Stress fractures in athletes

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Classification of bone stress injuries

1. **stress fracture (athletes, military recruits)**
2. **fatique fracture**
3. **cortex hypertrophy**
4. **marrow oedema - osteopathies**
5. **periostitis, insertional osteopathies**
6. **osteoporotic trabecular bone fractures**
7. **”growth pains” in children**

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Etiology of stress fractures

1. **Repetitive motion / exercise** (running, jumping, throwing, pushing, hitting, kicking, extension-flexion of spine)
2. **Fast increasing training intensity / amount**
3. **Maximal sports performances**
4. **Wrong programming of training**
5. **Risk increasing factors**
6. **Diseases, metabolic, hormonal disturbances**

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Etiology of stress fractures

1. **intrinsic factors** (wide pelvis, in-/outward rotation of lower extremity, pes cavus, thin bones, distal foot varus, muscular stiffness, muscular weakness…)
2. **extrinsic factors** (shoes, equipments, ground, training surface, weather conditions, climate, snow, ice…)
3. **”psychological factors”** (motivation, negletion of symptoms, overtraining, burn out, dietary habits,wrong training attitude…)

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Stress fractures – **risk factors** – ***Running biomechanics***

- **Running style**
- **Length of stride**
- **Impact force**
- **Heel – toe contact phase**
- **Muscle strength - fatique**
- **Hard running ground**
- **Running shoes**
- **Hyper-/hypopronation**

Most stress fractures in athletes are caused by running

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Training amount in runners with lower extremity stress fractures (Doctoral Thesis, Antero Hulkko 1988)

- **Endurance / middle distance runners**

--- 70 kms / week (50-200 kms)
--- training sessions from 5 to 12 / week
--- regular training from 2 to 18 years

- **joggers**

--- 30 kms / week
--- appearance of stress fracture 2-3 months after the onset of regular training or after 2 years

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Stress fractures in military recruits

- Appearance of stress fracture usually 2-3 months after the onset of regular training
- Appearance later in hard training soldiers (parachuters, marines, special forces)

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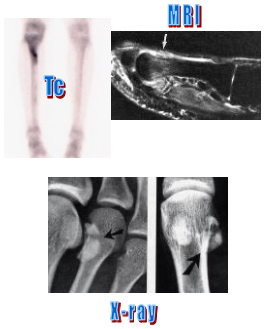
Stress fractures in athletes: affected bones

- **Tibia (20-60 %)**
- **Metatarsal bones (20-30 %)**
- **Fibula (5-10 %)**
- **Tarsal bones (5-20 %)**
- **Femur (5 %)**
- **Pelvis (5 %)**
- **Upper extremity (1-3 %)**
- **Lumbar arch (2-30 %)**



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Stress fractures – sports events

Track and field (%)

	Runners	Jumpers	Throwers
Tibia	50	30	20
MT bones	25	30	30
Tarsal bones	10	20	20
Fibula	5	5	5
Femur	5	5	+
Pelvis	5	+	+
Lumbar spine	+	5	10
Medial malleolus	+	+	-
Sacrum	+	+	-
Upper extremity	-	-	+
Ribs	-	-	+

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Common stress fractures – runners, dancers

- **Metatarsal bones (MT II-IV neck)**
- **Tarsal bones (navicular)**
- **Tibia (posteromedial proximal / distal shaft , subcondylar tibia)**
- **Pelvis (pubis)**
- **Fibula**
- **Femoral shaft and neck**

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Uncommon stress fractures – sports events

- **Vertebral arch**: javelin, high jump, dancing, ballet, gymnastics, downhill skiing
- **Medial malleolus**: jumping, decathlon, heptathlon, sprinting, orienteering
- **Patella**: soccer, jumping, orienteering, ice hockey
- **Anterior mid-tibia**: running, orienteering, dancing, jumping, soccer
- **Femoral neck** : cross-country skiing, running, orienteering
- **MTP I sesamoid bones**: running, jumping, cross-country skiing

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Uncommon stress fractures – sports events

- **Ribs 4. to 6.th**: golf, rowing
- **1.st rib**: weight / power lifting
- **Ulnar shaft**: basket ball
- **Olecranon**: javelin throwing
- **Humeral shaft**: shot put, granade throwing
- **1.st phalanx of big toe**: cross-country skiing
- **Distal radius / epiphysis**: gymnasts
- **Sacrum**: runners, old recreational athletes
- **Clavicle**: weight lifters
- **Acromion**: trap shooters

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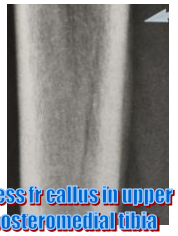
stress fr of femoral neck

high risk - surgical treatment

DIFFERENT STRESS FR´s



stress fr callus in upper posteromedial tibia

subcondylar stress fr of tibia

low risk - conservative treatment

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General risk factors for stress fractures

- Sports
- Sex
- Skeletal alignments
- Low bone density
- Hormonal factors
- Training parametres
- Footwear

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Anatomical / structural risk factors for stress fractures

- Narrow tibia
- High degree of external rotation of hip
- Varus alignment in the ankle and foot
- Hyperpronation
- High longitudinal arch of foot
- Leg length discrepancy

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Runners with multiple stress fractures

(Korpelainen et al, Amer J Sports Med 2001)

- **31 runners, 114 stress fr´s, 3 - 6 each**
- **Training amount 117 kms / week**
- **19 males, 12 females (6 oligomenorhea, 2 amenorhea)**
- **No difference in mean bone mineral density between the pts and controls**
- **In 2 amenorhea pts low (osteoporotic) BMD (more than 2,5 SD from the reference value)**
- **7 treated surgically, 107 conservatively**

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Rest from impact training (average)

- **MT- bones (neck, shaft) 4 weeks**
- **Upper and lower posteromedial tibia 6 weeks**
- **Distal fibula (”runner´s or skater´s fr) 3-4 weeks**
- **Navicular bone 3 months**
- **Femoral neck or shaft 4-6 months**
- **pelvis 1-3 months**

Late dg ---- delayed and non union of stress fracture may occur

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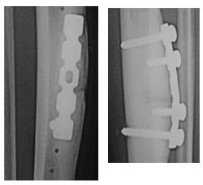
Stress fracture of anterior mid-tibia

- 3-10 % of tibial stress fractures
- Often delayed union or non union
- Surgical treatment often needed:

Orava et al: 1982
Orava et al 1984
Liimatainen, Orava et al 2015

Laminofixation



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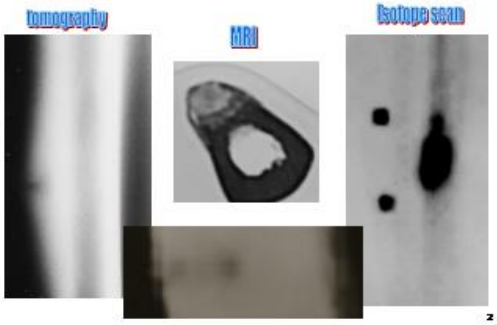
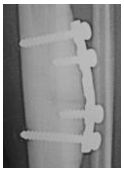
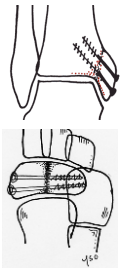
Mid-tibial stress fracture



Surgical treatment of stress fractures

- Femoral neck and femoral shaft
- Anterior mid-tibia
- Distal fibula
- Tarsal navicular
- MTP I sesamoid bones
- Patella
- I.st rib
- Humeral shaft
- Olecranon
- MT V basis
- Medial malleolus





Take home message

BONE STRESS INJURIES – STRESS FRACTURES

- **Relatively uncommon overuse injuries**
- **Diagnosis may be difficult and delayed**
- **Rest and follow-up**
- **Expert consultation, if complications or long lasting symptoms**

Thanks - Kiitos