

## SMOKING AND ORTHOPAEDIC SURGERY

The use of tobacco is a significant contributor to

- cardiovascular diseases: heart attack, angor
- oral, urinary and pulmonary neoplasms
- chronic respiratory diseases
- peripheral vascular arteritis

Many studies have been reported for many years related to detrimental effects of tobacco to various orthopaedic problems ( 21-35 )such as delayed fracture repair ( 6-9 ), delayed healing in tibial lengthening ( 14 ), risk of non-union ( 1-8 ), decreased bone density ( 12-19-25 ) .

### BIOLOGICAL EXPLANATIONS

There is some evidence that smoking accelerates the ageing processes, not only in the cardiovascular and pulmonary systems, but also in the musculoskeletal system (21-35): bone, tendon, joint. .

Direct damage to red blood cell precursors, macrophages, and fibroblasts ( 46 ), and the vasoconstrictive and thrombogenic effects of nicotine have been implicated as possible etiologic factors.

Collagen production is an important factor in wound repair and has been found to be decreased in smokers ( 18-21 ).

Carbon monoxide reduces tissue oxygenation and impairs the microcirculation within healing soft tissue and bone. Nicotine is also a potent vasoconstrictor and impairs the revascularisation of healing bone leading to impaired bone and wound healing ( 10 -28 -37).

Hypercoagulability observed in smokers may be explain by an increase of hematocrit value, red cell volume, and high plasma fibrinogen levels.

It has also been demonstrated that smoking has an effect on the immune system ( 5 ).

All of this leads to a decreased blood delivery to tissues ( 18 ).

### JOINT REPLACEMENT

In many articles published in the orthopaedic literature, smoking is **the single most important risk factor** for the development of serious postoperative complications in patients undergoing elective hip and knee arthroplasty ( 22-24-29-30-31-33 ).

This is true whether we consider all general complications as cardiopulmonary complications but also specific complications of surgery : wound healing because of

bad vascularisation, the risks of further surgery, and the need for admission to Intensive Care Unit after surgery.

This is particularly true when co-morbidity as diabetes is present.

Previous and current smokers have a 43% and 53% increased risk of systemic complications, respectively, compared with non smokers. In heavy smokers, the risk increases to 121% ( 2 ).

The risk for patient with a high Body Mass Index ( > 30 ) may increase to 58%.

The current smokers who undergo joint replacement consume more health resources and have longer surgical and anesthesia times ( 24 ).

### **BONE HEALING**

Spine surgeons have reported 3 to 4 times higher non union or delayed union after bony fusions because of delayed revascularisation within the graft, and predisposition to graft necrosis ( 11-12-45 ). Others found 50% delay in healing of open or closed tibial fractures in smokers.

Experimental works showed that the callus of smoking groups is mainly composed of woven bone instead of lamellar bone, leading to a decrease of the mechanical strength at 8 weeks.

Smoking adversely affects both primary fracture healing ( 1-16 ), impaired wound healing, delayed bony union, and non-union treatment, because of bad oxygenation of injured tissues ( 15-28 ) as well as having an adverse effect on the immune system.

Smokers are more likely to require further surgery, which may be related not only to impaired wound healing and infection, but to impaired healing of bone, which has also been recorded in dental and spinal surgery.

### **TENDON AND LIGAMENTS**

Nicotine is responsible of a delayed tendon-to-bone healing in experimental animal models. Chronic inflammation and decreased cell proliferation may partly explain the inferior biomechanical properties in the smokers group as compared with the nonsmoking group.

The same has been reported when using hamstring grafts ( DIDT ) ( 40).

People who smoke have a worse functional outcome following primary reconstruction of the ACL. Symptoms of instability and laxity have been reported by patients subjectively and objectively with side-to-side differences in ACL reconstruction.

Following reconstruction of the ACL some analysis ( 20 ) demonstrated in the smokers groups:

- a significantly increased frequency and intensity of pain , a decreased level of activity before the onset of pain, an increased incidence of locking and catching of the knee and subjective instability .
- a higher proportion of patients unable to return to their original level of sport
- a mean difference in side-to-side laxity of 2.2 mm (0 to 12) in smokersgroup, compared with 1.4 mm (0 to 14) in nonsmokers group.

### HEALTH-CARE ECONOMIC CONSEQUENCES

Occurrence of postoperative complications means that:

- it will affects surgical results
- an extended stay in hospital
- a treatment in ICU
- a prolonged antibiotic therapy
- a secondary surgery.

This is quite important for health-care economics as all are expensive.

### ARE REVERSIBLE EFFECTS POSSIBLE ?

Nevertheless, many of the adverse effects of smoking are reversible ( 30-31 ). It seems that it is possible to reduce the incidence of postoperative complications by persuading patients to **stop smoking some time before surgery.**

Cessation prior to surgery and during the period of rehabilitation has been proved to significantly reduce post-operative complications and improve the chance of success.

The time to reach physiologic baseline after smoking cessation has been reported to range from **six to eight weeks.** It needs at least 6 weeks to normalise biological blood values and to decrease the risk of short term complications ( 31-32-34-45 ).

## REFERENCES

1-Ahmad A, Saleh M, Hashmi M-effects of smoking on healing of nonunions in long bones-j bone joint surg2001-83B,supp2,230

2-Azodi OS, Belloc R, Eriksson K, Adami J- the impact of tobacco use and bodymass index on the lenght of stay in hospital and the risk of post-operative complications among patients undergoing THR- j bone joint surg2006-88B,10:1316-1320

- 3-Baker RR, Pereira da Silva JR, Smith G. The effect of tobacco ingredients on smoke chemistry. Part I: flavourings and additives. *Food Chem Toxicol* 2004;42 (Suppl):3-37.
- 4-Bennett-Guerrero E, Welsby I, Dunn TJ, et al. The use of a post-operative morbidity survey to evaluate patients with prolonged hospitalisation after routine, moderate-risk, elective surgery. *Anest Analg* 1999;89:514-9.
- 5-Bergmann KC. Effect of smoking on immune function. *Allerg Immunol (Leipz)* 1980;26:3-14.
- 6-Bollander ME, Bucholz RW, Heppenstall RB: factors that affect fracture healing: symposium-Am J Orthop 1997;30:161-164
- 7-Brooks-Brunn JA. Predictors of post-operative pulmonary complications following abdominal surgery. *Chest* 1997;111:564-71.
- 8-Brown CW, Orme TJ, Richardson HD: the rate of pseudarthrosis in patients who are smokers and nonsmokers: a comparison study: *Spine* 1986,11:942-943
- 9-Castillo RC, Bosse MJ, MacKenzie EJ, Patterson BM, LEAP Study Group. Impact of smoking on fracture healing and risk of complications in limb-threatening open tibia fractures. *J Orthop Trauma* 2005;19:151-7.
- 10-Connolly P, Dudeney S, McManus F, Fitzpatrick JM- the effects of nicotine on osteoblast SaSO<sub>2</sub> cell proliferation and cell function in vitro-J Bone Joint Surg Br-81B,supp3,1999:296-297
- 11-Daftari TK, Whitesides TE, Heller JG- nicotine on the revascularisation of bone graft-*Spine* 1994,19:904-911
- 12-Glassman SD, Anagnost SC, Parker A, et al. The effect of cigarette smoking and smoking cessation on spinal fusion. *Spine* 2000;25:2608-15.
- 13-Goldman L, Caldera DL, Nussbaum SR, et al. Multifactorial index of cardiac risk in noncardiac surgical procedures. *N Engl J Med* 1977;297:845-50.
- 14-Gualdrini G, Zatti A, Esposti D- the effects of cigarette smoke on the progression on septic pseudo-arthritis of the tibia treated by Ilizarov external fixator-*Chir Organi Mov*81: 395-400,1996
- 15-Gullihorn L, Karpman R, Lippiello L. Differential effects of nicotine and smoke condensate on bone cell metabolic activity. *J Orthop Trauma* 2005;19:17-22
- 16-Hashmi M, Ali A, Rigby A, Saleh M-clinical effects of smoking in a nonunion population-j bone joint surg2003-85B,supp2:123
- 17-Huang MF, Lin WL, Ma YC. A study of reactive oxygen species in main stream of cigarette. *Indoor Air* 2005;15:135-40
- 18-Jensen JA, Goodson WH, Hopf HW, Hunt TK: cigarette smoking decreases tissue oxygen - *Arch Surg* 1991,126:1131-1134

- 19-Jones JK, Triplett RG. The relationship of cigarette smoking to impaired intraoral wound healing: a review of evidence and implications for patient care. *J Oral Maxillofac Surg* 1992;50:237-9.
- 20-Karim, A.; Pandit, H.; Murray, J.; Wandless, F.; Thomas, N. P-Smoking and reconstruction of the anteriorcruciate ligament-j bone joint surg 88-B(8), August 2006, pp 1027-1031
- 21-Kwiatkowski TC, Hanley EN, Ramp WK: cigarettes smoking and its orthopedics consequences : *Am J Orthop* 1996,25:590-597
- 22-Kotani N, Hashimoto H, Sessler DI, et al. Smoking decreases alveolar macrophage function during anaesthesia and surgery. *Anesthesiology* 2000;92:1268-77.
- 23-Kozlowski LT, Heatherton TF, Ferrence RG. Pack size, reported cigarette smoking rates, and the heaviness of smoking. *Can J Public Health* 1989;80:266-70.
- 24-Lavernia CJ, Sierra RJ, Gomez-marin O- Smoking and joint replacement: resource consumption and short term outcome- *Clin Orthop* 1999,367,172-180
- 25-Law MR, Hackshaw AK: a meta analysis of cigarette smoking, bone mineral density, and risk of hip fracture: recognition of a major effect-*Br Med J* 1997,315:841-846
- 26-Mangano DT. Perioperative cardiac morbidity. *Anesthesiology* 1990;72:153-84.
- 27-Mangano DT, Layug LL, Wallace A, Tateo I. Effect of atenolol on mortality and cardiovascular morbidity after noncardiac surgery. *N Engl J Med* 1996;335:1713-20.
- 28-Misery L. Nicotine effects on skin: are they positive or negative? *Exp Dermatol* 2004;13:665-70.
- 29-Møller AM, Maaloe R, Pedersen T. Post-operative intensive care admittance: the role of tobacco smoking. *Acta Anaesthesiol Scand* 2001;45:345-8
- 30-Møller AM, Villebro N, Pedersen T, Tønnesen H. Effect of preoperative smoking intervention on postoperative complications: a randomised clinical trial. *Lancet* 2002;359:114-7
- 31-Moller AM, Pedersen T, Villebro N, Munksgaard A. Effect of smoking on early complications after elective orthopaedic surgery. *J Bone Joint Surg [Br]* 2003;85-B:178-81.
- 32-Moore S, Mills BB, Moore RD, Miklos JR, Mattox TF. Perisurgical smoking cessation and reduction of postoperative complications. *Am J Obstet Gynecol* 2005;192:1718-21
- 33-Moores LK. Smoking and post-operative pulmonary complications: an evidence-based review of the recent Literature. *Clin Chest Med* 2000;21(1):139-46.
- 34-Peters MJ, Morgan LC, Gluch L. Smoking cessation and elective surgery: the cleanest cut. *Med J Aust* 2004;180:317-18
- 35-Porter SE, Hanley EN Jr. The musculoskeletal effects of smoking. *J Am Acad Orthop Surg* 2001;9:9-17.
- 36-Priebe H. The aged cardiovascular risk patient. *Br J Anaesth* 2000;85:763-78.

37-Raikin SM, Landsman JC, Alexander VA, Froimson MI, Plaxton NA. Effect of nicotine on the rate and strength of long bone fracture healing. *Clin Orthop* 1998;353:231-7.

38-Ridderstolpe L, Gill H, Granfeldt H, Ahlfeldt H, Rutberg H. Superficial and deep sternal wound complications: incidence, risk factors and mortality. *Eur J Cardiothorac Surg* 2001;20:1168-75.

39-Scabbia A, Cho KS, Sigurdsson TJ, Kim CK, Trombelli L. Cigarette smoking negatively affects healing response following flap debridement surgery. *J Periodontol* 2001;72:43-9.

40-Song EK, Rowe SM, Chung JY, Moon ES, Lee KB. Failure of osteointegration of hamstring tendon autograft after anterior cruciate ligament reconstruction. *Arthroscopy* 2004;20:424-8.

41-Sorensen LT, Jorgensen T, Kirkeby LT, et al. Smoking and alcohol abuse are major risk factors for anastomotic leakage in colorectal surgery. *Br J Surg* 1999;86:927-31.

42-Tegos TJ, Kalodiki E, Sabetai MM, Nicolaidis AN. The genesis of arteriosclerosis and risk factors: a review. *Angiology* 2001;52:89-98.

43-Warner DO. Preventing post-operative pulmonary complications: the role of the anesthesiologist. *Anesthesiology* 2000;92:1467-72.

44-Wettersley J, Hansen EG, Kamp-Jensen M, Roikjaer O, Kanstrup IL. PaO<sub>2</sub> during anaesthesia and years of smoking predict late post-operative hypoxemia and complications after upper abdominal surgery in patients without preoperative cardiopulmonary dysfunction. *Acta Anaesthesiol Scand* 2000;22:9-16.

45-Whitesides TE, Hanley EN, Fellrath RF: controversies smoking abstinence. Is it necessary before spinal fusion? *Spine* 1994,19:2012-2014

46-Wong LS, Martins-Green M. Firsthand cigarette smoke alters fibroblast migration and survival: implications for impaired healing. *Wound Repair Regen* 2004;12:471-84.