength of fracture healing in rats. *J Orthop Res*, 2006, Vols. 24 : 1472-9.
- Kyrö A, Usenius JP, Aarnio M, Kunnamo I, Avikainen V.** Are smokers a risk group for delayed healing of tibial shaft fractures? *Ann Chir Gynaecol*, 1993, Vols. 82 : 254-62.
- Santolini E, West R, Giannoudis PV.** Risk factors for long bone fracture non-union : a stratification approach based on the level of the existing scientific evidence. *Injury*, 2015 Dec, Vols. 46 Suppl 8 : S8-S19.
- Chakkalakal DA, Novak JR, Fritz ED.** Inhibition of bone repair in a rat model for chronic and excessive alcohol consumption. *Alcohol*, 2005, Vols. 36 : 201-14.
- Driver J, Weber CE, Callaci JJ, Kothari AN, Zapf MA, Roper PM, Borys D, Franzen CA, Gupta GN, Wai PY,**

- Zhang J, Denning MF, Kuo PC, Mi Z.** Alcohol inhibits osteopontin-dependant transforming growth factor-B1 expression in human mesenchymal stem cells. *J Biol Chem*, April 2015, Vols. 290(16) : 9959-73.
- 26. Aspenberg P.** Drugs and fracture repair. *Acta Orthop*, 2005, Vols. 76 : 741-8.
- 27. Gaston S, Simpson W.** Inhibition of fracture healing. *J Bone Joint Surgery*, 2007, Vols. 89-B : 1553-60.
- 28. Simon AM, Manigrasso MB, O'Connor JP.** Cyclooxygenase 2 function is essential for bone fracture healing. *J Bone Miner Res*, 2002, Vols. 17 : 963-76.
- 29. Murnaghan M, Li G, Marsh DR.** Nonsteroidal anti-inflammatory drug-induced fracture nonunion: an inhibition of angiogenesis? *J Bone Joint Surg [Am]*, 2006, Vols. 88-A(Suppl 3) : 140-7.
- 30. Paralkar VM, Grasser WA, Mansolf AL.** Regulation of BMP-7 expression by retinoic acid and prostaglandin E(2). *J Cell Physiol*, 2002, Vols. 190 : 207-17.
- 31. Arikawa T, Omura K, Morita I.** Regulation of bone morphogenetic protein-2 expression by endogenous prostaglandin E2 in human mesenchymal stem cells. *J Cell Physiol*, 2004, Vols. 200 : 400-6.
- 32. Fracon RN, Teofilo JM, Moris IC, Lamano T.** Treatment with paracetamol, ketorolac or etoricoxib did not hinder alveolar bone healing : a histometric study in rats. *J Appl Oral Sci*, 2010, Vols. 18(6) : 630-634.
- 33. Bergenstock M1, Min W, Simon AM, Sabatino C, O'Connor JP.** A comparison between the effects of acetaminophen and celecoxib on bone fracture healing in rats. *J Orthop Trauma*, 2005, Vols. Nov-Dec ; 19(10) : 717-23.
- 34. Huifang Liu, Ke Yao, Wenjie Zhang, Jun Zhou, Taixiang Wu, Chengqi He.** Coffee consumption and risk of fractures : a meta-analysis. *Arch Med Sci*, 2012, Vols. 8(5) : 776-783.
- 35. Hodgson JM, Devine A, Burke V, Dick IM, Prince RL.** Chocolate consumption and bone density in older women. *Am J Clin Nutr*, 2008, Vols. 87(1) : 175-80.
- 36. Ding L1, He Z, Xiao H, Chai L.** Xue Factors affecting the incidence of aseptic nonunion after surgical fixation of humeral diaphyseal fracture. *J Orthop Sci*, 2014, Vols. 19(6) : 973-7.