Porous TTA course

Gian Luca Rovesti

Clinica M. E. Miller - Cavriago - Italy


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Surgical options

Conventional techniques:
aimed to eliminate the drawer sign

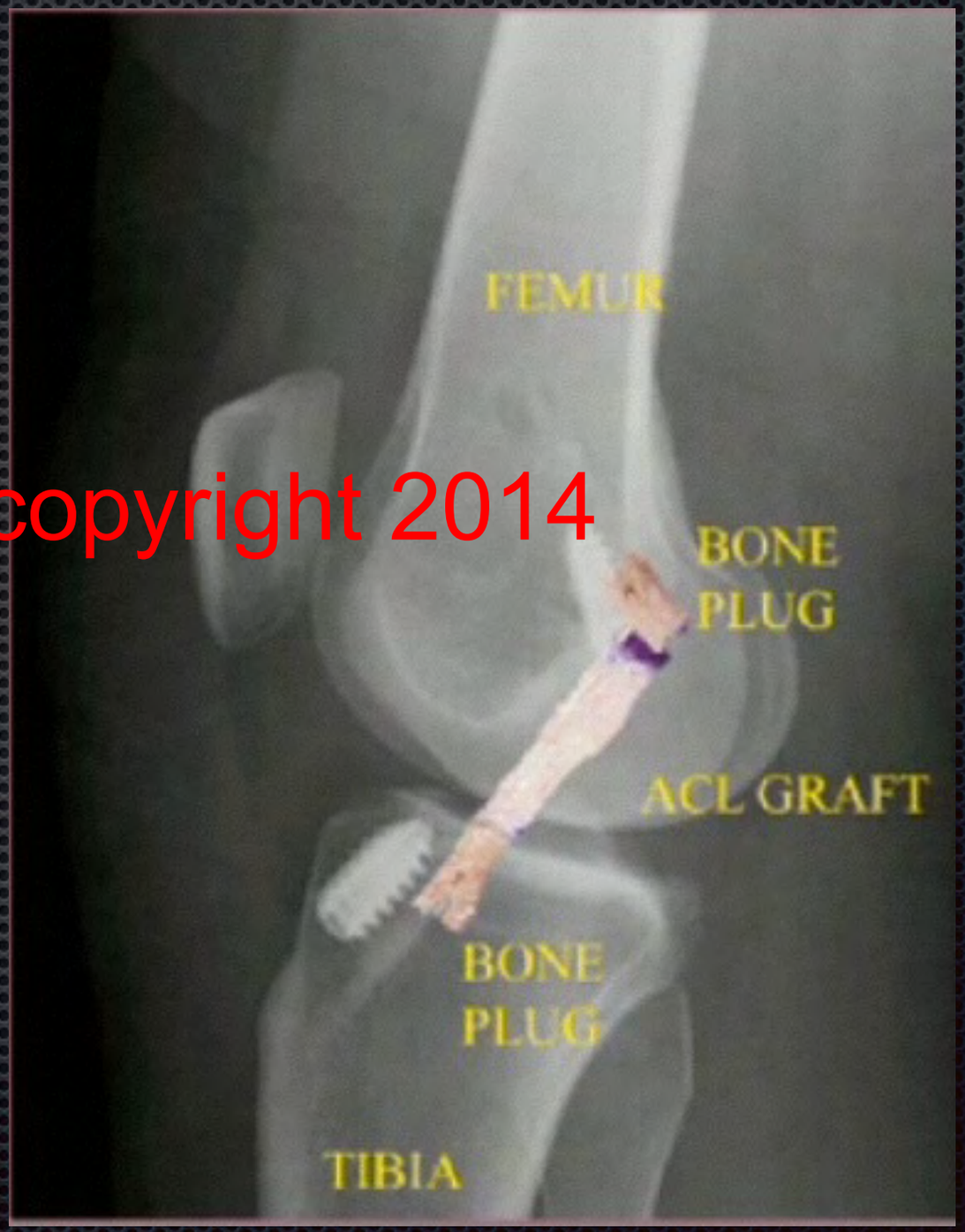
1. Intracapsular
2. Extracapsular

Intracapsular

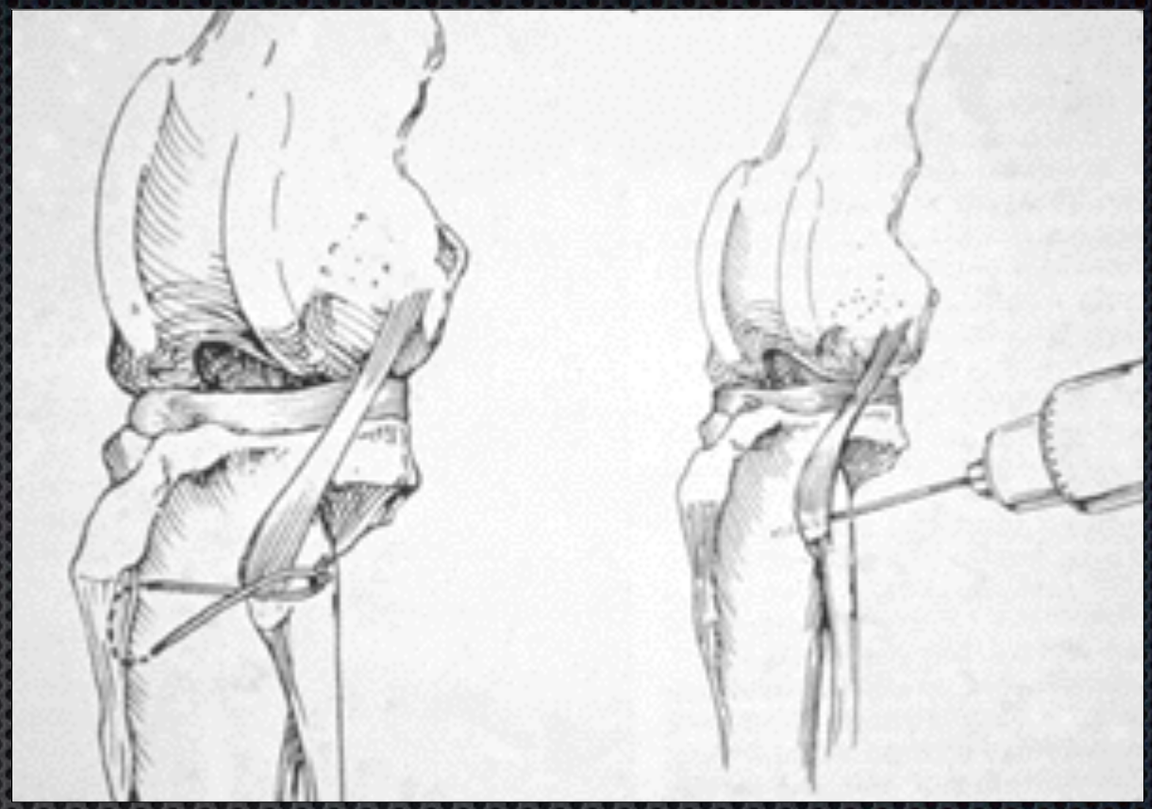
In people

In veterinary patients

- fascia lata (Paatsama)
- over the top



Extracapsular



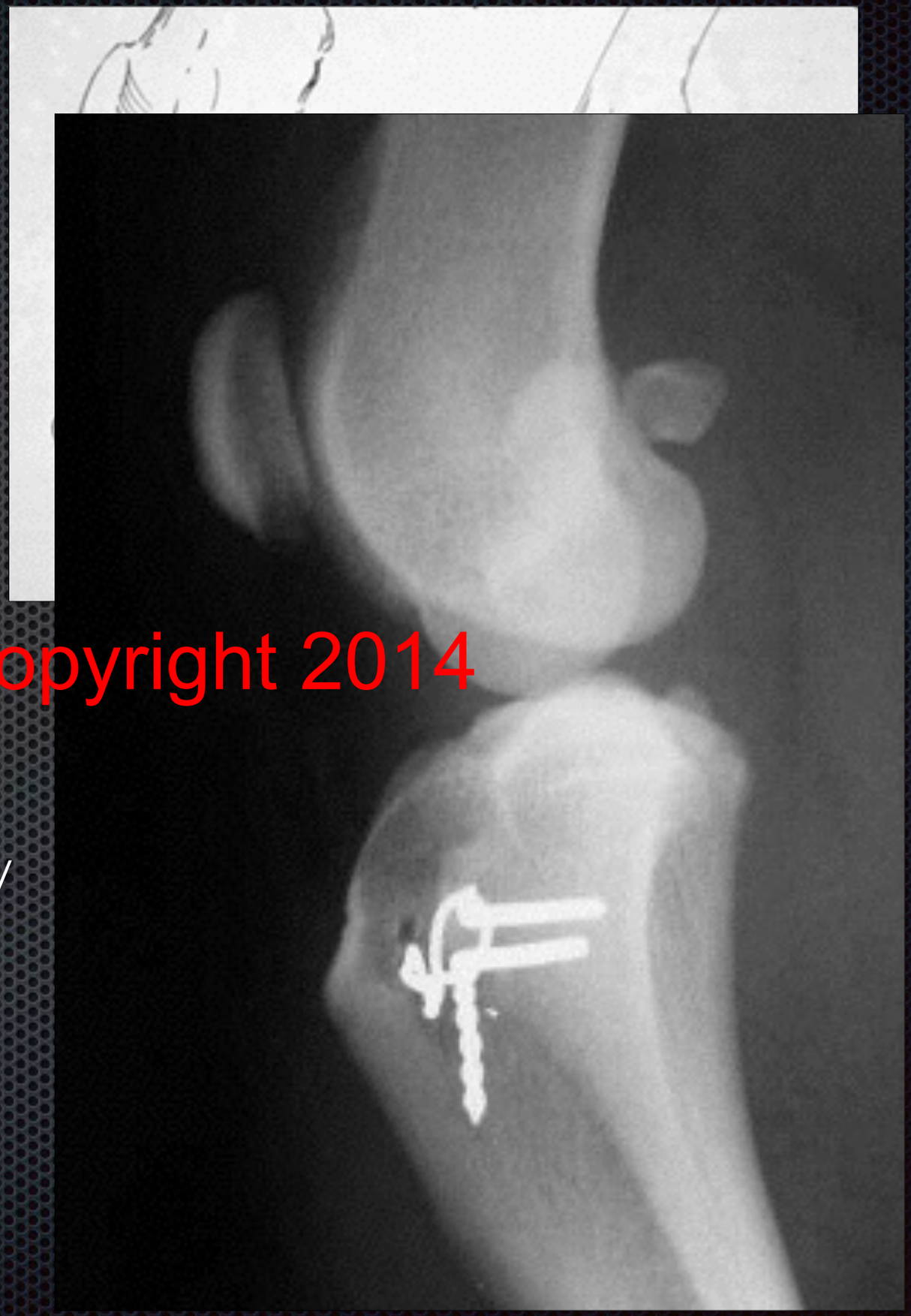
Biological stabilization

- FHT
- Femoral biceps advancement/ embrication

Extracapsular

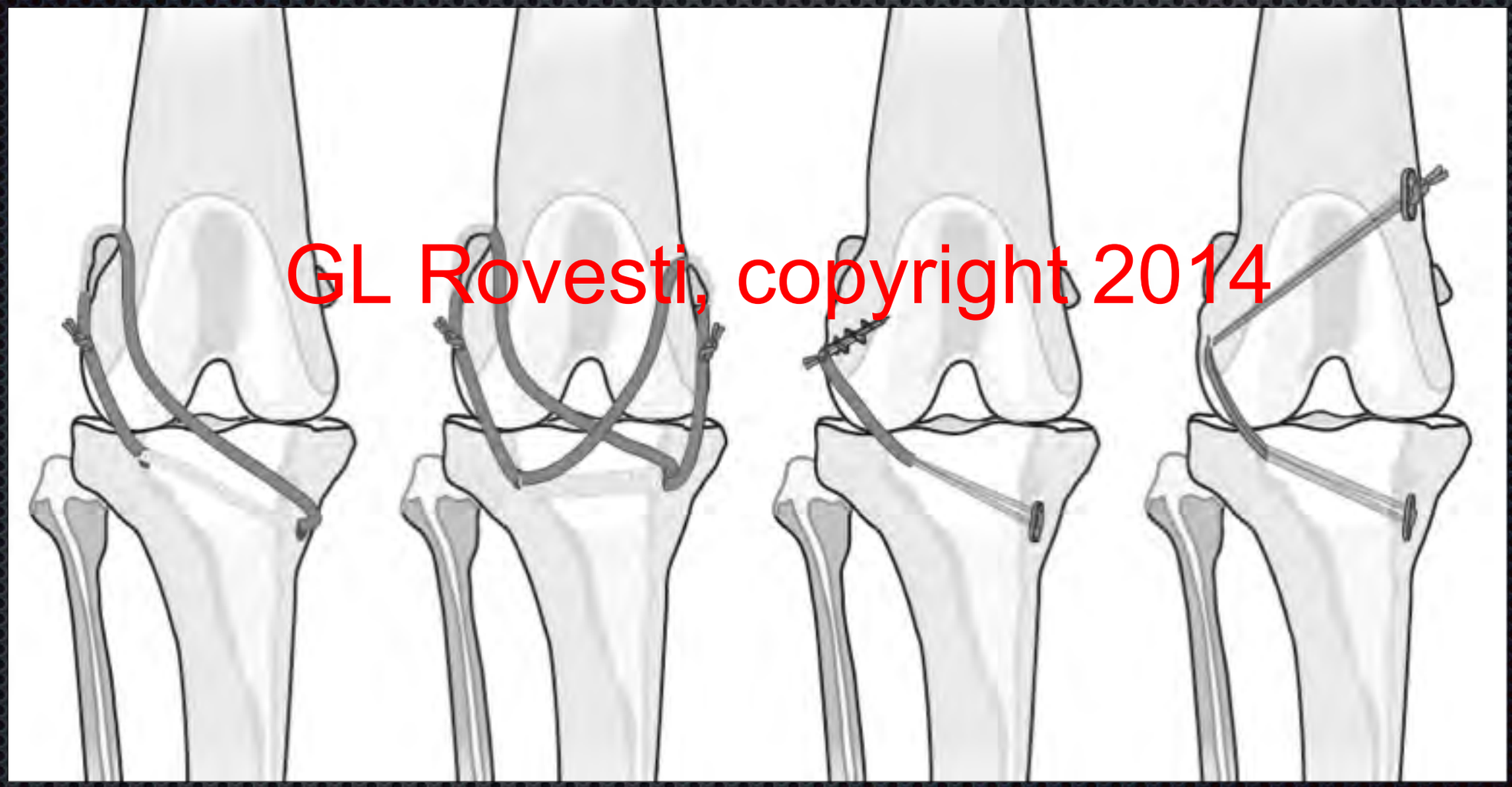
Biological stabilization

- FHT
- Femoral biceps advancement/ embrication



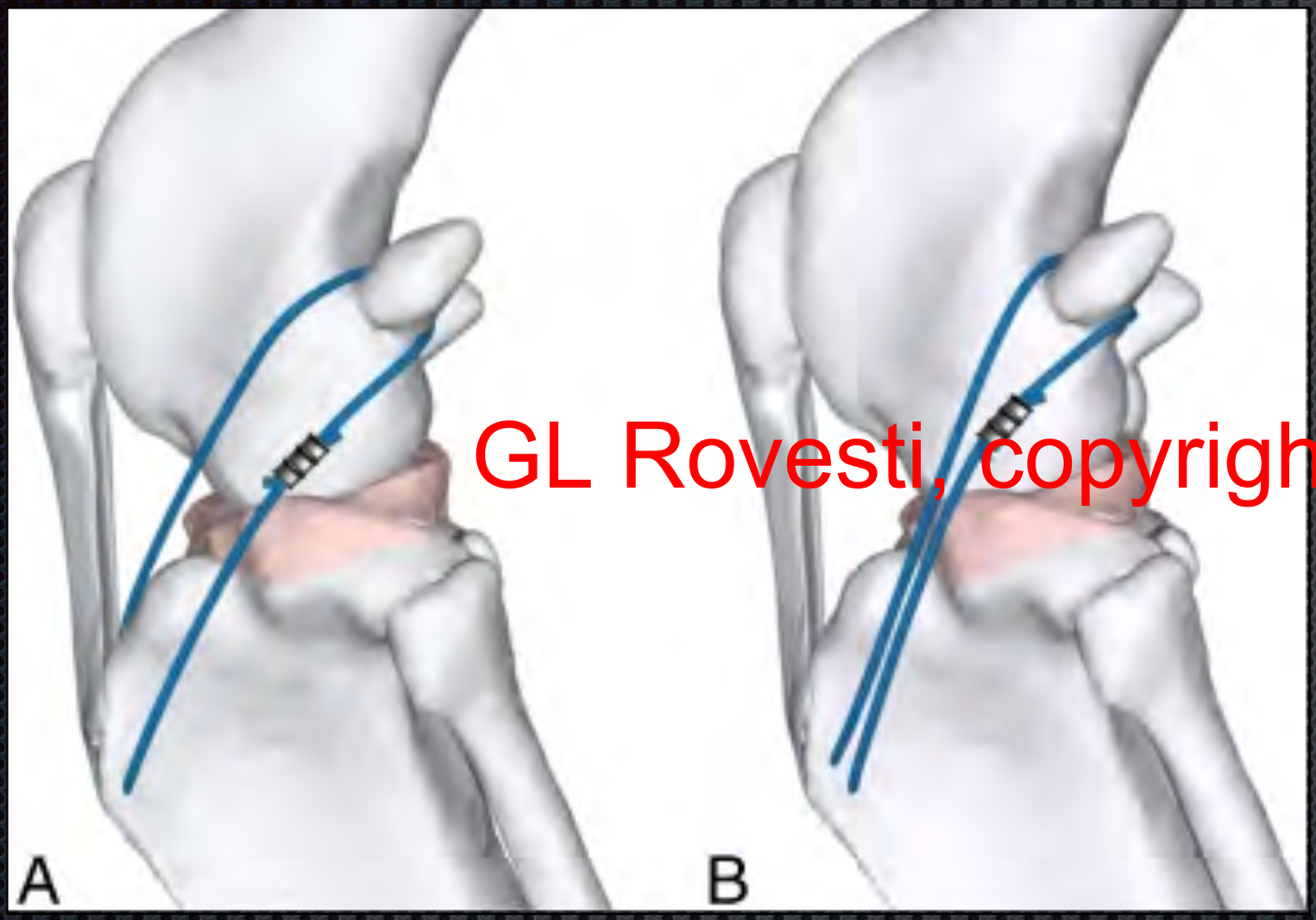
Extracapsular

Synthetic stabilization

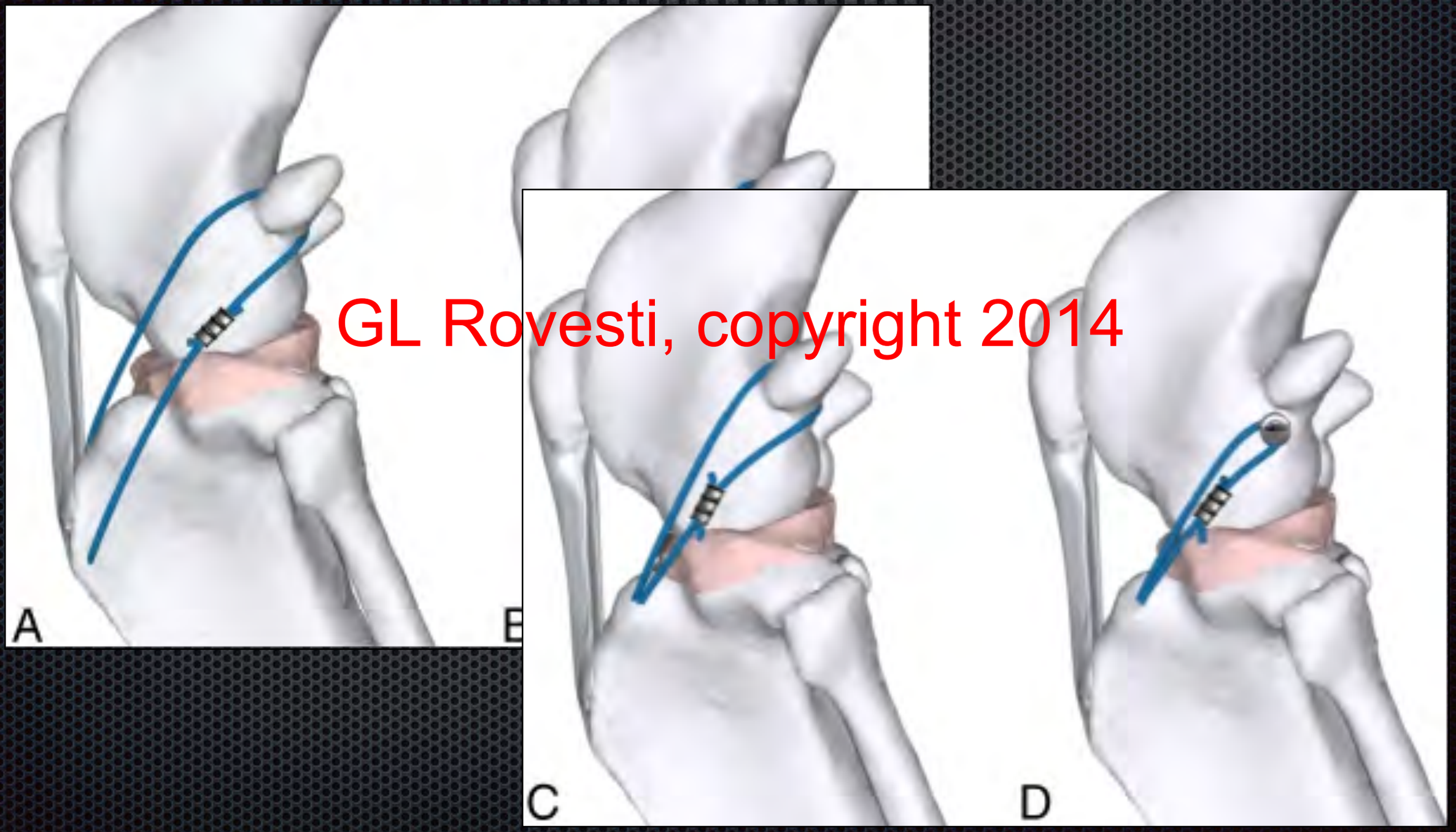


LFTS MRIT LSA TightRope

Isometry?

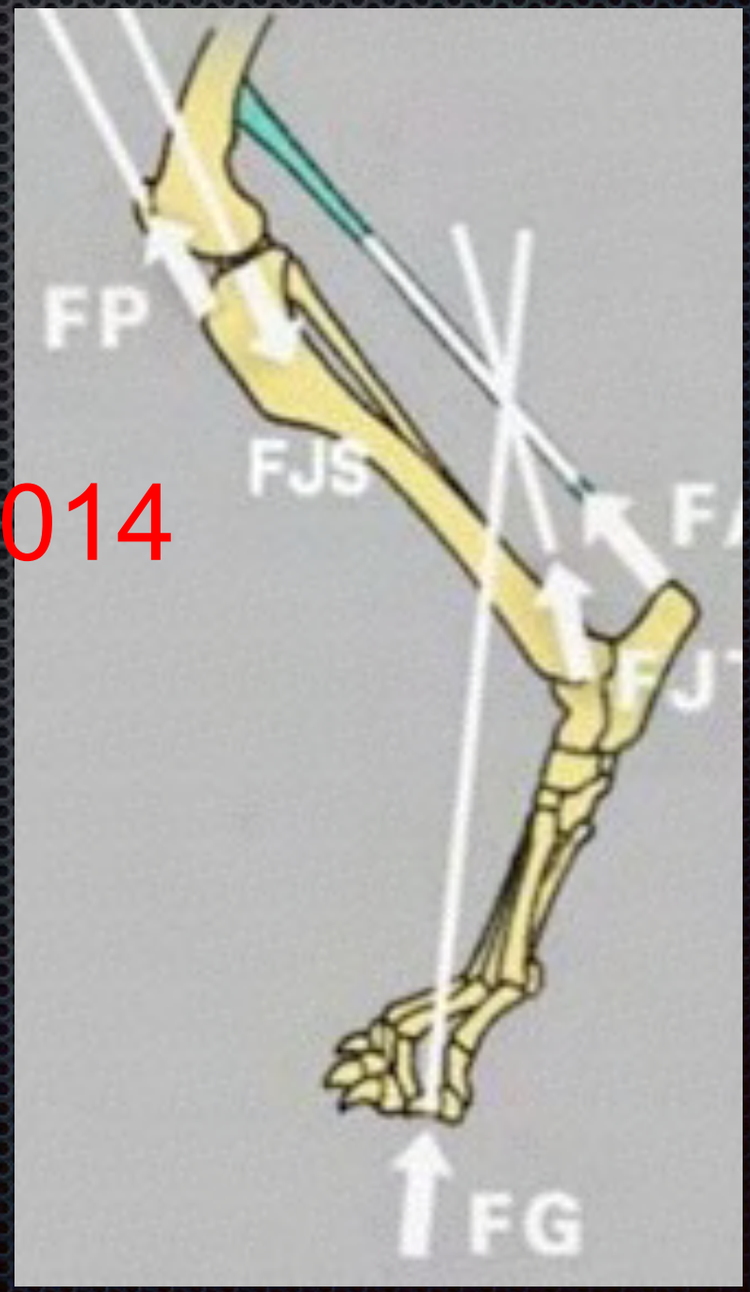


Isometry?



Tibial thrust

- Shows the functional instability of the stifle in the stance phase
- Combines the joint forces (gravity) with the periarticular forces
- Leveling techniques aim neutralizing it



Tibial compression mechanism: a diagnostic aid in stifle injuries. Henderson R, Milton J. JAAHA 14, 474-479, 1978.
Cranial tibial thrust: a primary force in the canine stifle. Slocum B, Devine T. JAVMA 183, 456-459. 1983

Radiographic tibial thrust

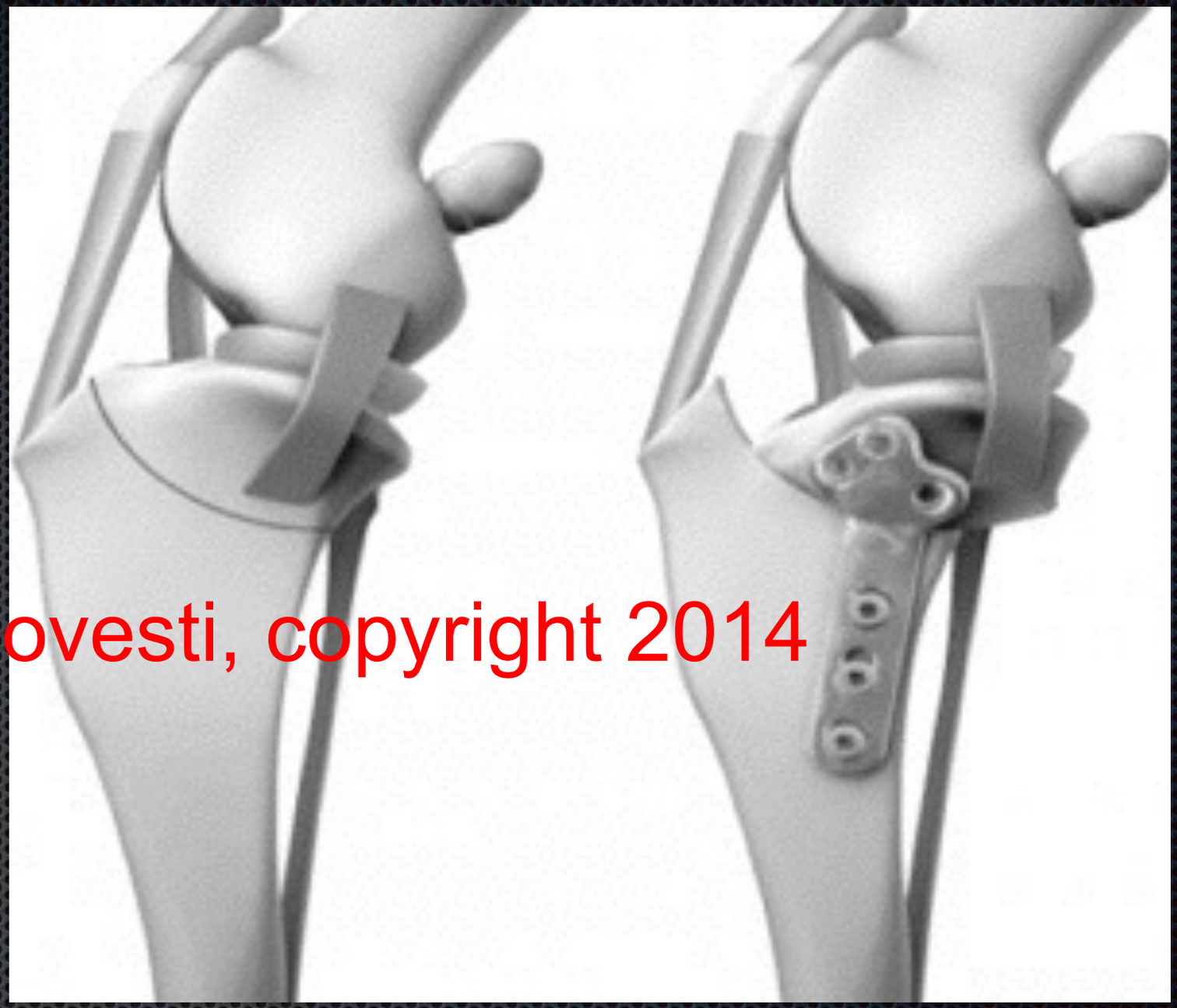
Radiographic tibial thrust

Radiographic tibial thrust

"Concept of dynamic stabilization"

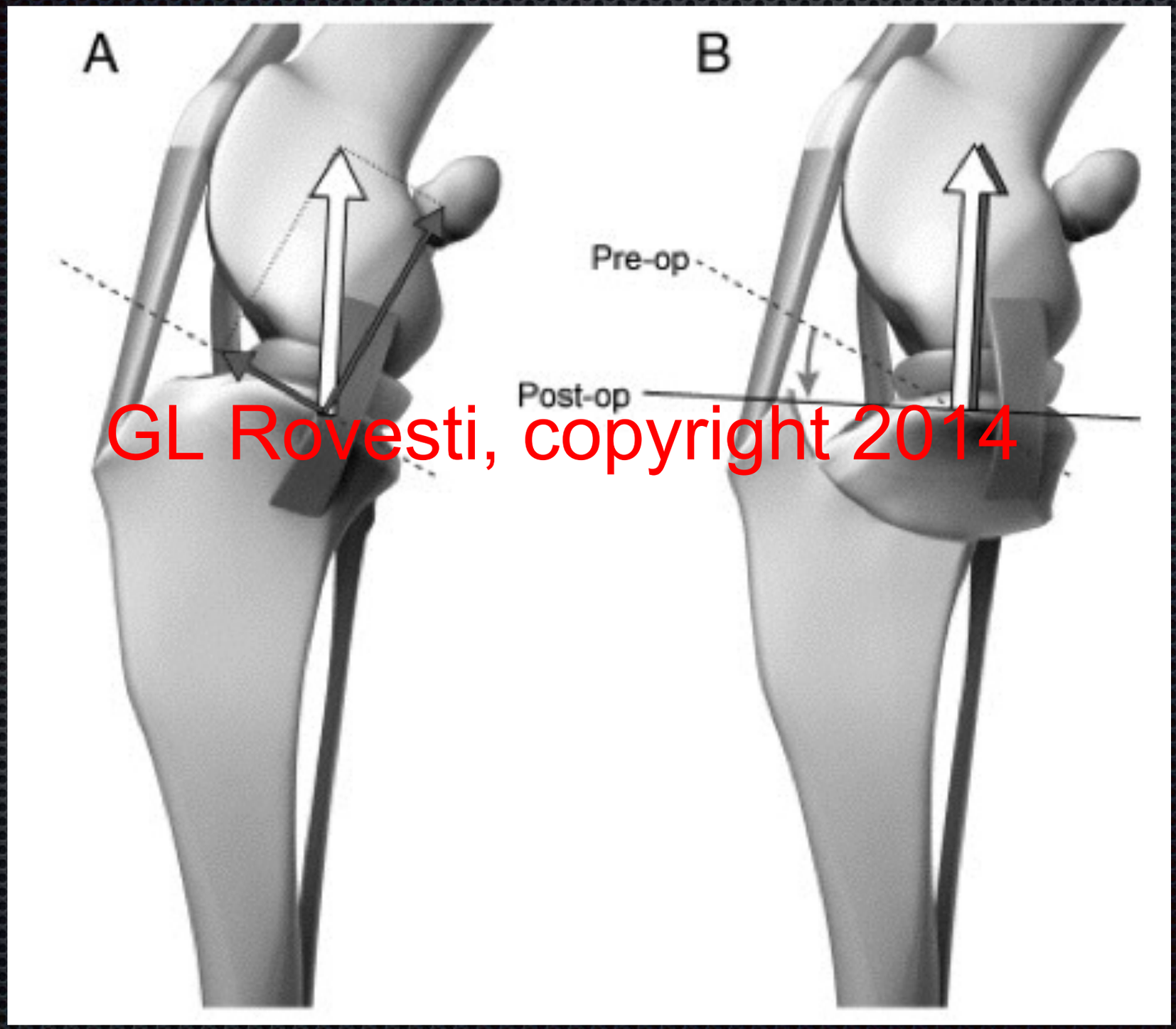
Where the cranial and caudal tibial thrust meet……

TPLO

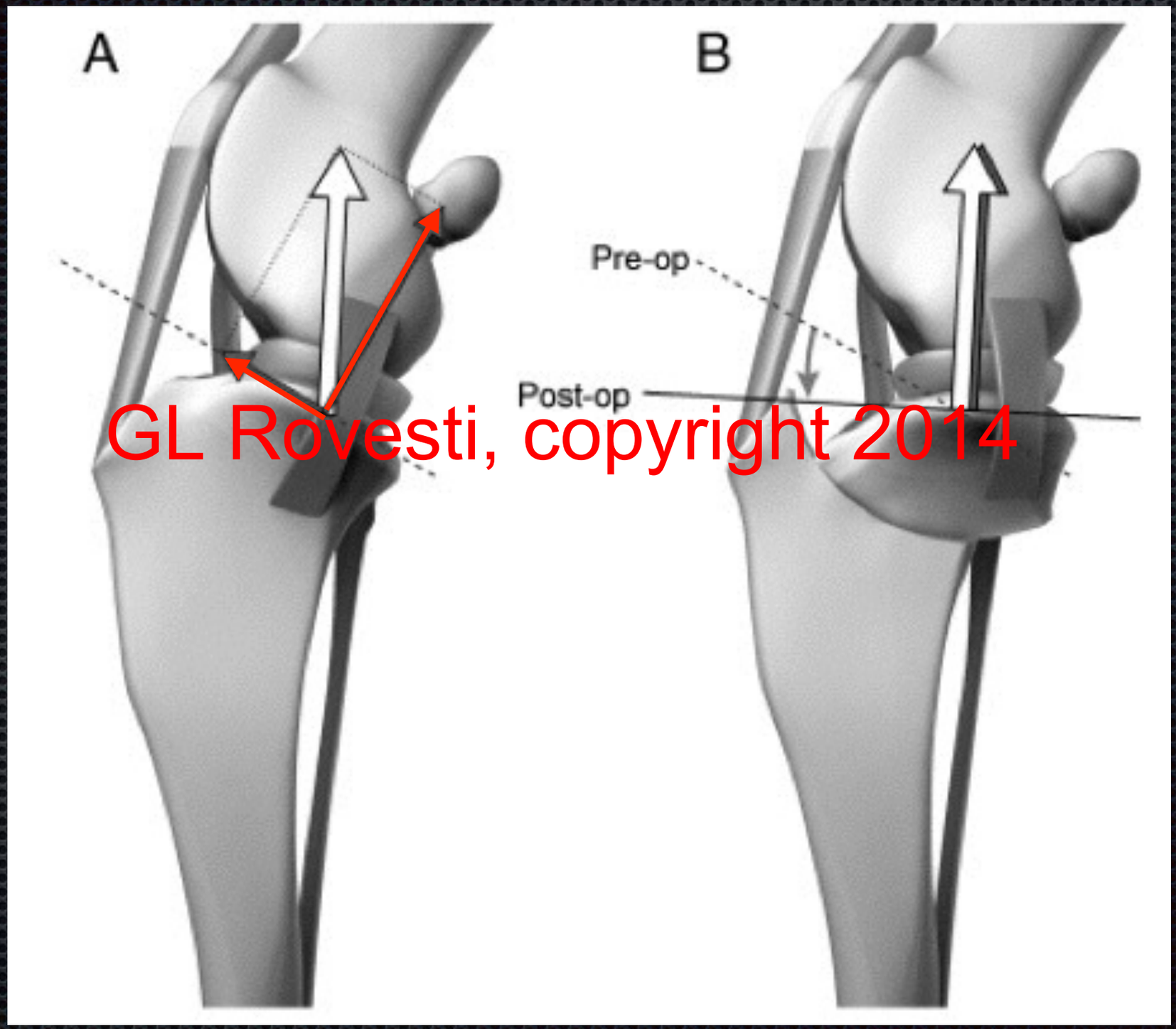


Tibial plateu leveling osteotomy for repair of craneal cruciate ligament rupture in the canine.
Slocum B, Slocum TD, Vet Clin North Am, 23:777-795,1993

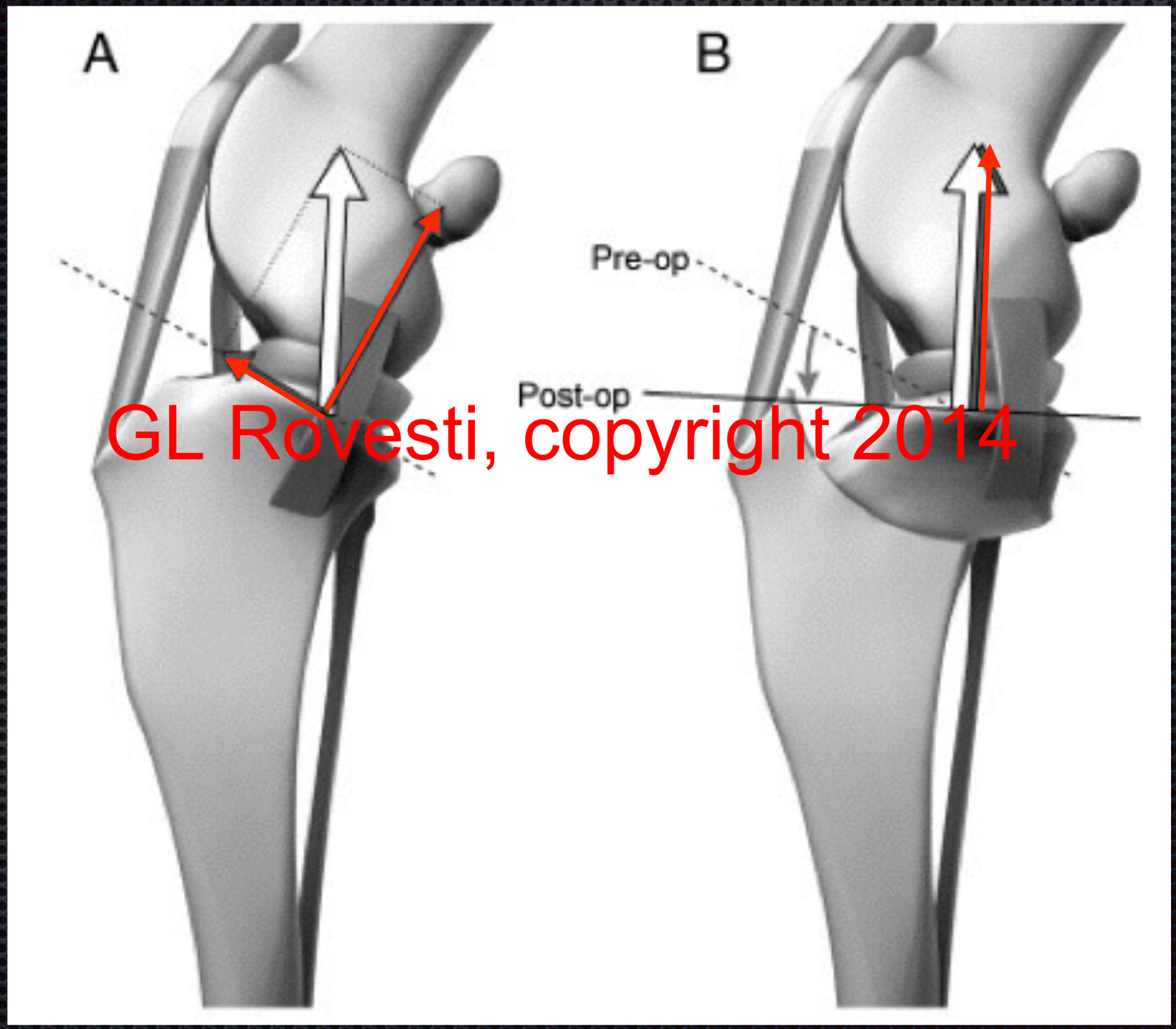
TPLO: biomechanics



TPLO: biomechanics



TPLO: biomechanics

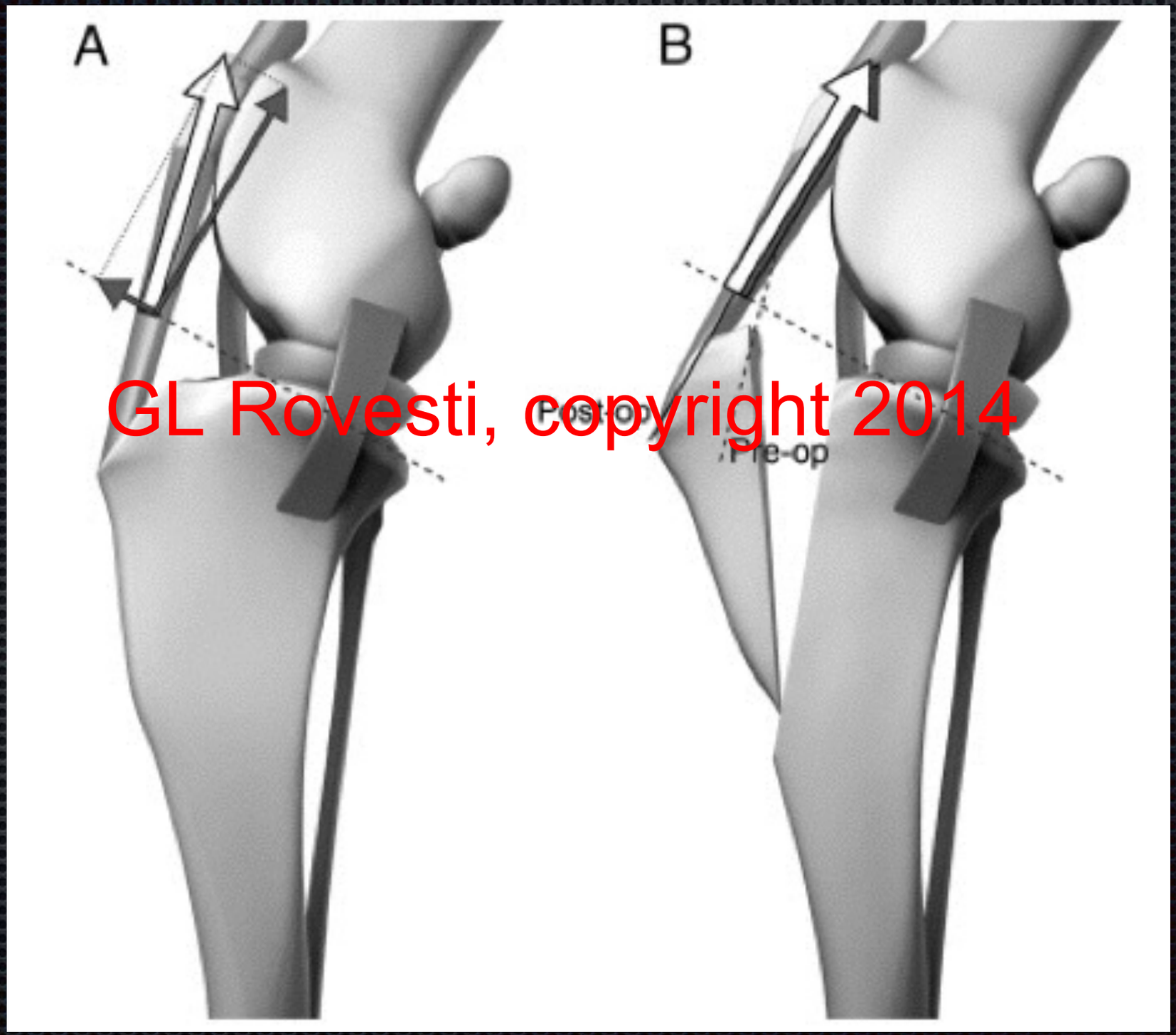


TPLO

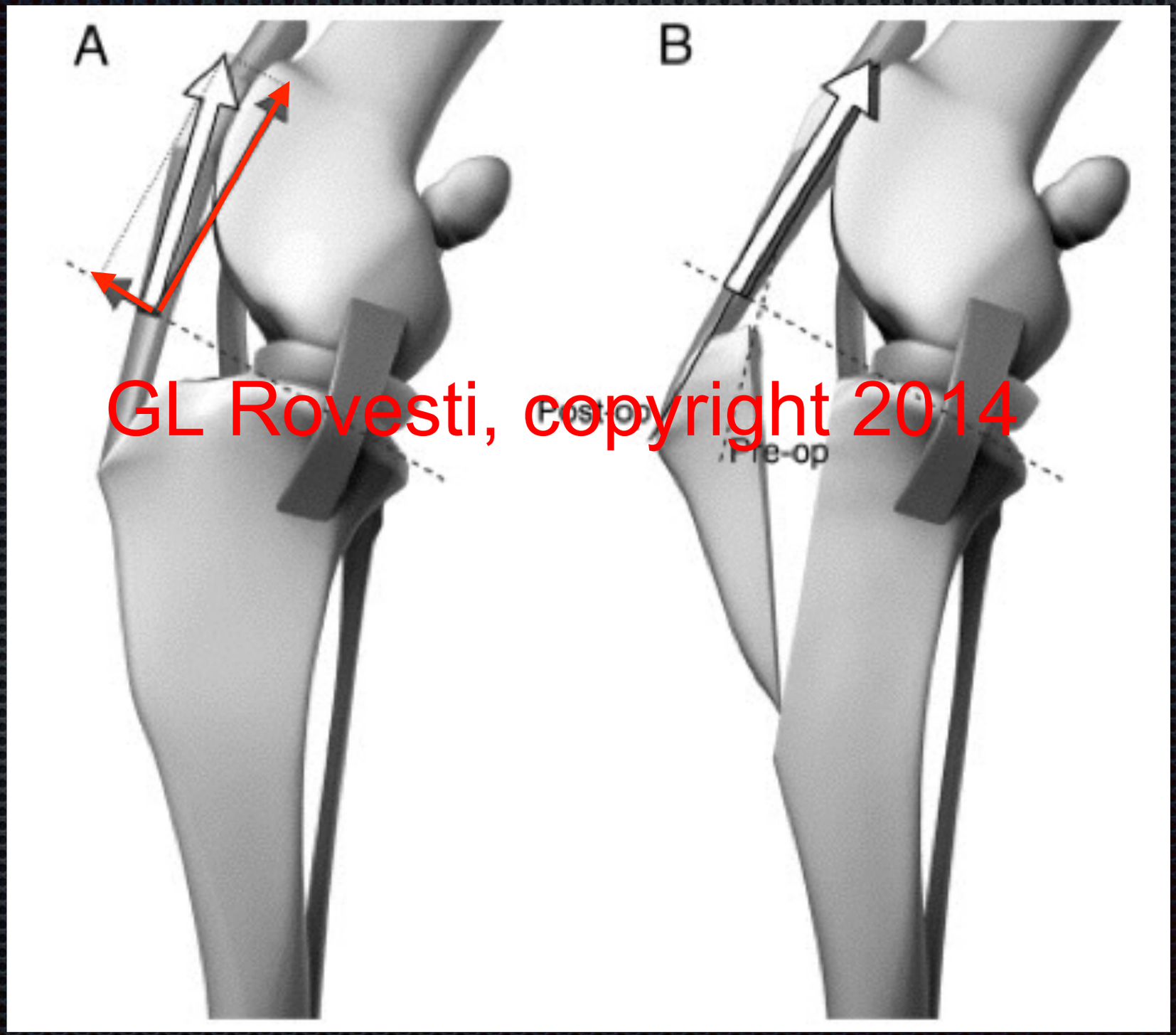
- Changes the cranial TT into caudal
- Needs an intact LCP
- Avoid hypercorrection: TPA 5°-10°

Warzee CC et al. Effect of tibial plateau leveling on cranial and caudal tibial thrust in canine cruciate-deficient stifles: an in vivo experimental study. Vet Surg 2001, 30:278-286

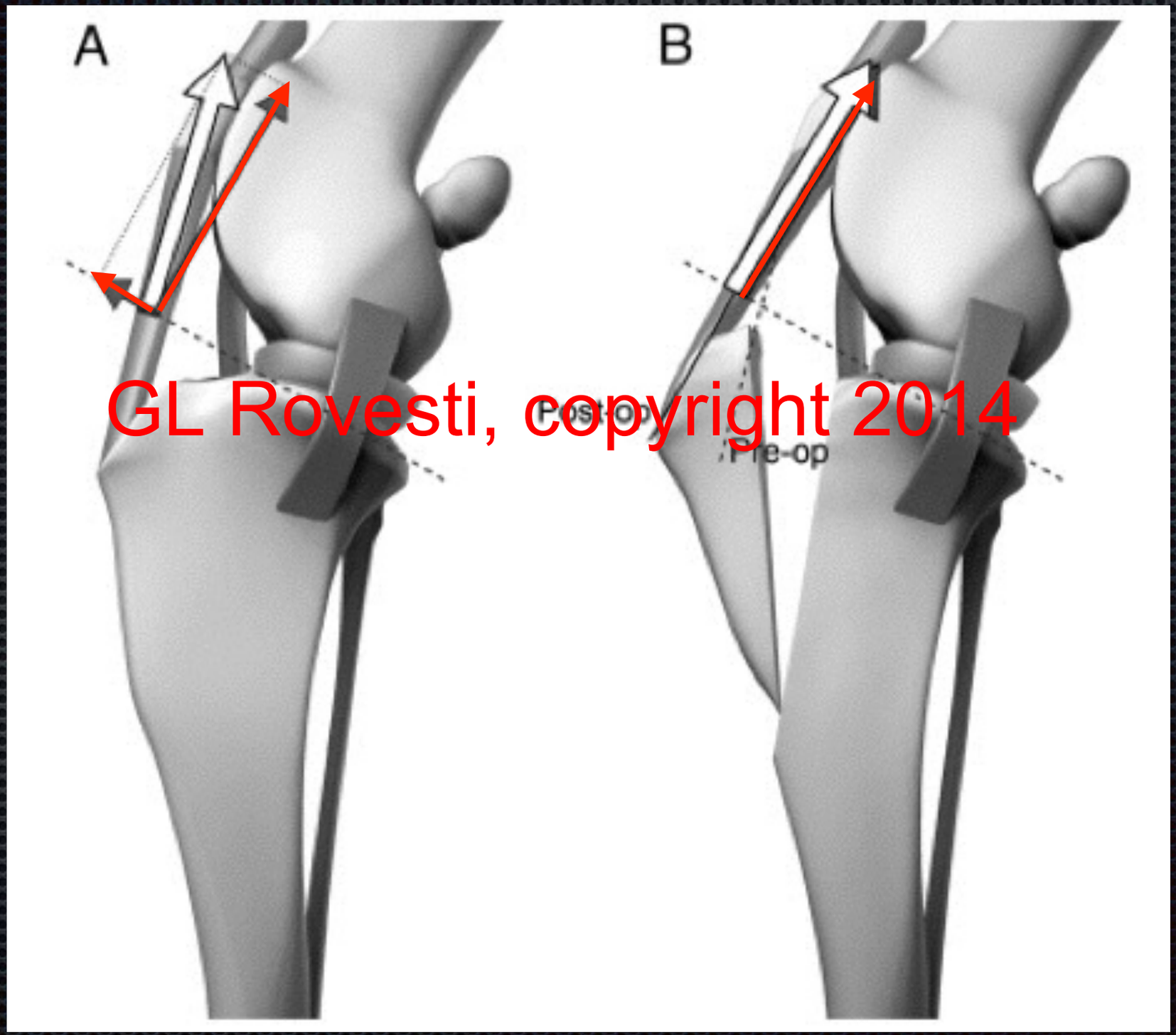
TTA: biomechanics



TTA: biomechanics



TTA: biomechanics



Theoretical pros

- Increases the lever arm by the tibial crest
- Reduces patellar tendinitis
- Better stifle congruency in maximum flexion compared to TPLO
- Reduces meniscal overloading

Boudrieau RJ. TPLO or TTA? Invited Review.
Vet Surg 38:1-22, 2009

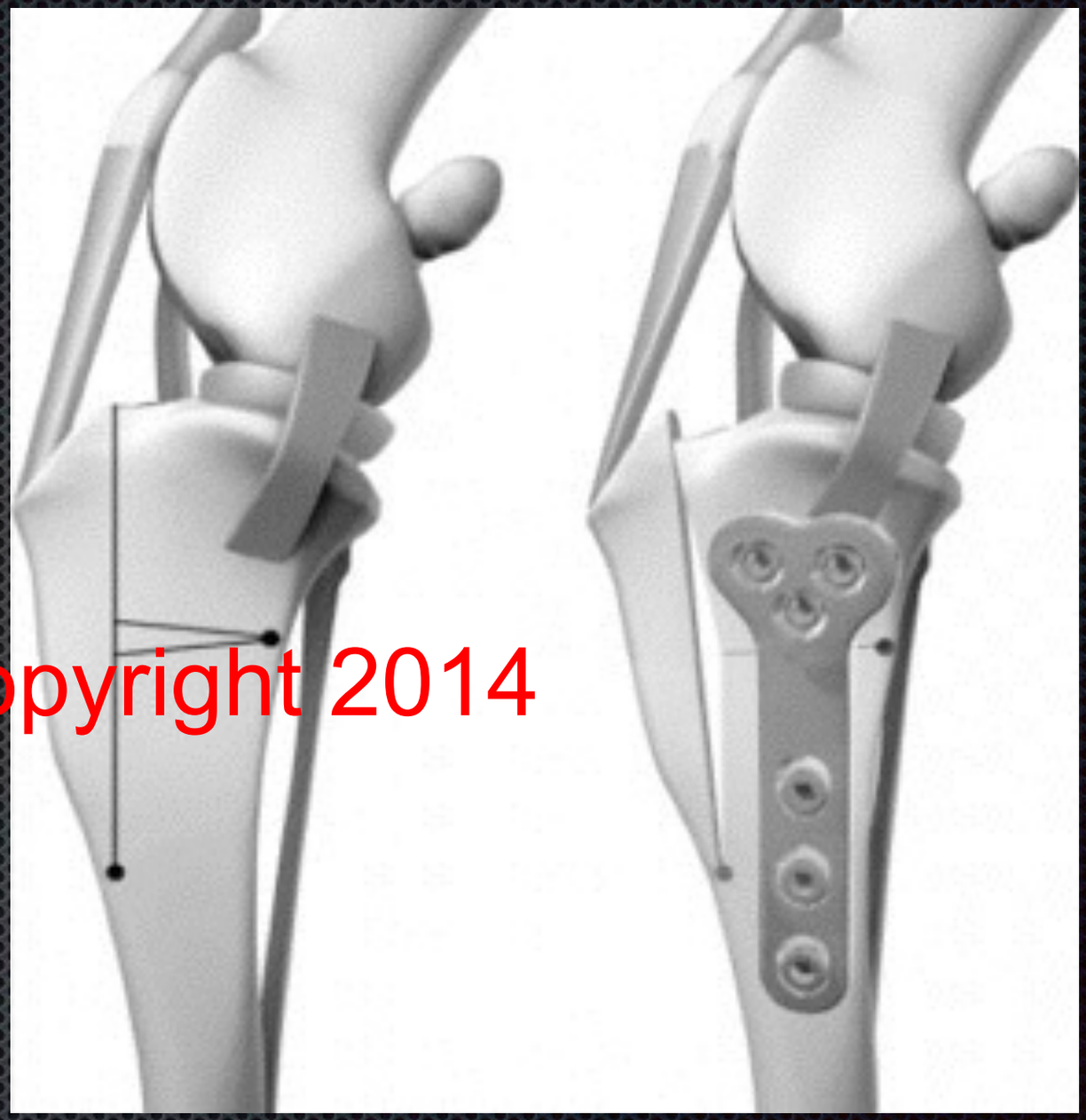
Complications

- Implants rupture
- Tibial crest deviation
- Meniscal damage
- Delayed bone healing

- Tibial tuberosity advancement in 65 canine stifles. Hoffman DE et al, VCOT, 19:219-227, 2006
- TTA for stabilization of CrCL: surgical technique, early results and complications in 101dogs. Lafaver S et al, Vet Surg, 36:573-586, 2007

TTO

- Combination of tibial wedge ostectomy and TTA



Bruce WJ et al. Evaluation of the triple tibial osteotomy.....
VCOT 20:159-168, 2007

CCL and concomitant joint diseases

- menisci
- cartilage
- collateral structures

Evaluation of 100 consecutive stifle arthroscopies

M&M

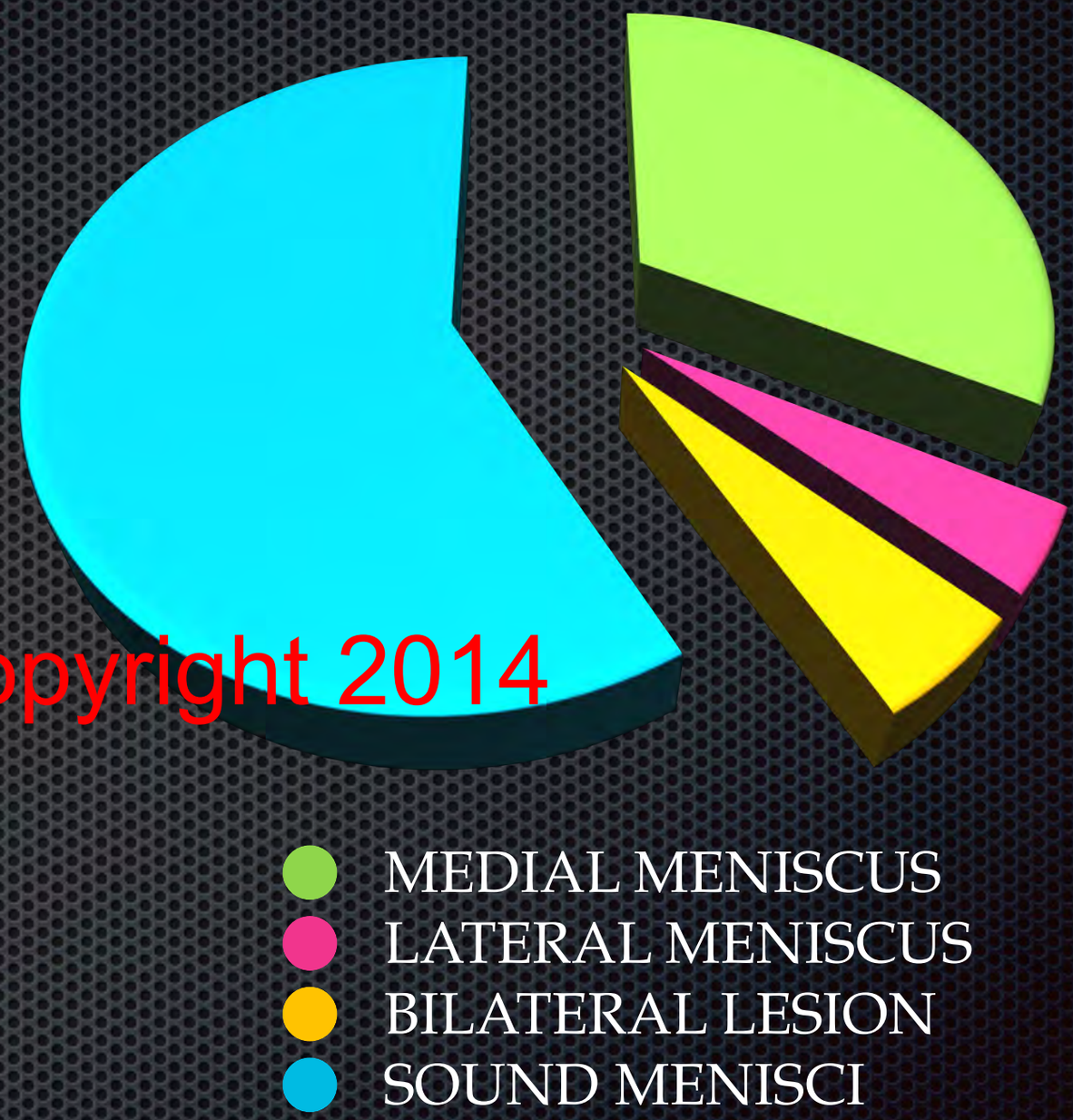
- 100 consecutive stifle arthroscopies (12 bilateral - not same procedure)

- inclusion criteria: every stifle that underwent arthroscopy up to 100 cases (Jan 9th 2009 - April 17th 2012)
- no previous diagnosis of CCL rupture in each case
- joint distraction applied only when needed, not standard

Results

MENISCAL LESIONS:
29% medial meniscus
3% lateral meniscus
5% bilateral

(including every degree of severity or structure change)

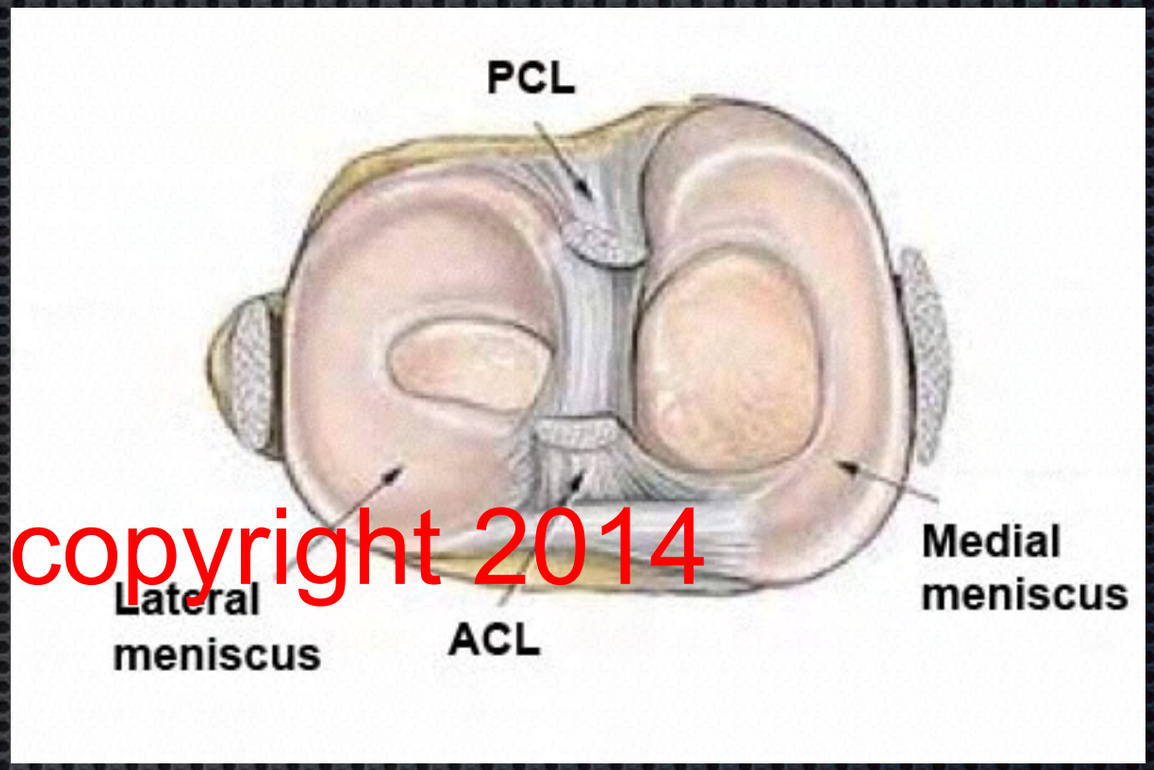


Results

CARTILAGE LESIONS

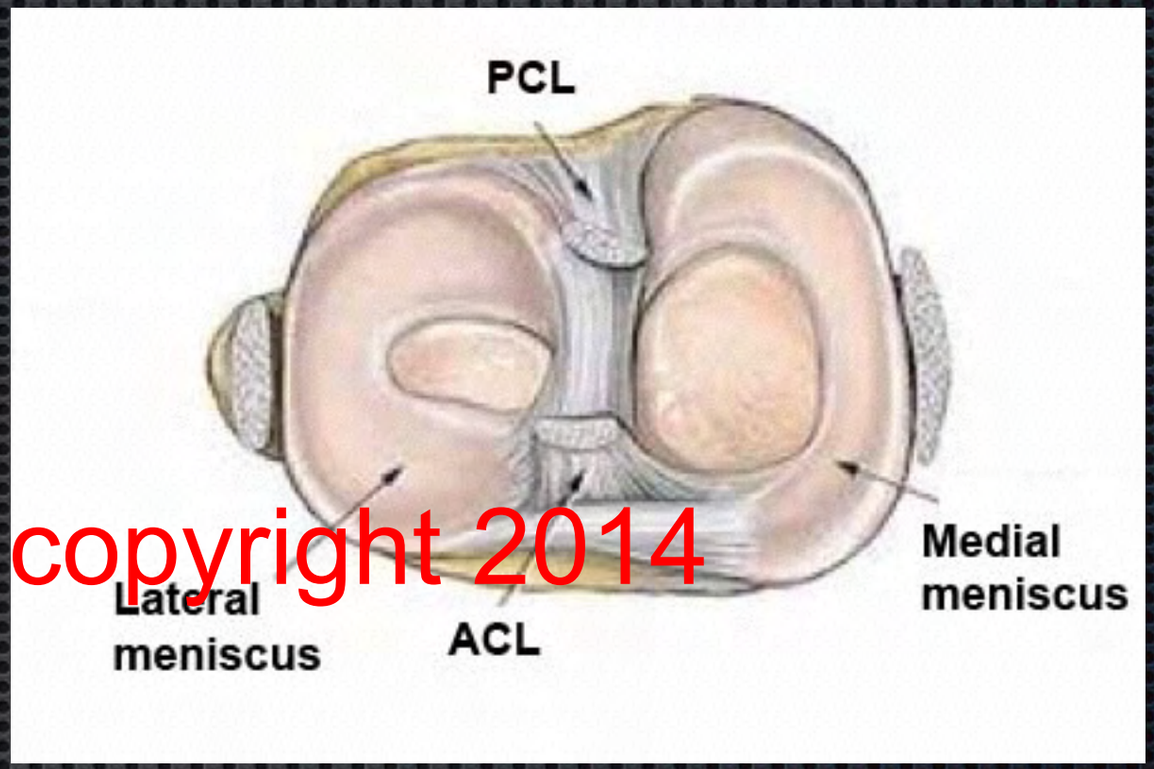
- Isolated cartilage lesions 1
- Cartilage lesion + meniscal lesion 5

Menisci



- Most meniscal lesions are associated to a CCL lesion, while isolated lesions are rare (Flo GL 1993; Luther JK 2009)

Menisci



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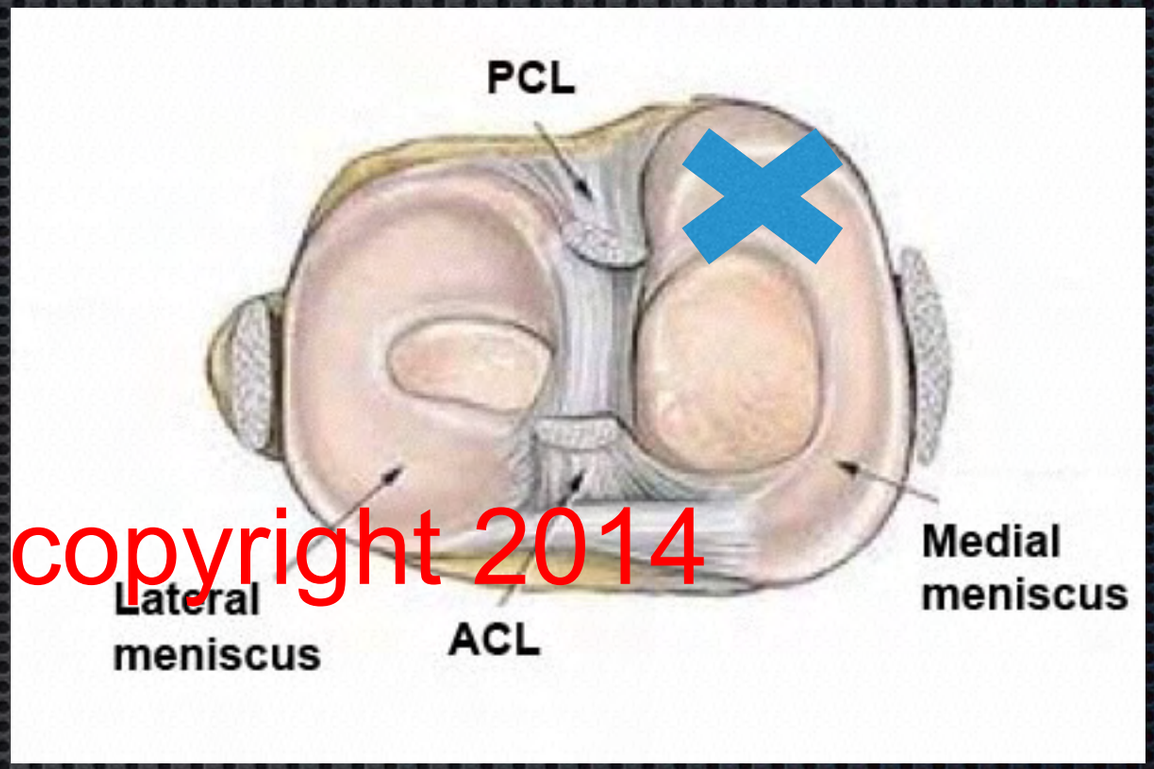
Menisci



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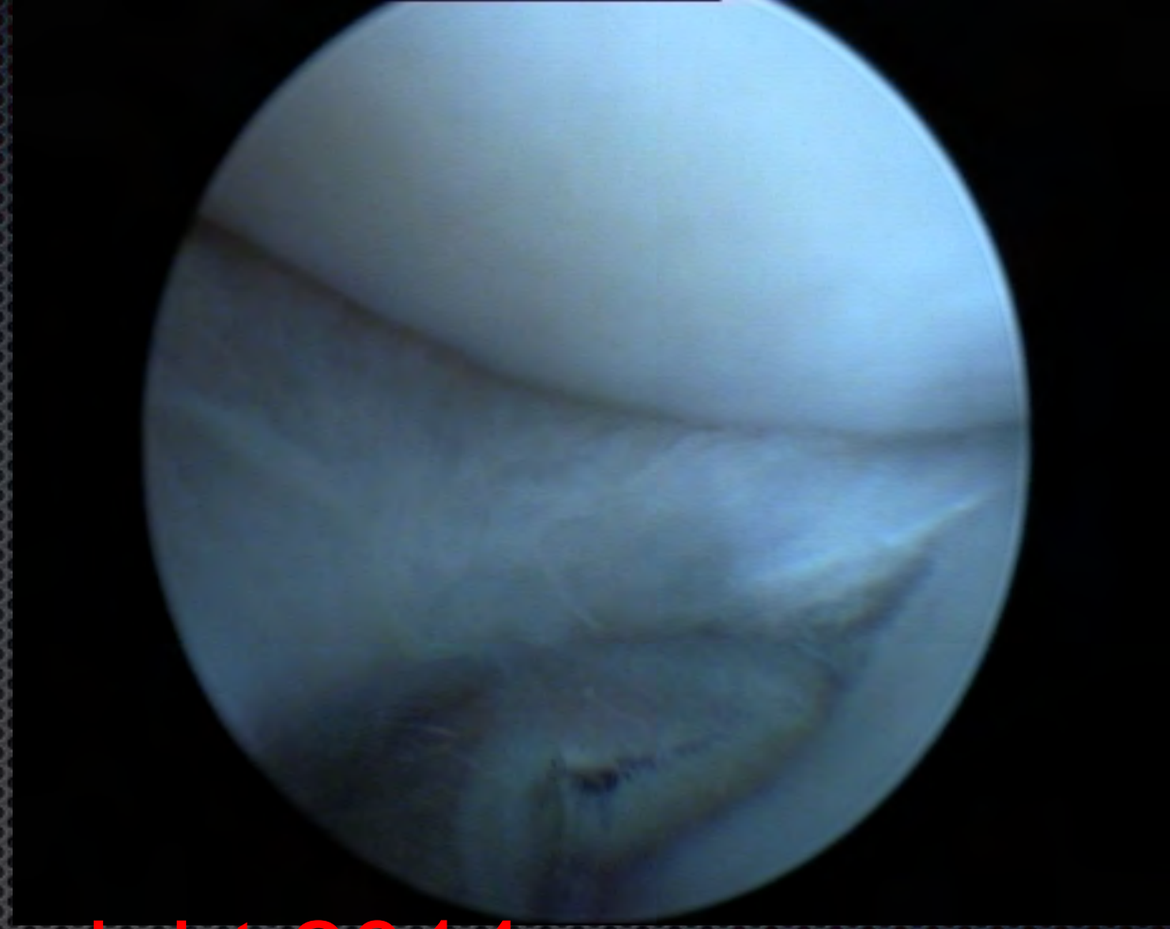
Medial meniscus lesions



- Radial: 19
- Bucket handle: 6
- Complex: 7
- Discoid meniscus: 2

- 85% of medial meniscus lesions involve the caudal horn
- Two isolated meniscal lesions in patients already operated on for CCL rupture

Lateral meniscus lesions

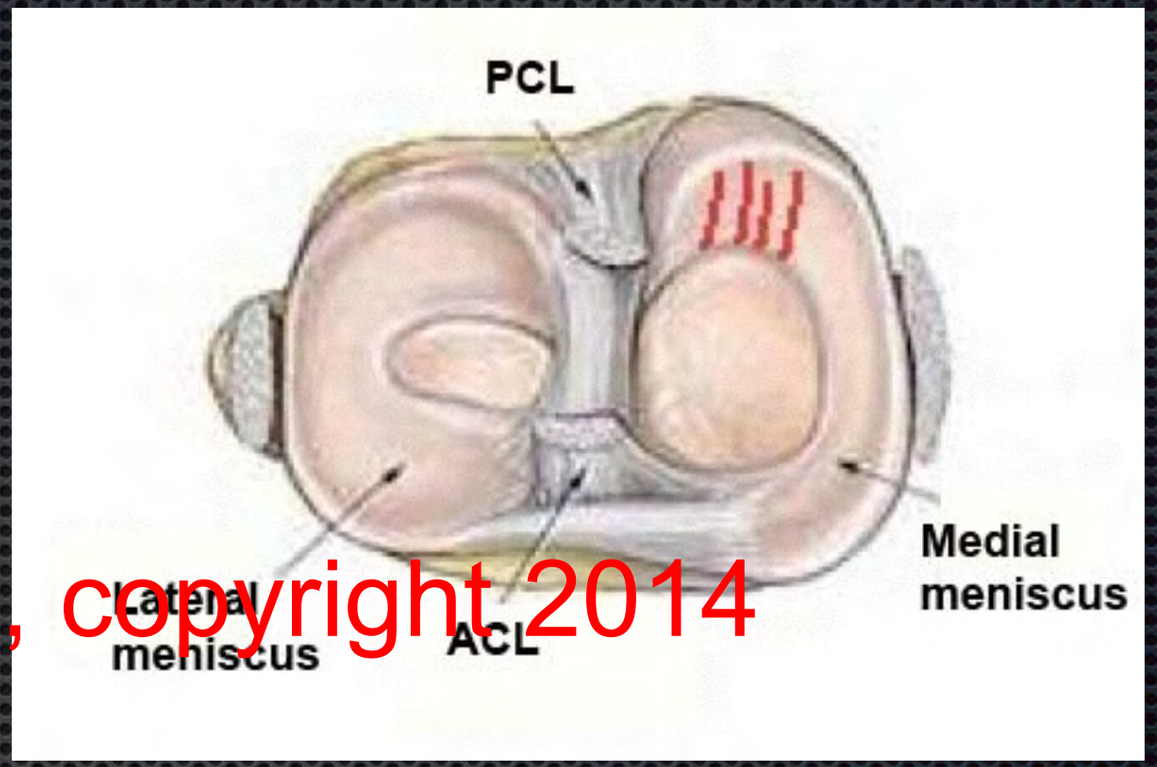
- Radial: 6
- Bucket handle: 3

- Discoid meniscus: 1

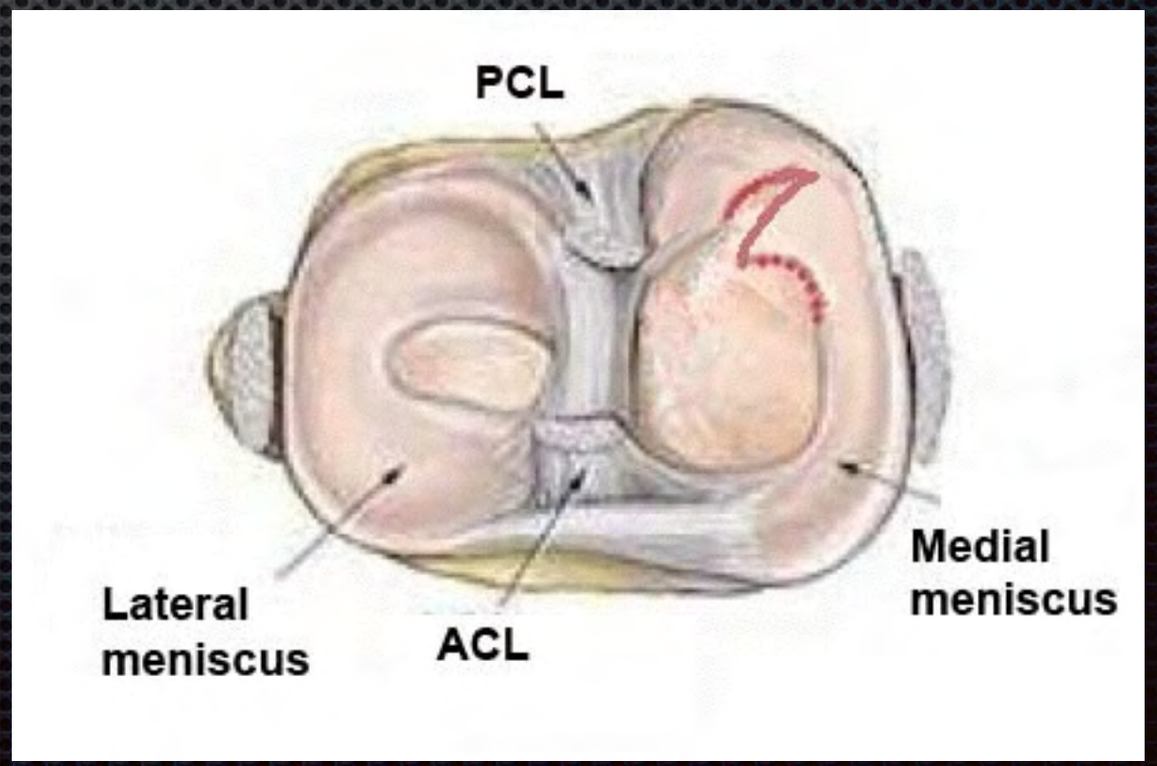
- Most of lateral meniscus lesions involve the small curvature

Classification of meniscal lesions

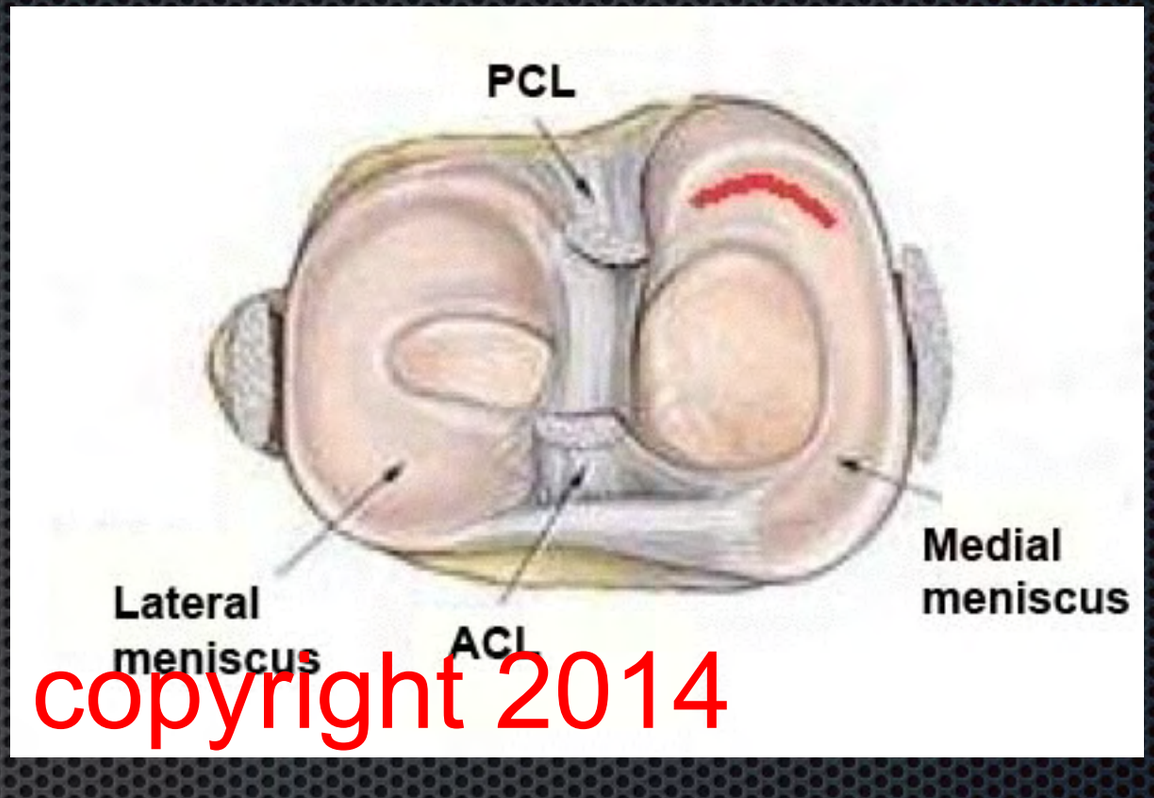
- RADIAL LESIONS



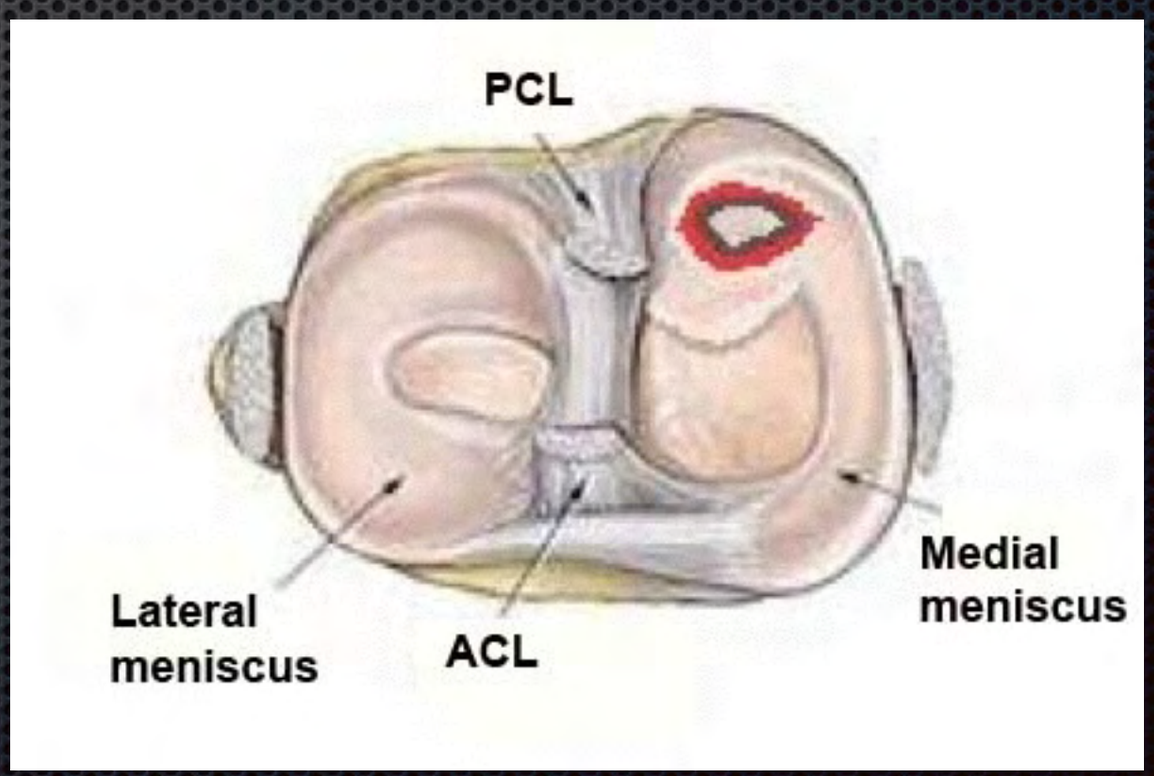
- FLAP



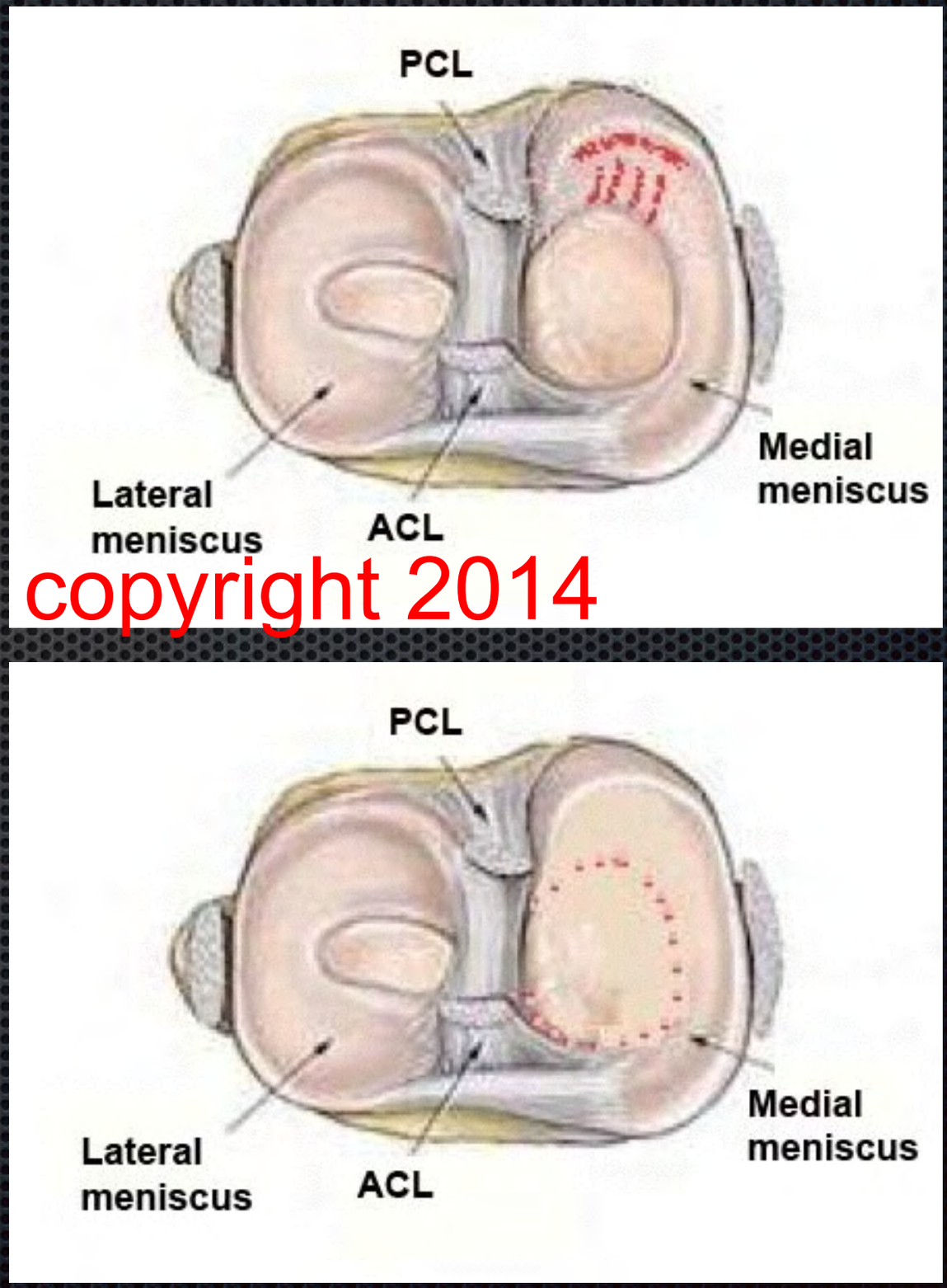
- VERTICAL-LONGITUDINAL



- BUCKET-HANDLE LESIONS



- COMPLEX
  - HORIZONTAL
  - COMPRESSION



- DISCOID MENISCUS
- congenital anomaly

Cartilage lesions

Treatment of cartilage lesions?

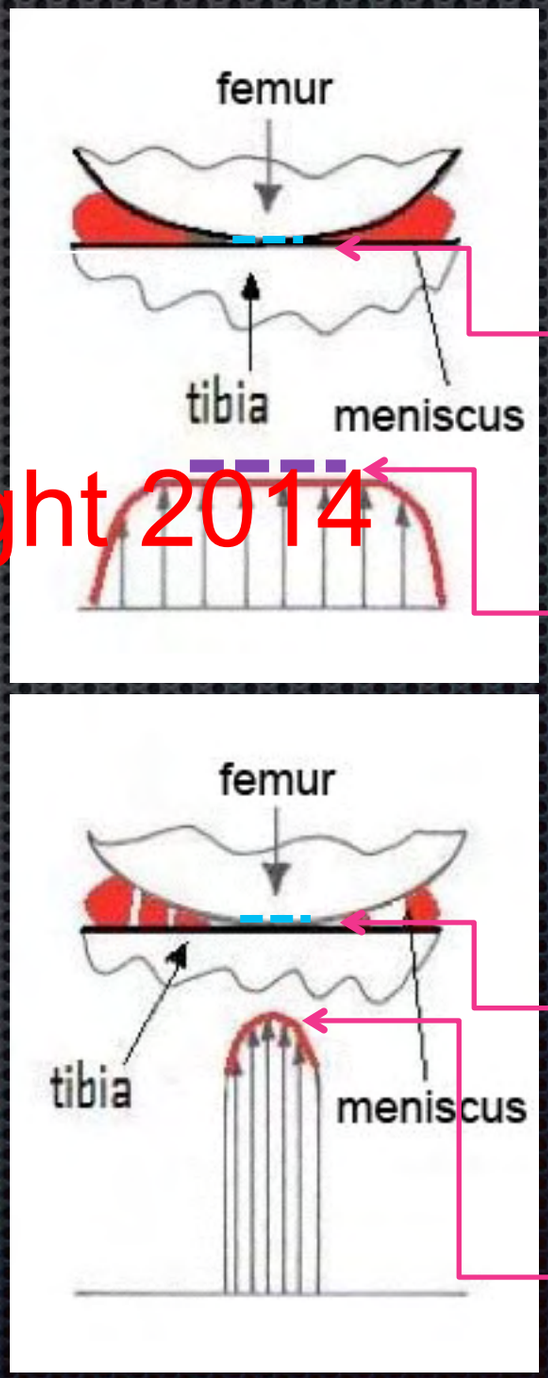
- Platelet growth factors
  - autologous blood
  - sodium citrate

- centrifugation 460 G for 8 minutes
- 1/2 surnatant
- CaCl 10% 5% in volume of plasma

- lesion curettage
- staminal cells of fat origin

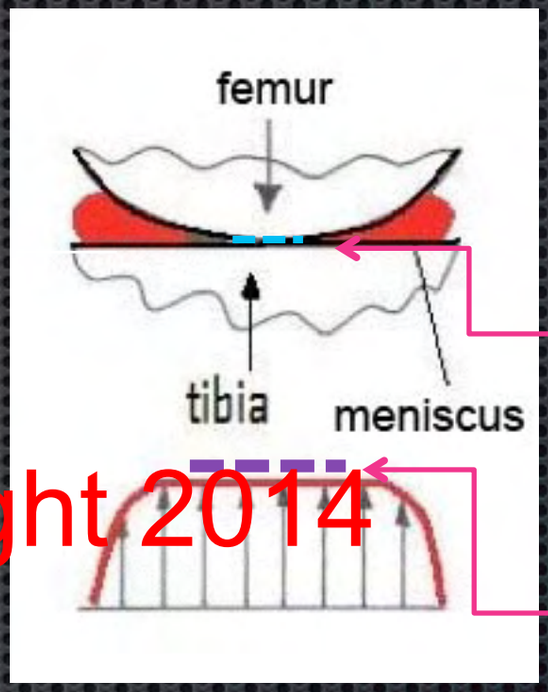
- autologous osteochondral grafts
- meniscal transplantation

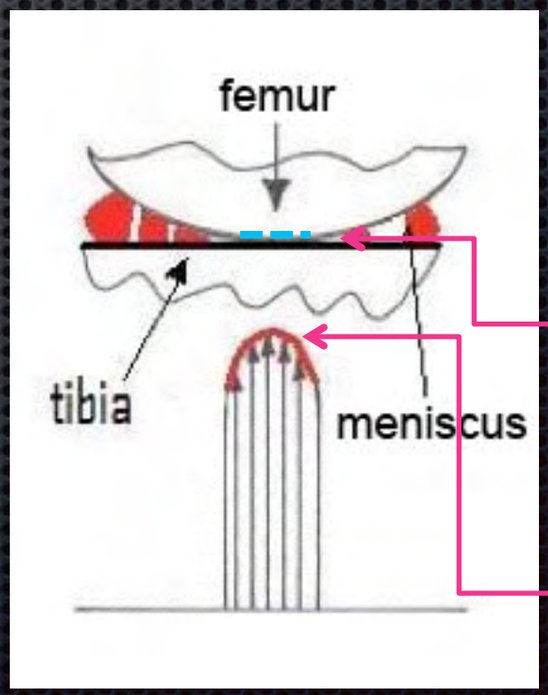
Meniscal lesion: treatment?



Meniscal lesion: treatment?

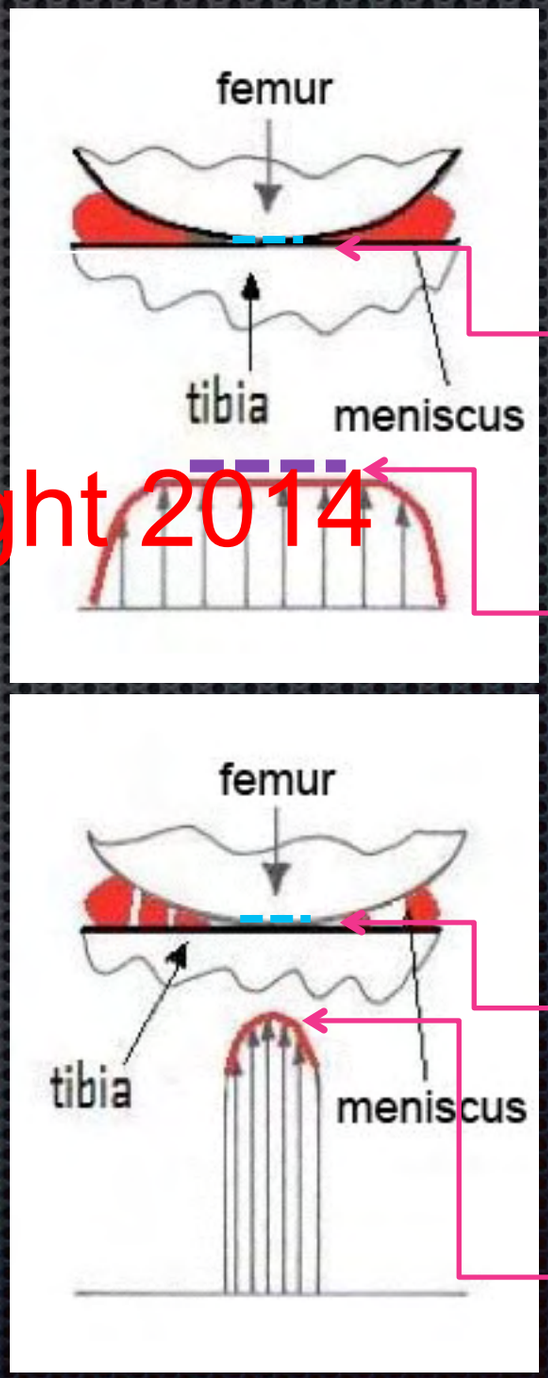
- Bucket handle lesions show a decrease in CA





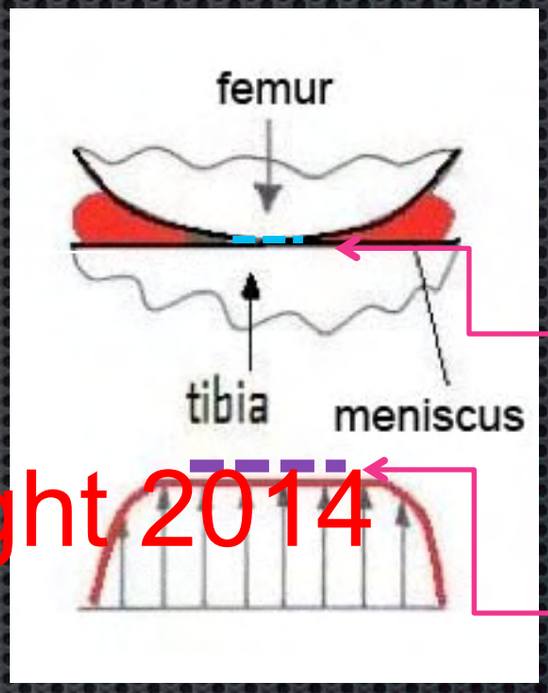
Meniscal lesion: treatment?

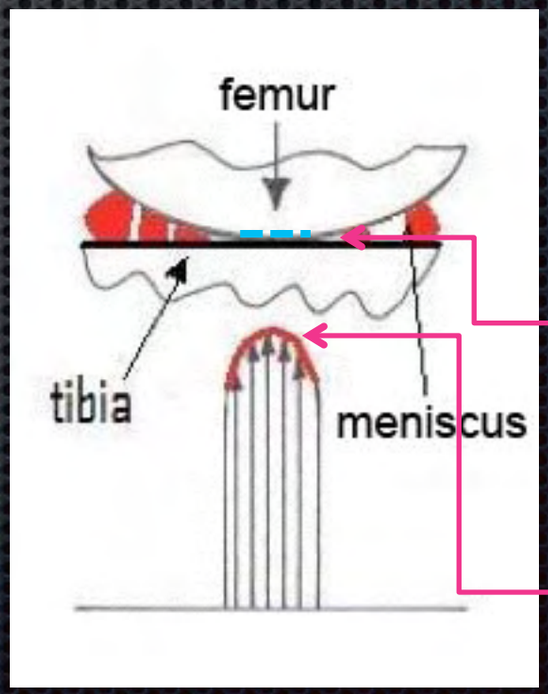
- Bucket handle lesions show a decrease in CA
- Radial and vertical lesions don't show any difference in PCP



Meniscal lesion: treatment?

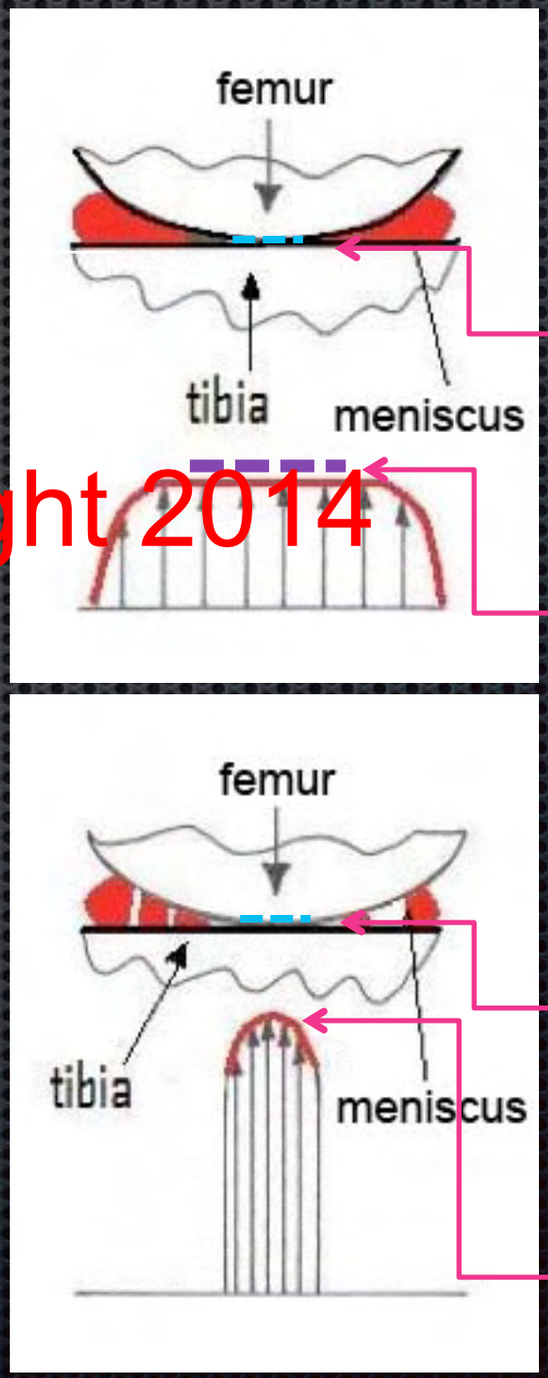
- Bucket handle lesions show a decrease in CA
- Radial and vertical lesions don't show any difference in PCP
- Bucket handle, flap and complex lesions: > 45% PCP in the medial joint compartment





Meniscal lesion: treatment?

- Bucket handle lesions show a decrease in CA
- Radial and vertical lesions don't show any difference in PCP
- Bucket handle, flap and complex lesions: > 45% PCP in the medial joint compartment
- They should be treated (Thieman K.M. , Pozzi A. 2009)



Joint distraction

Meniscal suture

- MENISCAL SUTURE (Cook & Fox 2007; Luther et al. 2007; Thieman et al. 2010)
- OUT-IN-OUT TECHNIQUE

Meniscal suture

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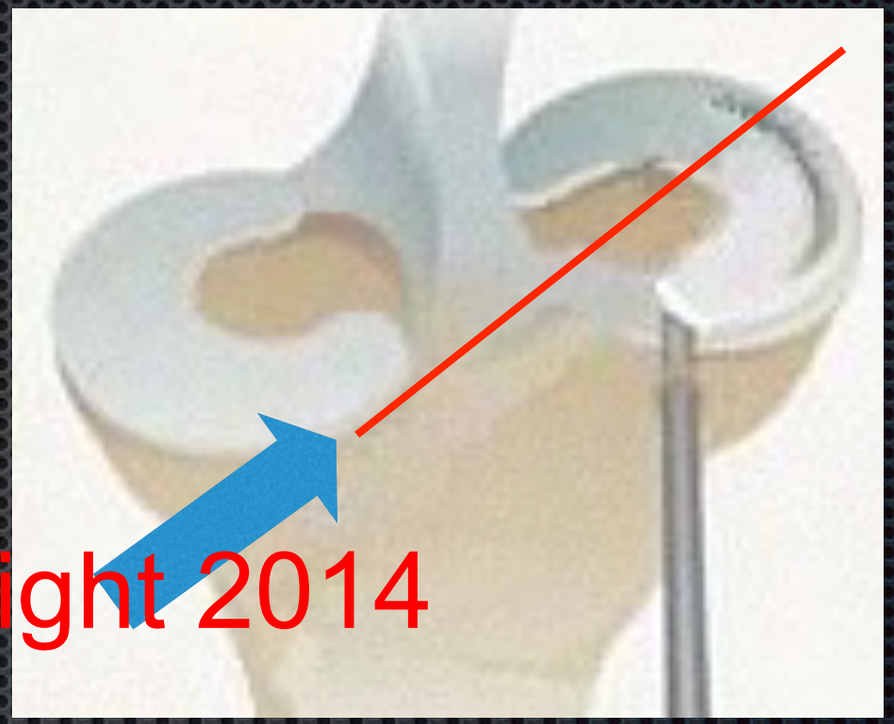
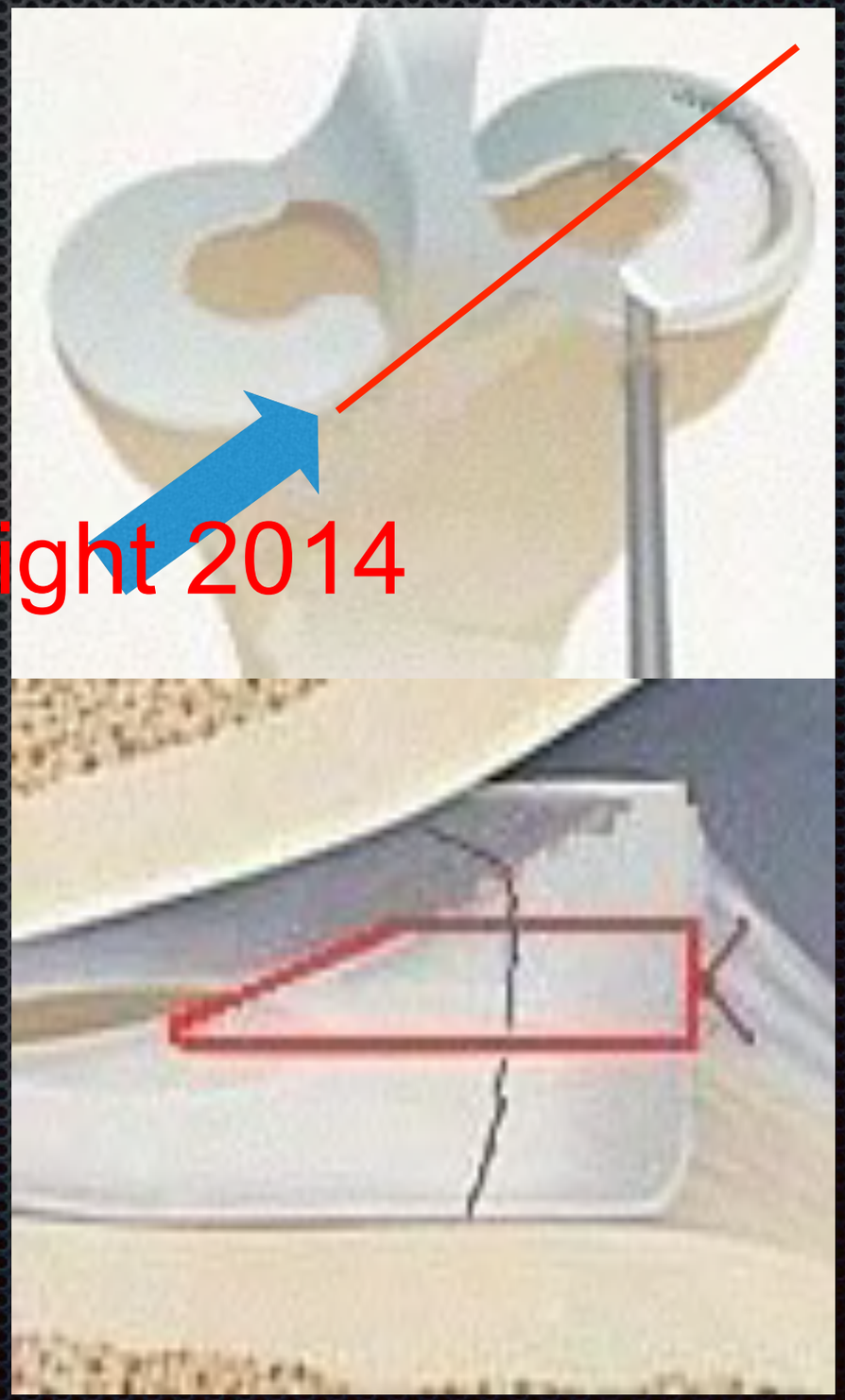


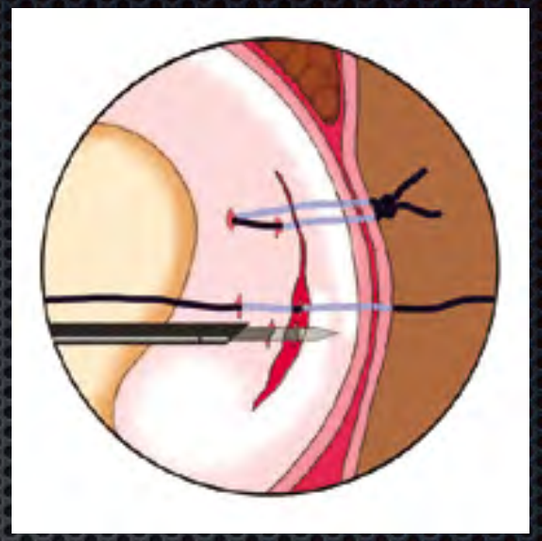
Meniscal suture

- MENISCAL SUTURE (Cook & Fox 2007; Luther et al. 2007; Thieman et al. 2010)
- OUT-IN-OUT TECHNIQUE



Meniscal suture

Conclusions



- Meniscal exploration
- Maximum possible meniscal preservation

Porous TTA

Philosophy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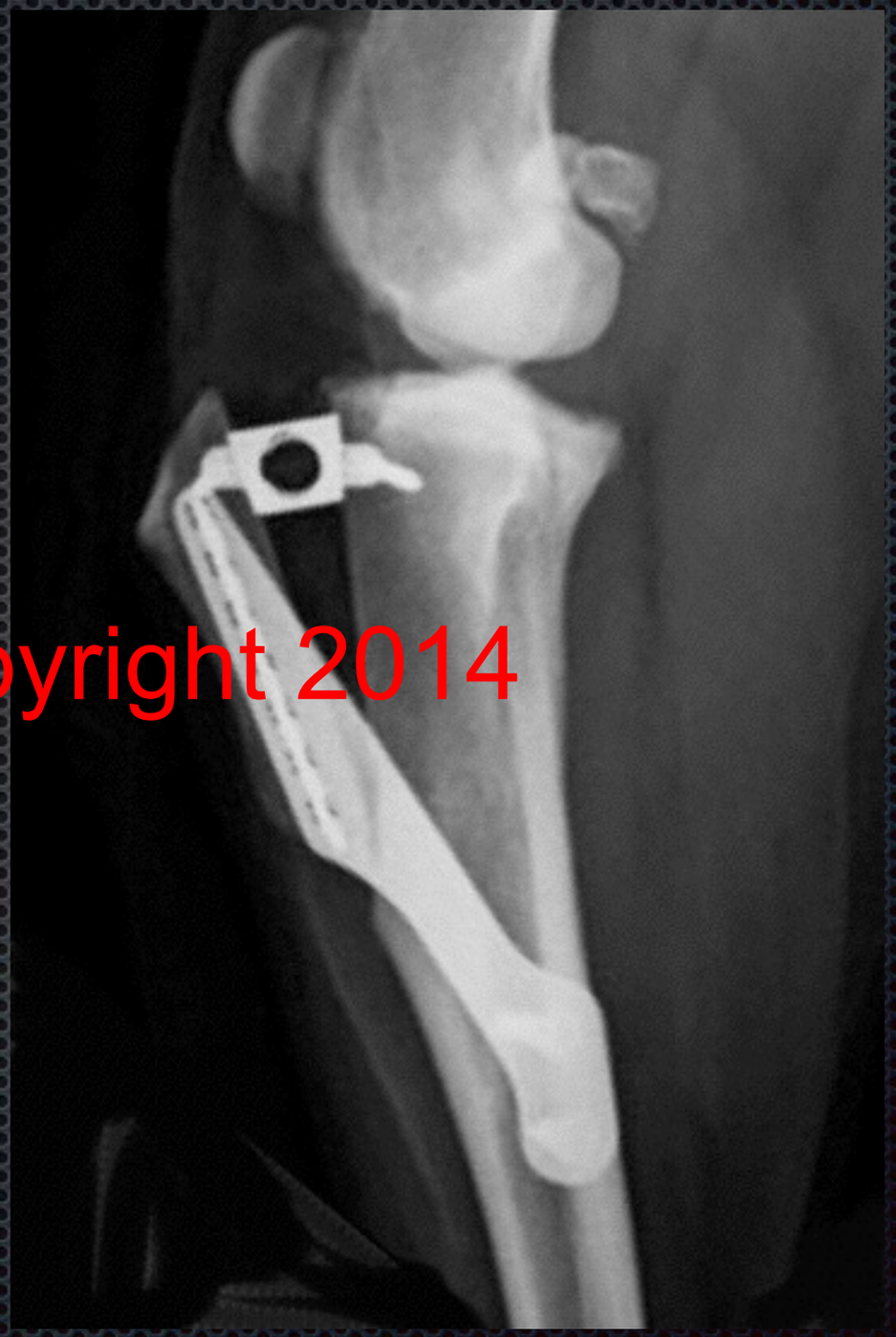
Problem



Boudrieau RJ: Bone grafting and tibial tuberosity advancement. *Vet Surg* 2011;40:641-2; authors reply 643

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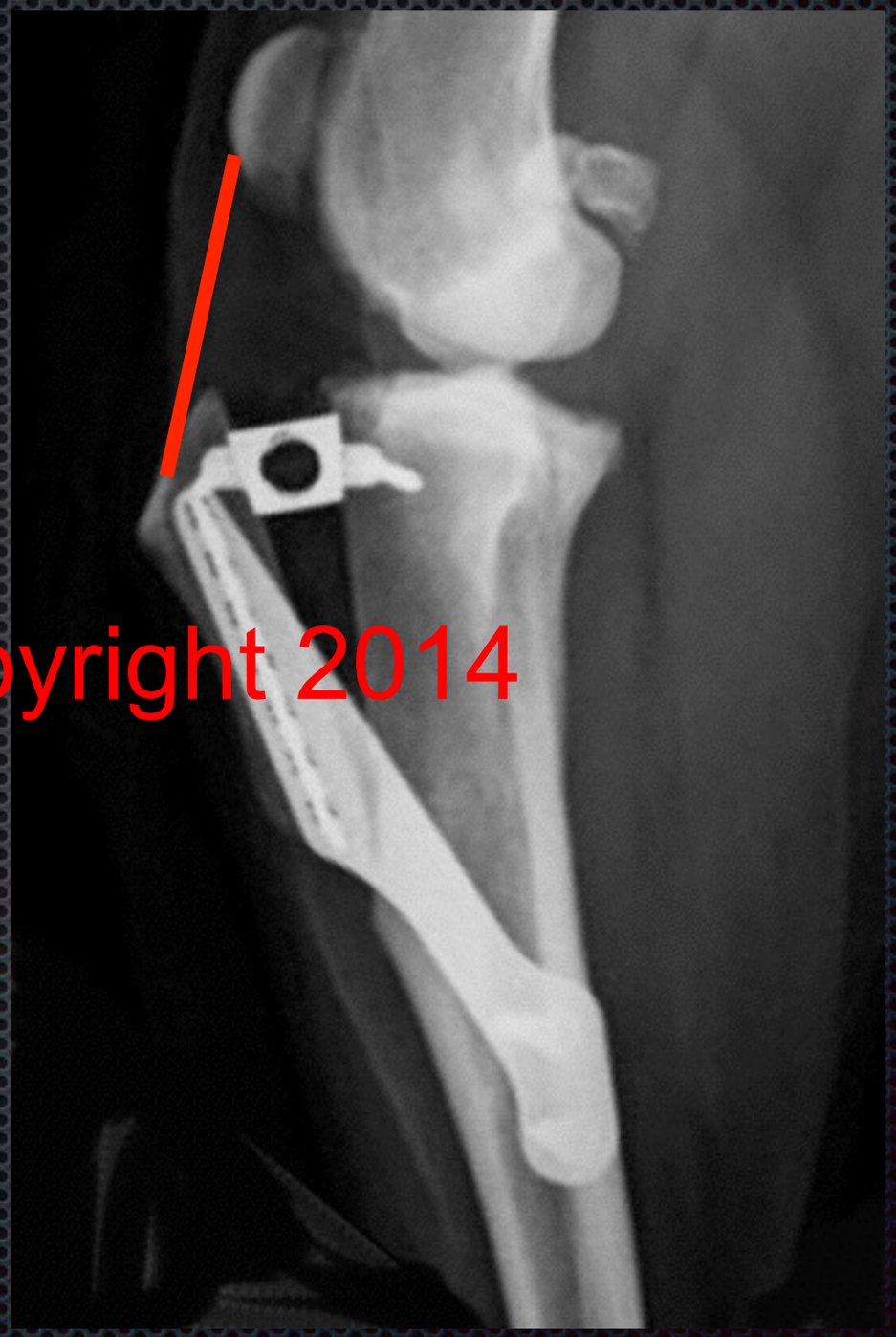

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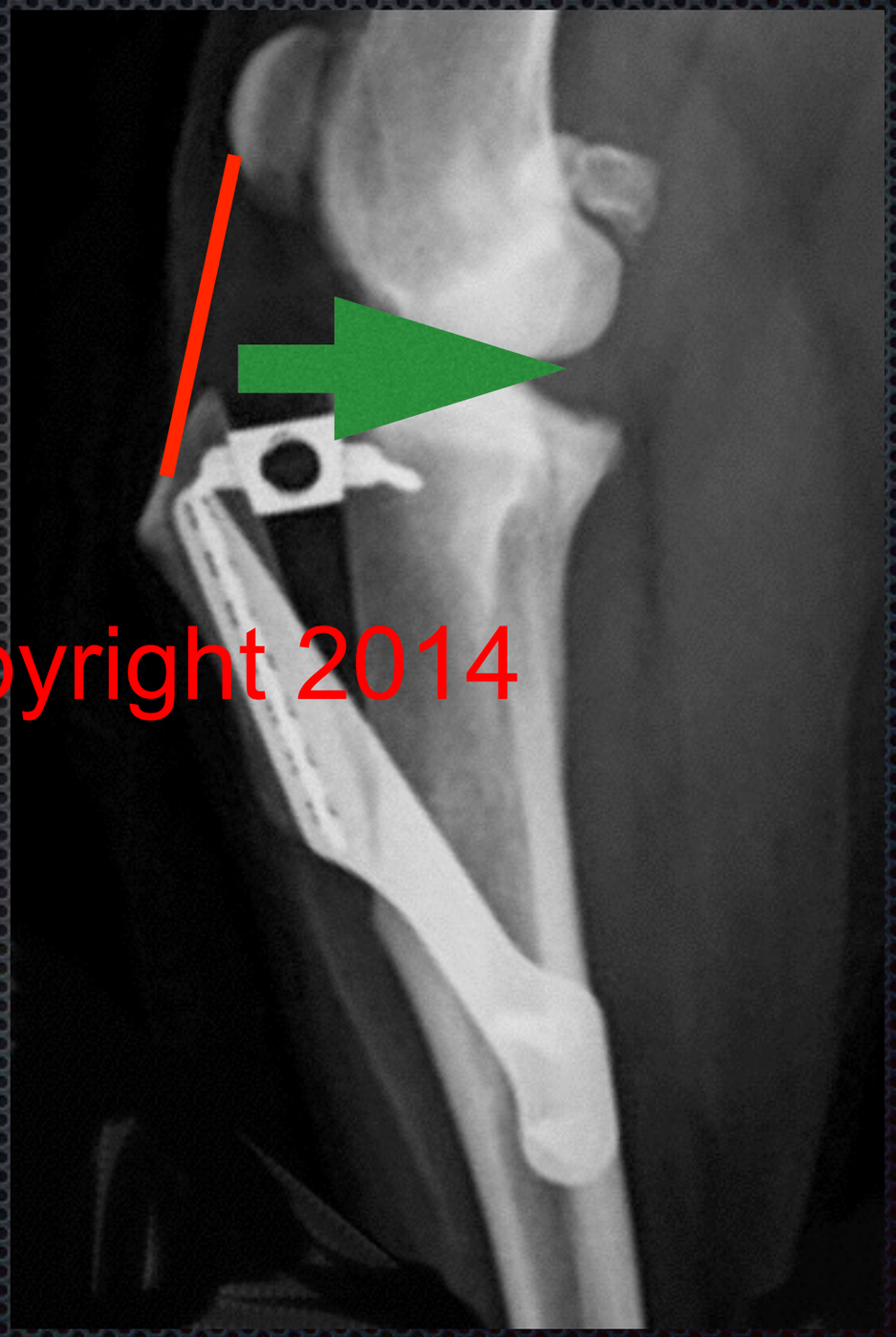

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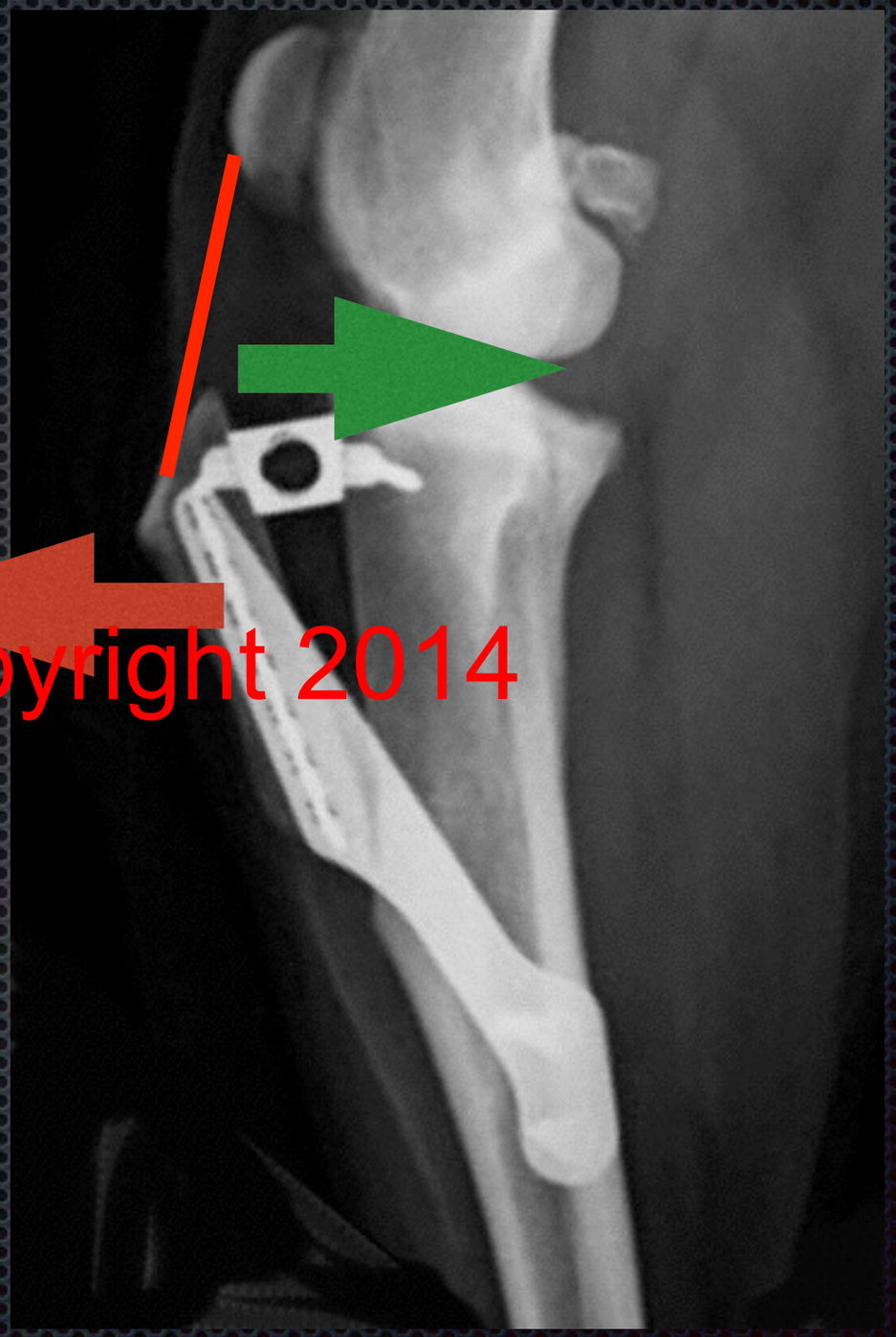

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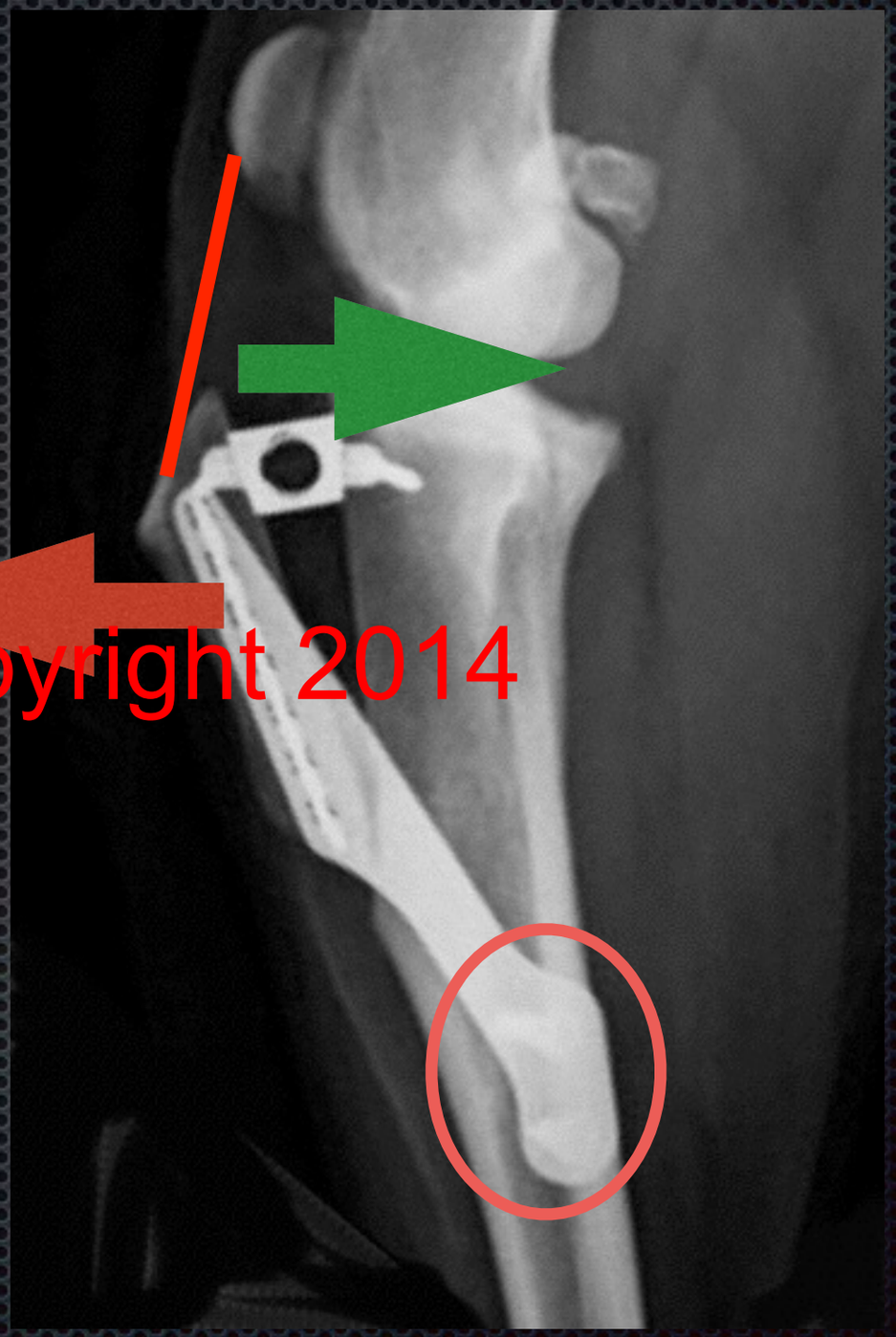

Boudrieau RJ: Bone grafting and tibial tuberosity advancement. *Vet Surg* 2011;40:641-2; authors reply 643

Effects of Rotation and Osteotomy Angulation on Patellar Tendon Insertion Position during Circular Tibial Tuberosity Osteotomy

Gian Luca Rovesti[1], DVM, Diplomate ECVS, Nikola Katic[2], DVM, Boris Dalpozzo[1], DVM, Francesco Dondi[3], DVM, PhD, and Gilles Dupré[2], DVM, Diplomate ECVS

[1]Clinica veterinaria M. E. Miller, Cavriago, Italy, [2]Clinic for Small Animal Surgery, Ophthalmology, Dentistry and Rehabilitation, Department for Small Animal and Horses, Veterinary Medicine University of Vienna, Vienna, Austria and [3]Department of Veterinary Medical Sciences, University of Bologna, Bologna, Italy

Corresponding Author
Gian Luca Rovesti, DVM, Diplomate ECVS, Via della Costituzione 10-42025, Cavriago (RE), Italy
E-mail: grovest@clinicamiller.it

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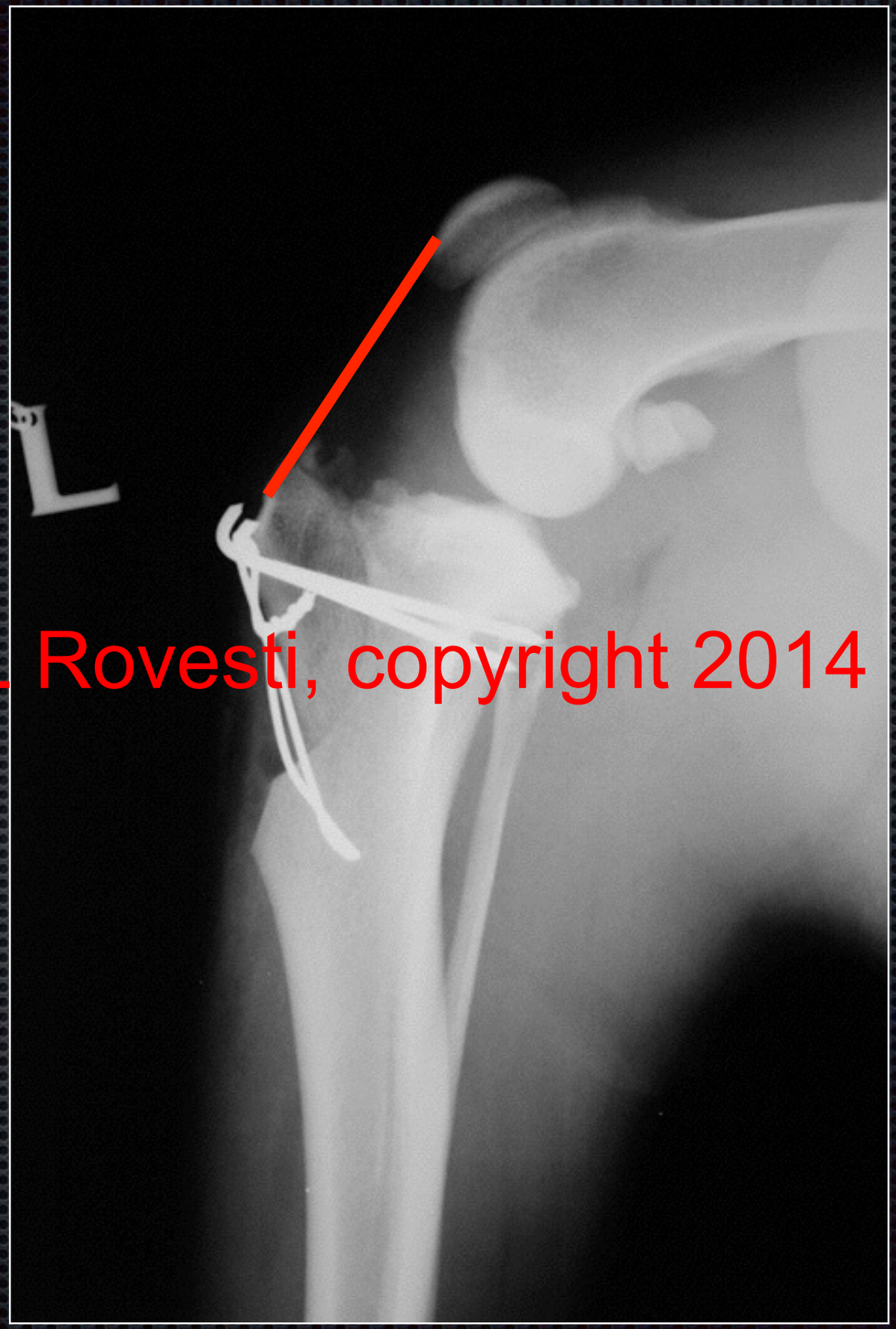
Objective: To evaluate the influence of rotation of the tibial tuberosity (TT) in the sagittal plane and angulation of osteotomy in the frontal plane (FPA) on the displacement of patellar tendon (PT) insertion.
Study Design: *Ex vivo* biomechanical study.
Sample Population: Canine tibiae (n = 36).
Methods: Nine groups of 4 tibiae each had a circular osteotomy of the TT at an FPA from −20° to +20° with increments of 5° for each group. The osteotomized TT was rotated by angles of rotation (AORs) of 10°, 20°, or 30° in the sagittal plane. The craniocaudal (CCD), distoproximal (DPD), and mediolateral (MLD) displacements of a marker located at the PT insertion on the TT were evaluated radiographically. Differences between groups were analyzed by Mann–Whitney U test and Friedman 2-way ANOVA.
Results: There was a significant correlation between the AOR and CCD. A positive FPA resulted in a high CCD and lateral shift of the TT at every AOR. Performing an osteotomy at an FPA of 0° produced the maximum amount of DPD.
Conclusions: FPA and AOR during circular osteotomy of the TT influence the final displacement of the PT insertion in all 3 planes.

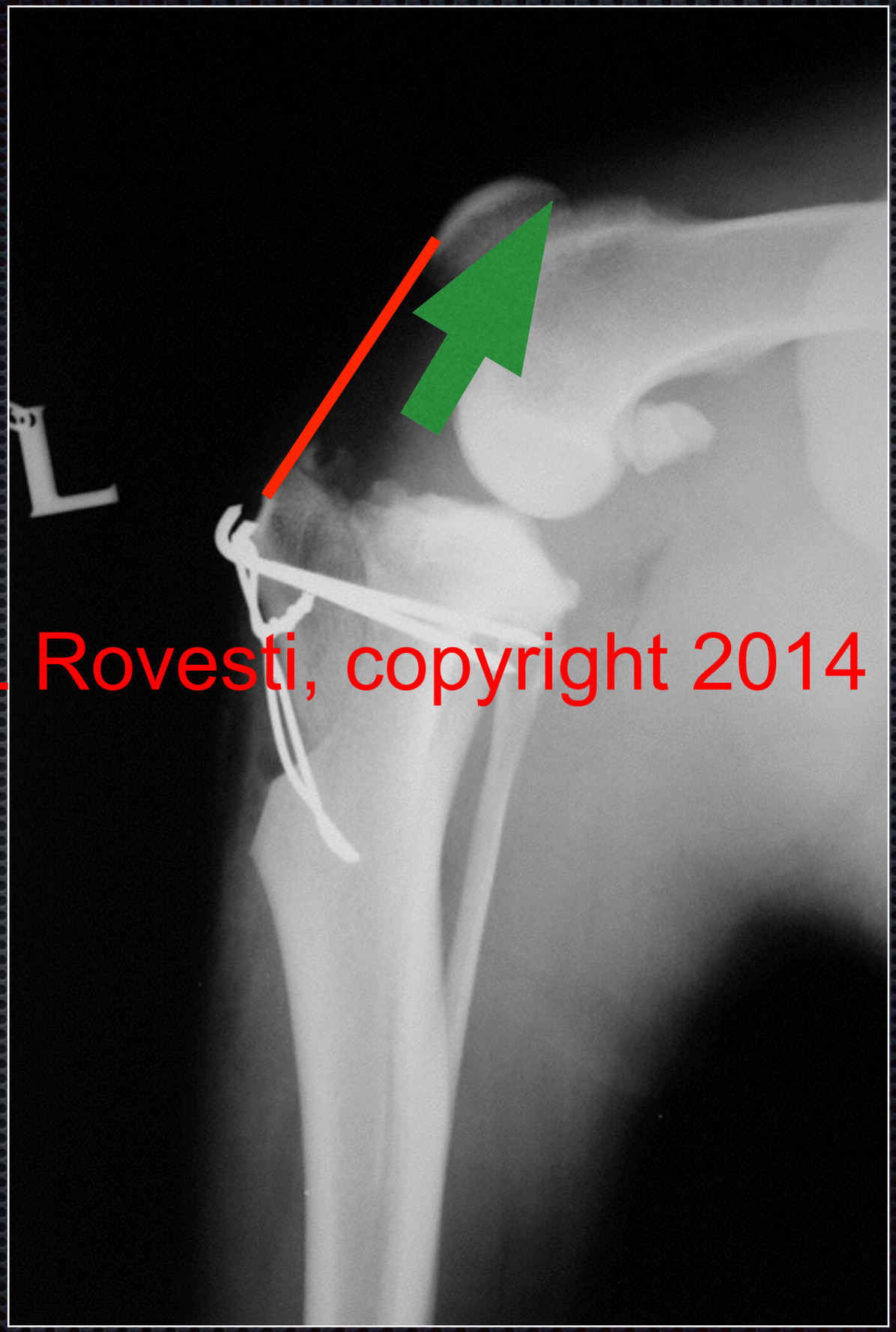
Rupture of the cranial cruciate ligament (CrCL) is one of the most common causes of pelvic limb lameness in dogs.[1,2] Many causal mechanisms exist to explain CrCL rupture,[3–6] and many surgical techniques for subsequent stifle stabilization have been proposed.[7–12] Since Slocum's investigations into the forces acting around the stifle joint[4] and the introduction of the tibial plateau leveling osteotomy (TPLO) in 1993,[13] increasing interest has emerged in the use of tibial osteotomies to treat CrCL insufficiency in dogs.[14–18] Tibial tuberosity advancement (TTA) was developed using a biomechanical approach that identified the quadriceps muscle as the main force acting on the stifle joint, leading to an overall force vector parallel to the patellar tendon (PT). The aim of the TTA technique is to modify the angle between the PT and tibial plateau (TP) by advancing the tibial tuberosity (TT), thus obtaining a PT-TP angle of 90° with the stifle at 135° of flexion.[19] This is achieved by an osteotomy of the tibial crest and insertion of a titanium cage in the osteotomy site.[14] Healing time for the gap between the advanced TT and the tibial metaphysis in course of TTA was reported to be >14 weeks in 41% of cases[20] and >12 weeks in 16% of cases.[15] Although it was shown there is no need for a cancellous bone graft over the gap,[20] this view was subsequently questioned.[21] Unfortunately, none of the current osteotomy techniques limits progression of degenerative joint disease (DJD), and to date, no technique has emerged as superior.[19] Reported complications for all techniques usually reflect the surgeon's ability level and the technical difficulties inherent to the procedure.[19]

A new technique with the same rationale as TTA, called circular tibial tuberosity osteotomy (cTTA) was recently described.[22] It is performed by a circular osteotomy of the TT followed by a craniad rotation. The main theoretical advantage of the technique is that it allows a continuous degree of correction, with no need for standard cage sizes. Rather, the osteotomy results in continuous contact between the TT and the tibial metaphysis, without creating a gap at the osteotomy site. This makes interfragmentary compression possible and therefore obviates the need for cancellous bone grafting. No further details were provided[22]; however, the angle between the frontal plane of the tibia and the plane of the osteotomy may profoundly affect the direction in which the bone will move during rotation.[19,23]

Our purpose was to evaluate the influence of the angulation of osteotomy in the frontal plane (FPA) of the TT

Study was performed at the Veterinary Medicine University of Vienna and at the Clinica Miller in Cavriago and Statistical Evaluation at the University of Bologna.

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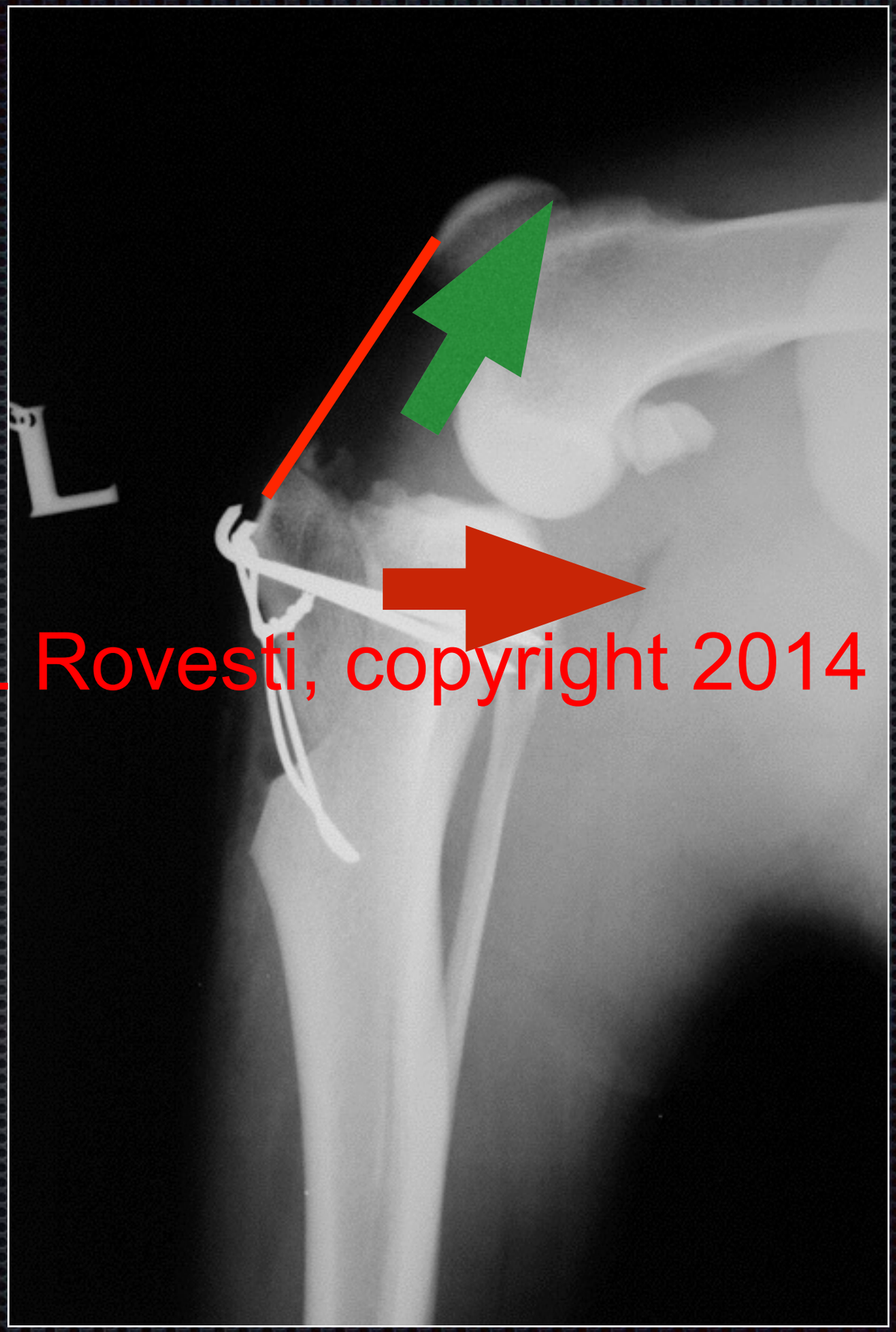
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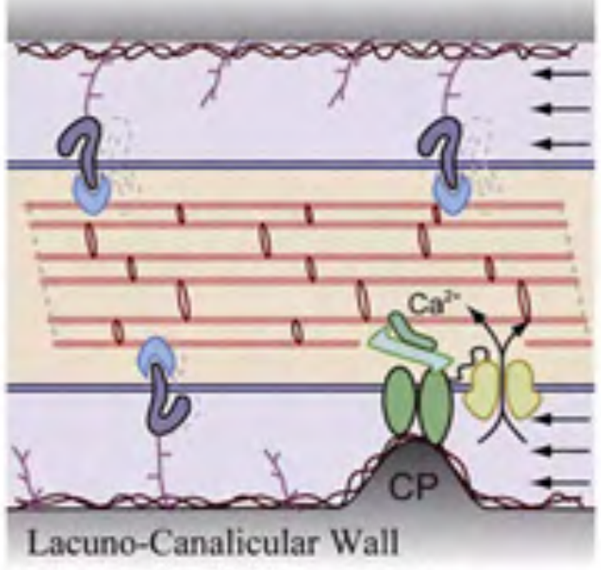
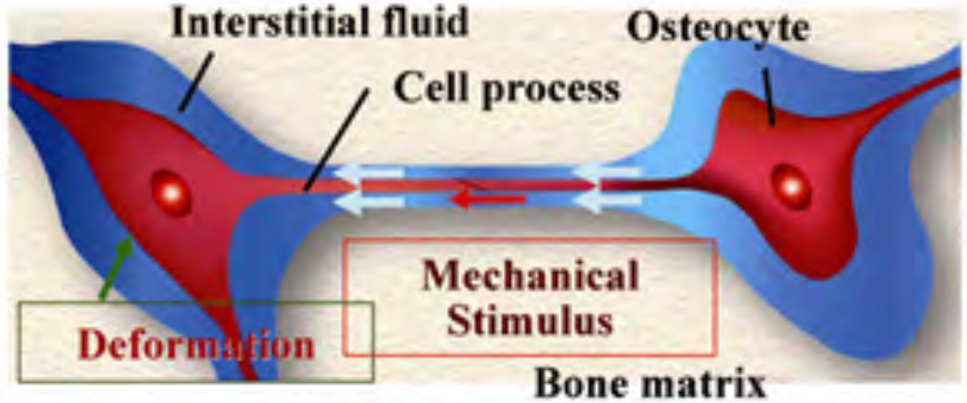
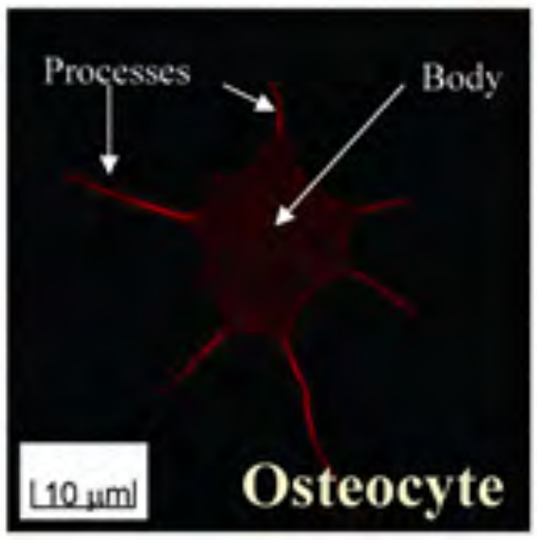
OSTEOCYTES FUNCTION

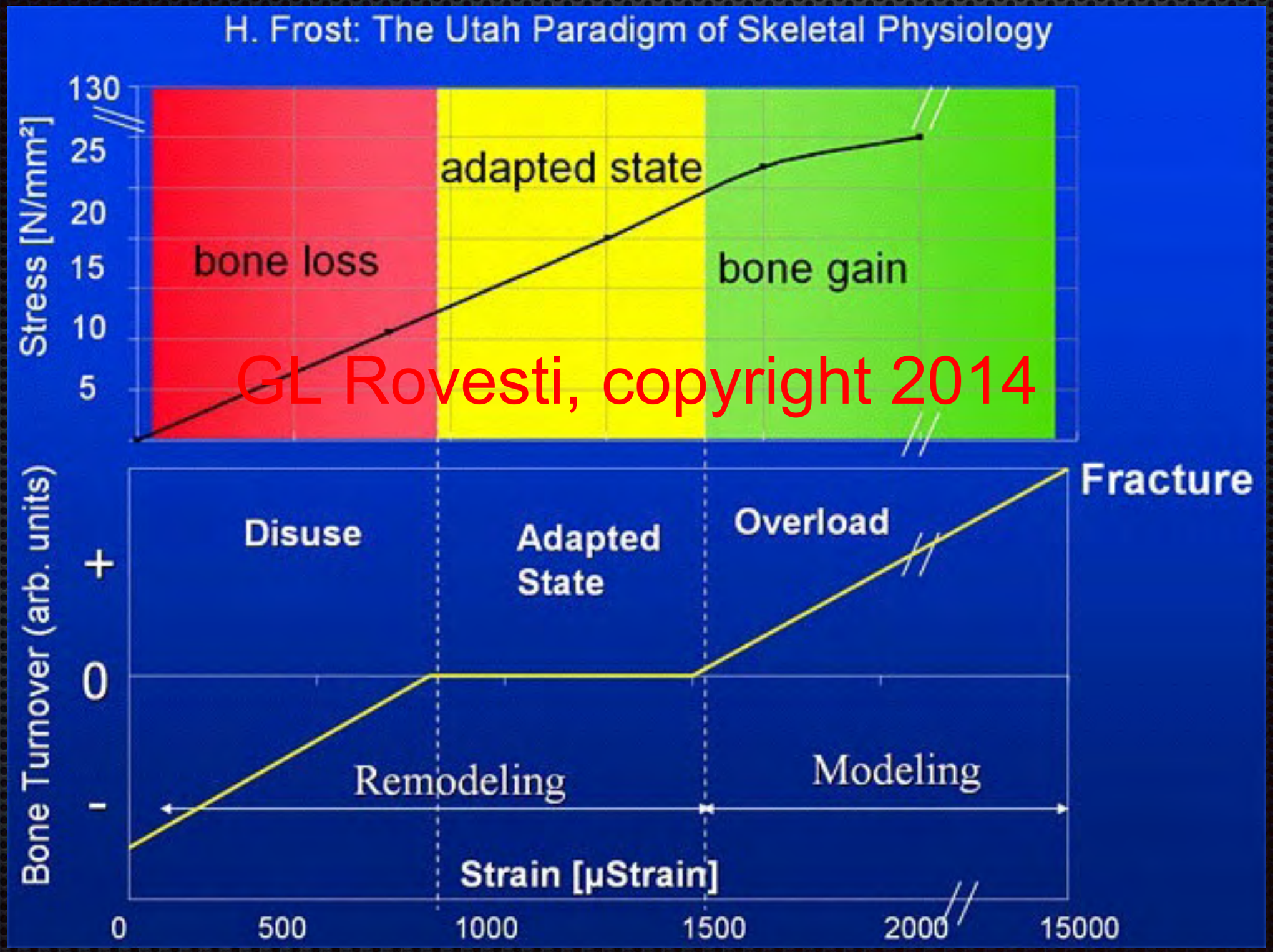






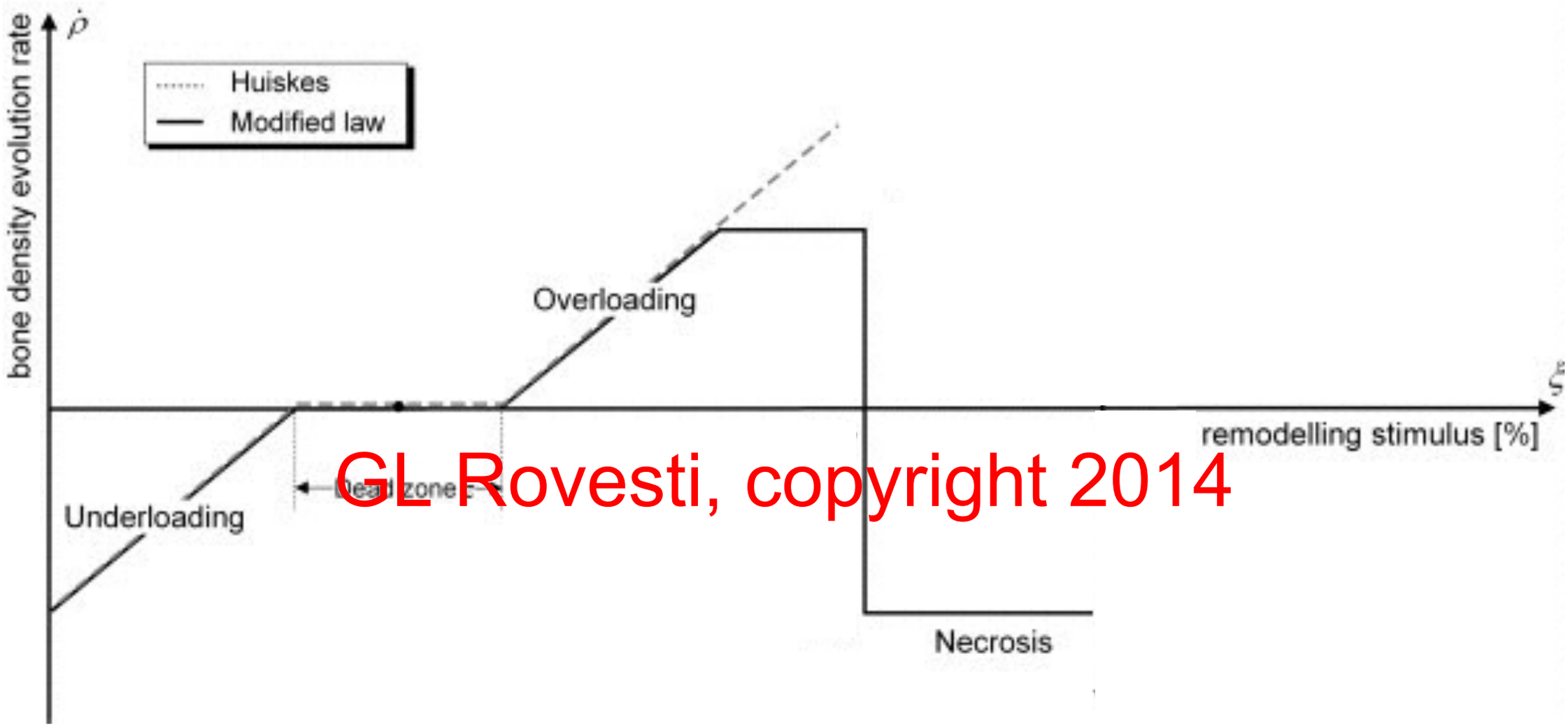
mechanotransduction

Mechanostat



BONE REMODELING THRESHOLDS

Behrens *et al. BioMedical Engineering OnLine* 2009



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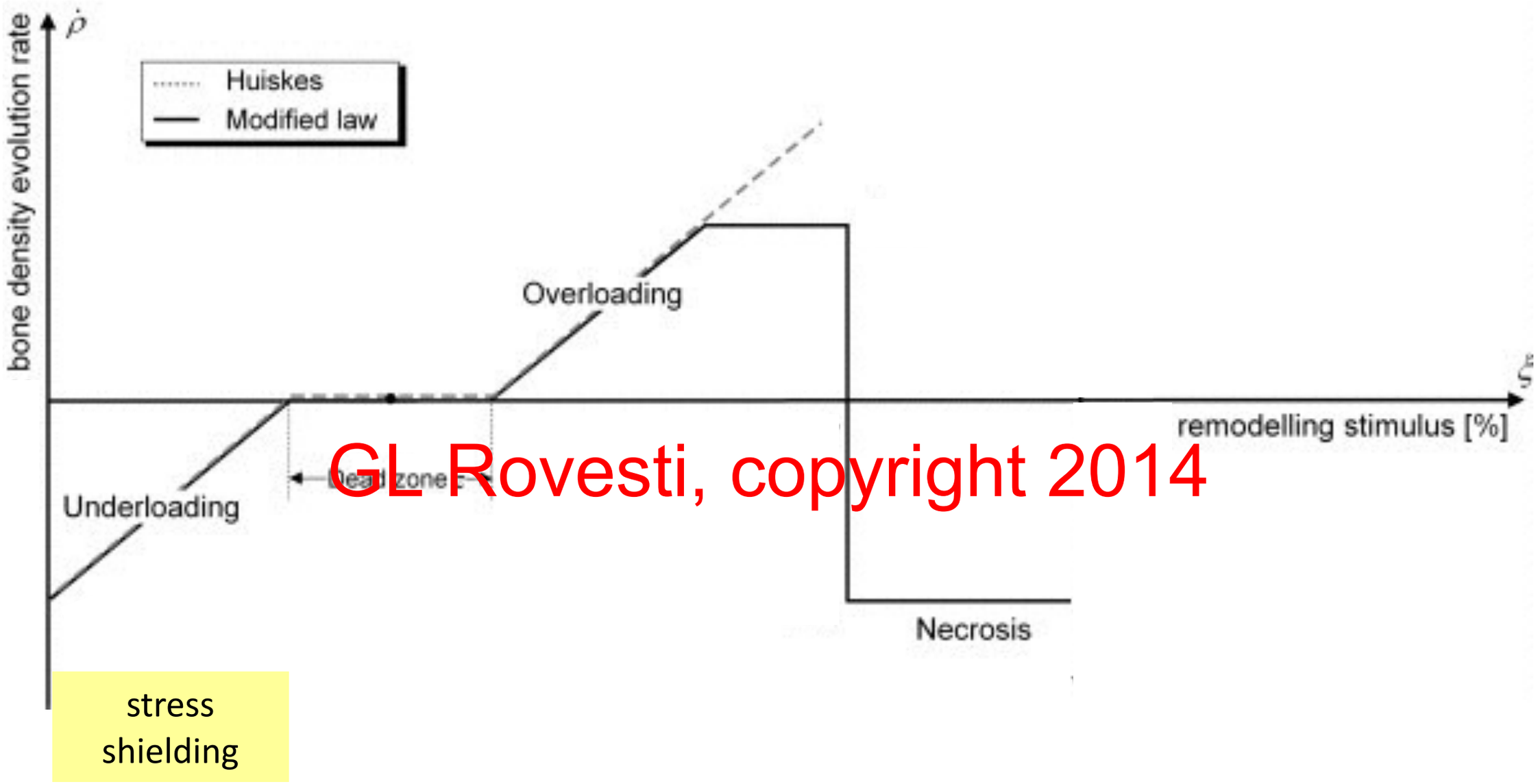
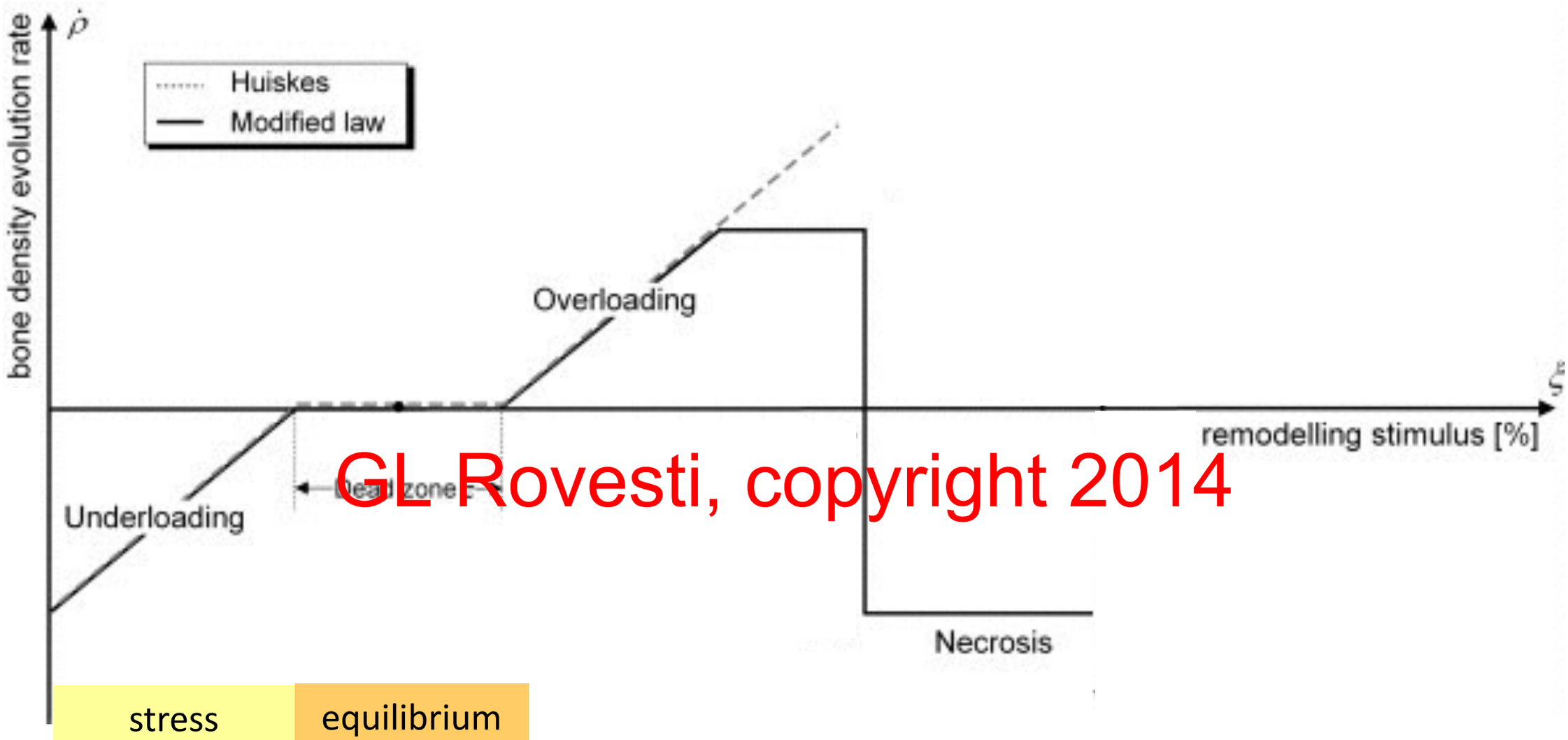


stress shielding

BONE REMODELING THRESHOLDS

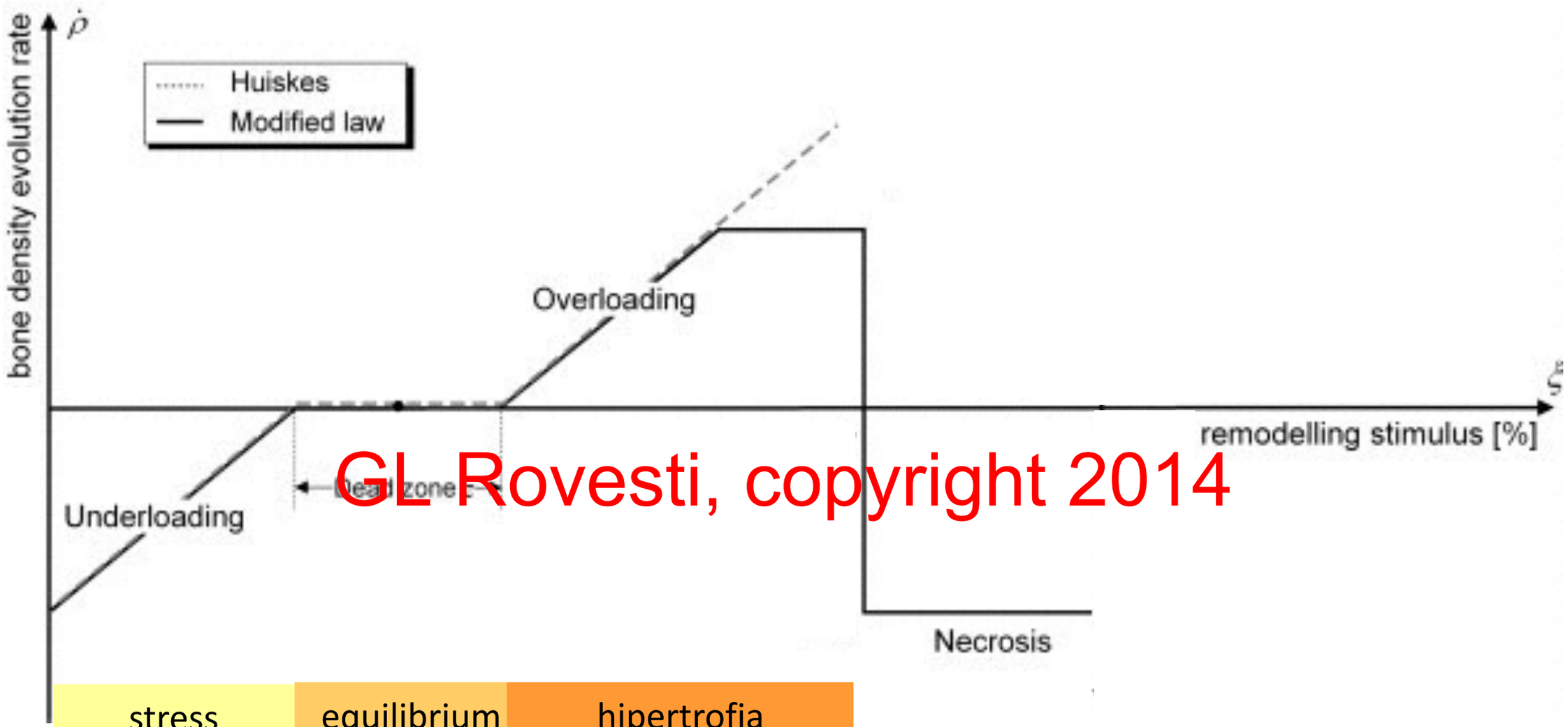
Behrens *et al. BioMedical Engineering OnLine* 2009



stress shielding	equilibrium

BONE REMODELING THRESHOLDS

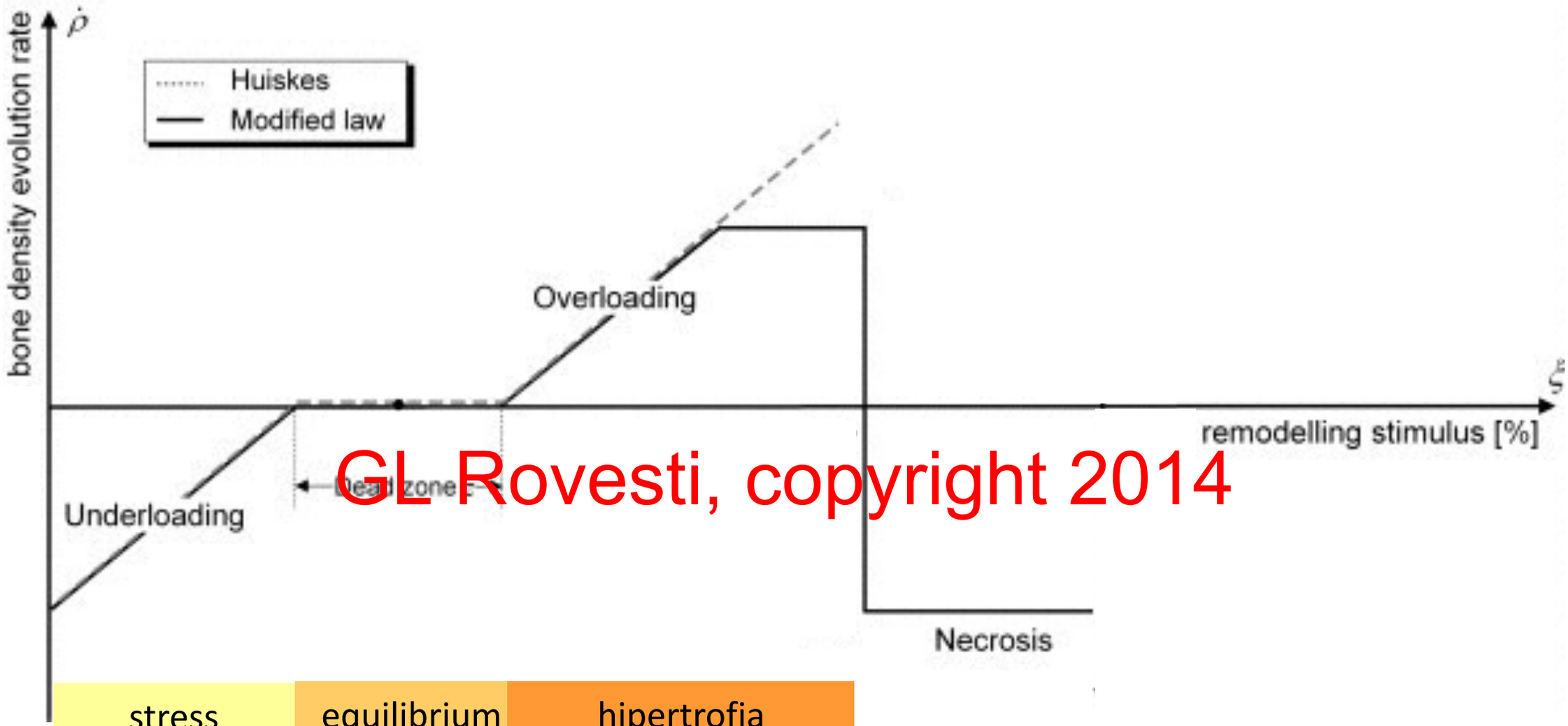
Behrens *et al. BioMedical Engineering OnLine* 2009



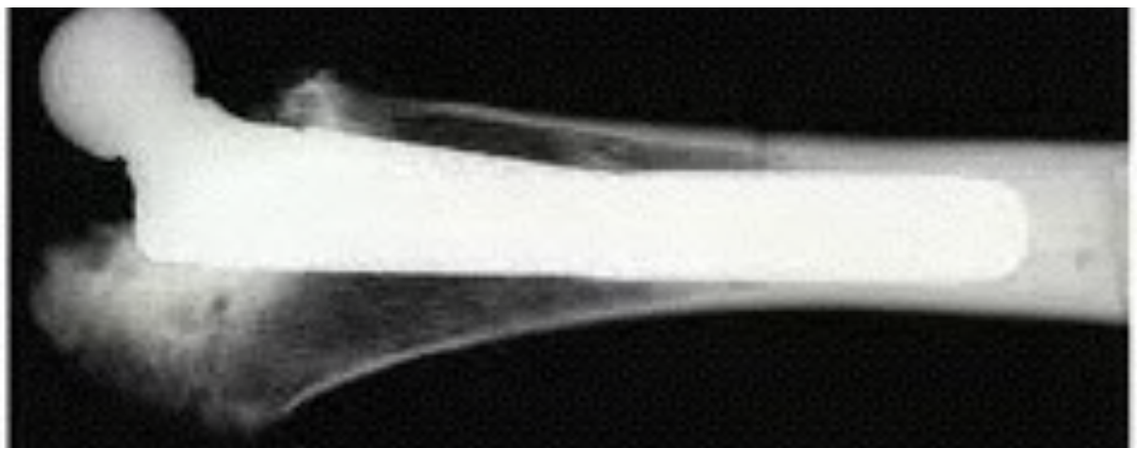
stress shielding	equilibrium	hipertrofia of bone tissue

BONE REMODELING THRESHOLDS

Behrens *et al. BioMedical Engineering OnLine* 2009



stress shielding	equilibrium	hipertrofia of bone tissue



BONE REMODELING THRESHOLDS

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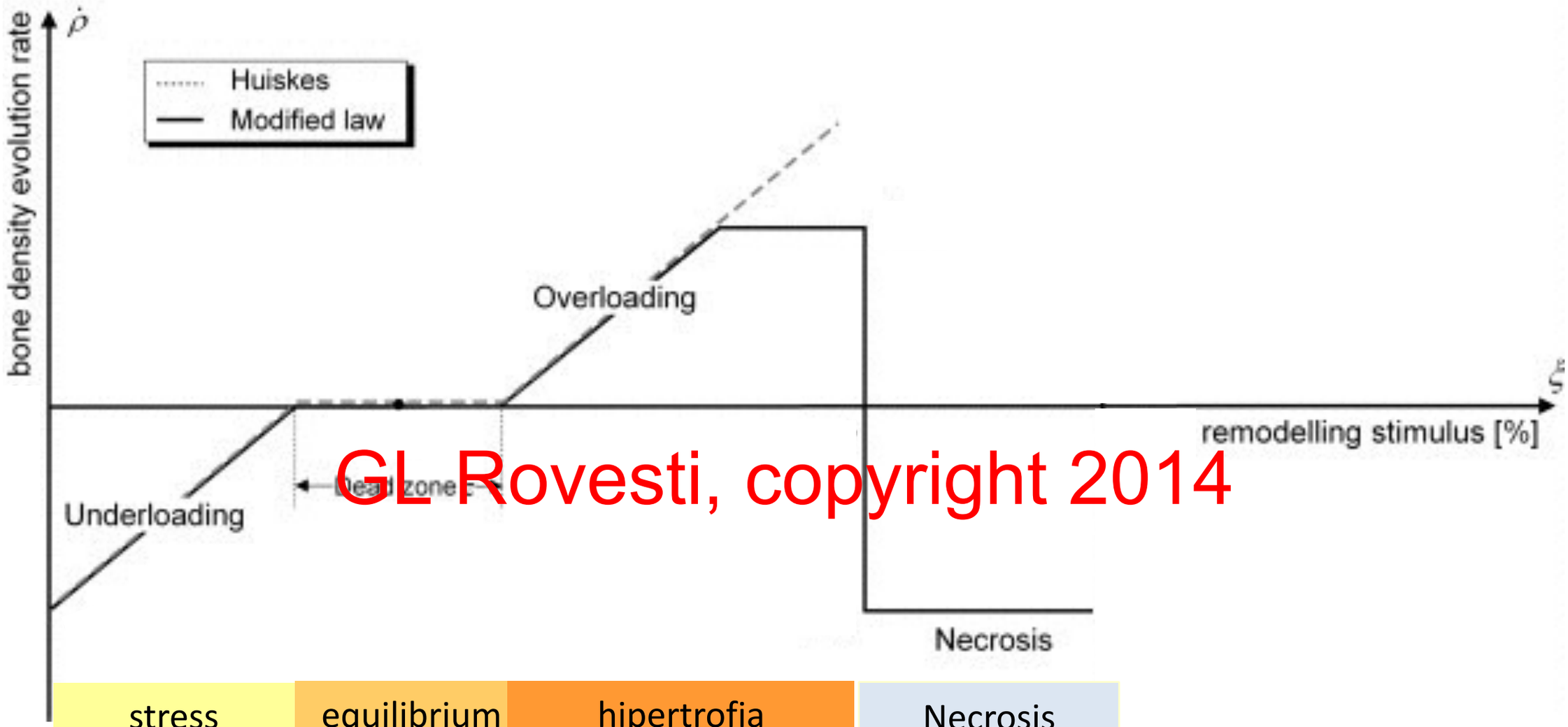
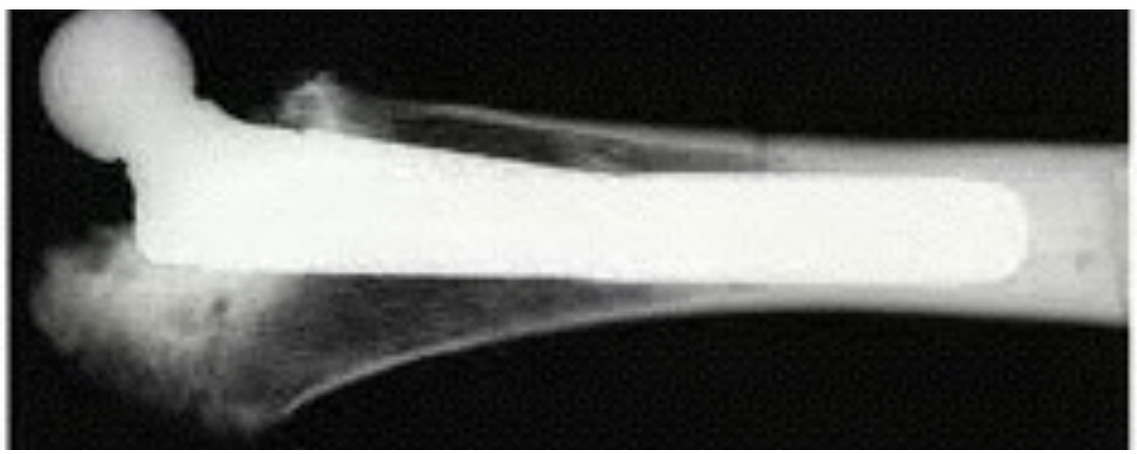
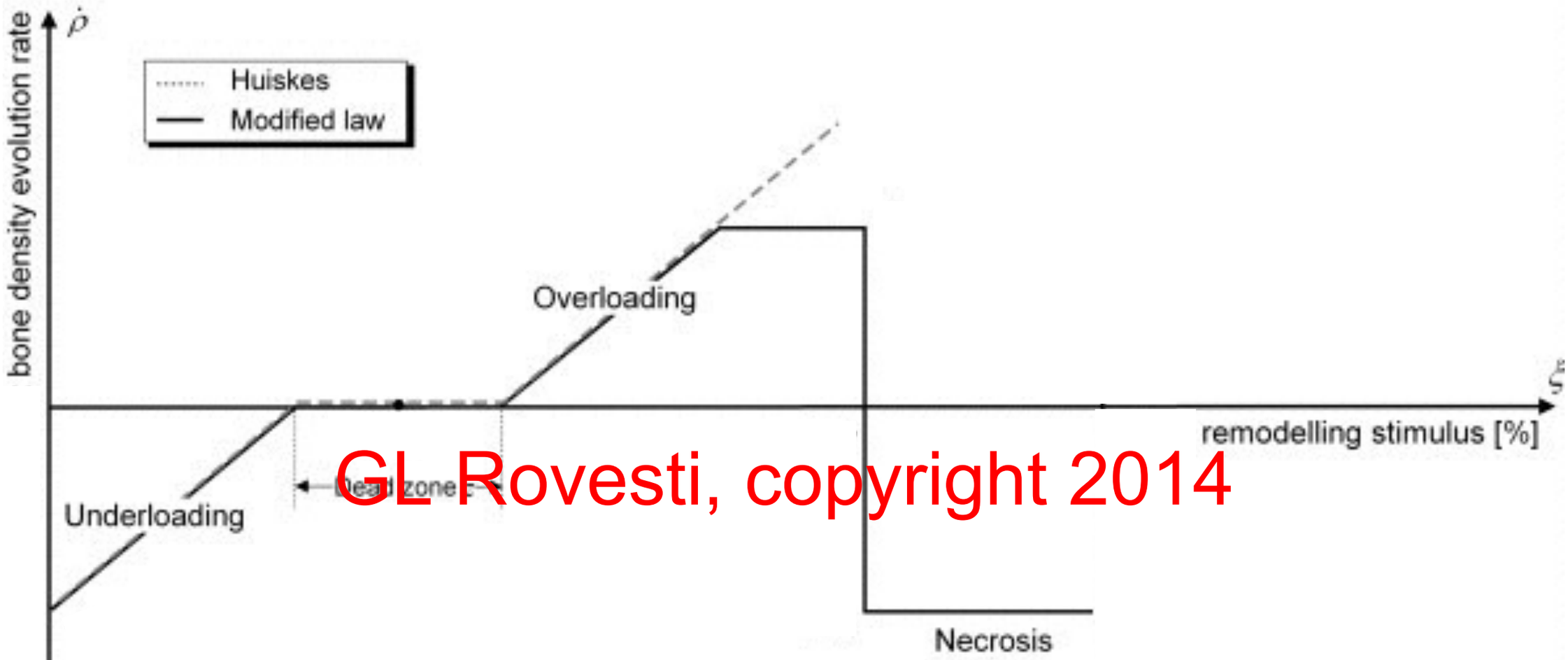


stress shielding	equilibrium	hipertrofia of bone tissue	Necrosis

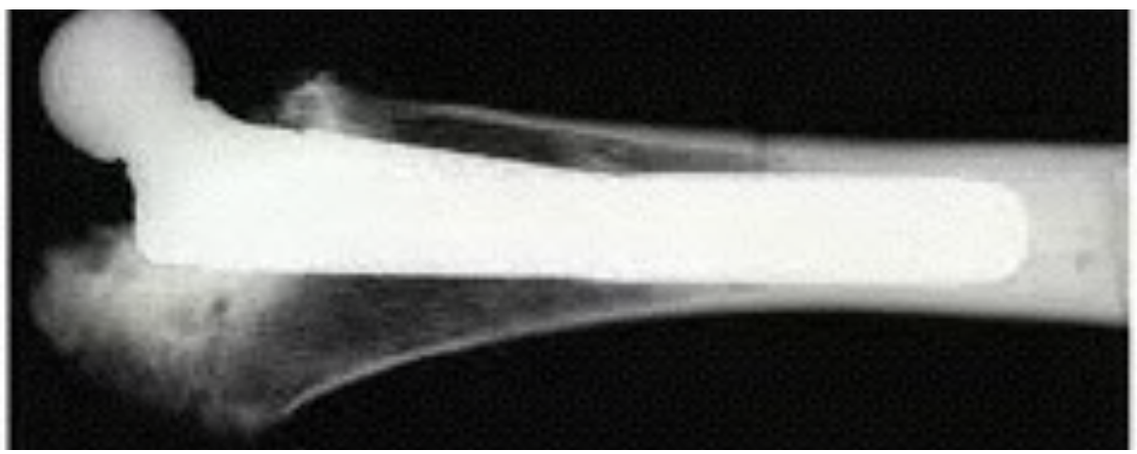


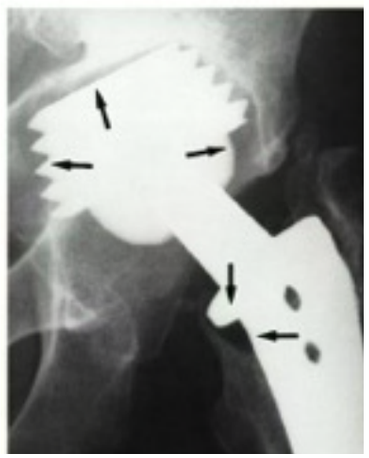
BONE REMODELING THRESHOLDS

Behrens *et al. BioMedical Engineering OnLine* 2009



stress shielding	equilibrium	hipertrofia of bone tissue	Necrosis





BONE REMODELING THRESHOLDS

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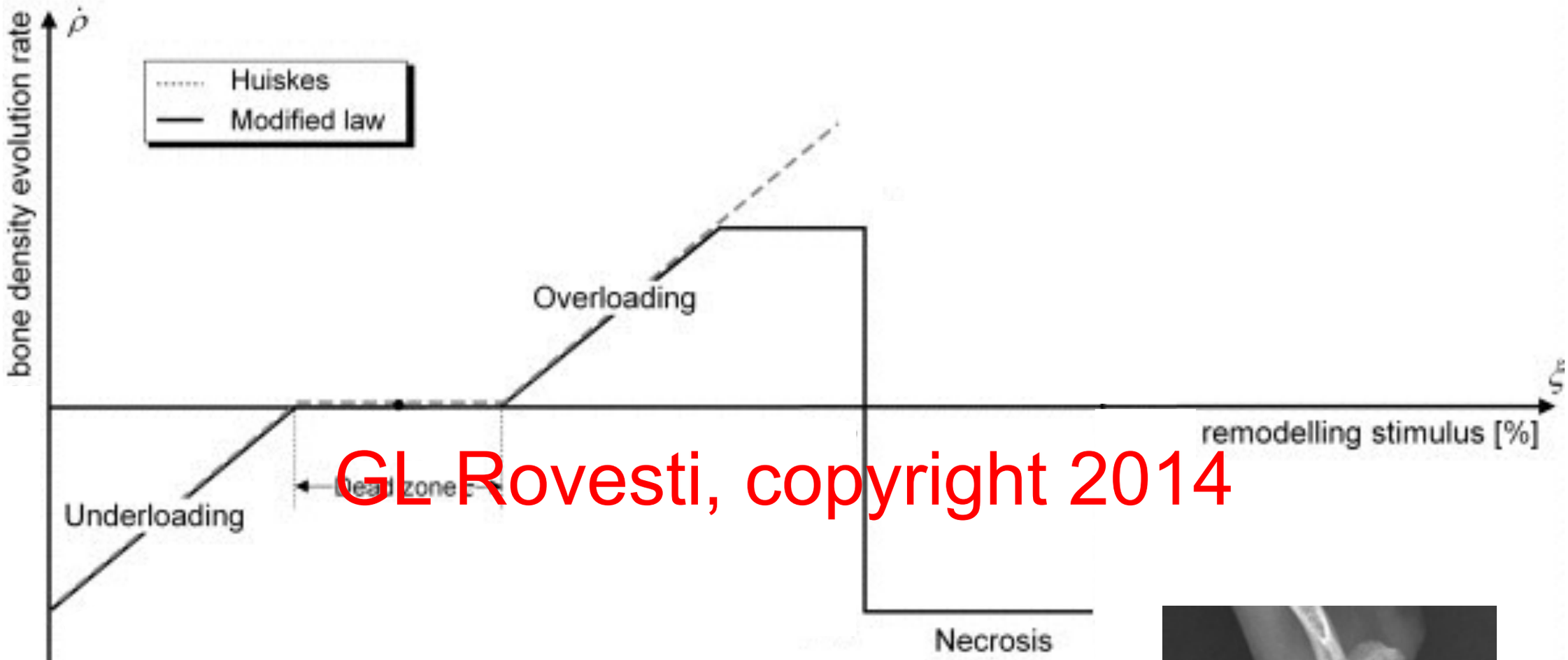
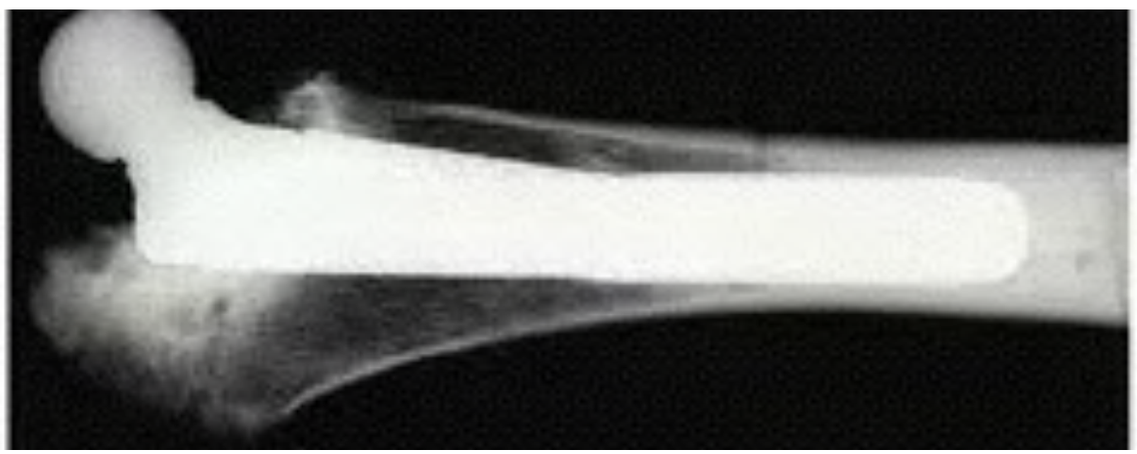
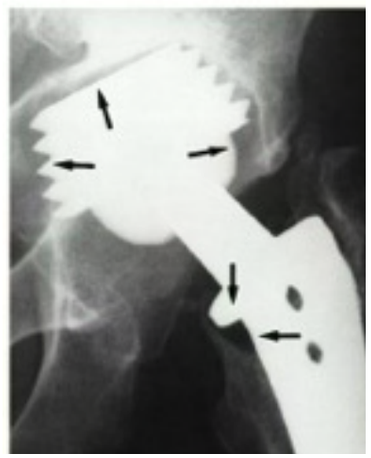
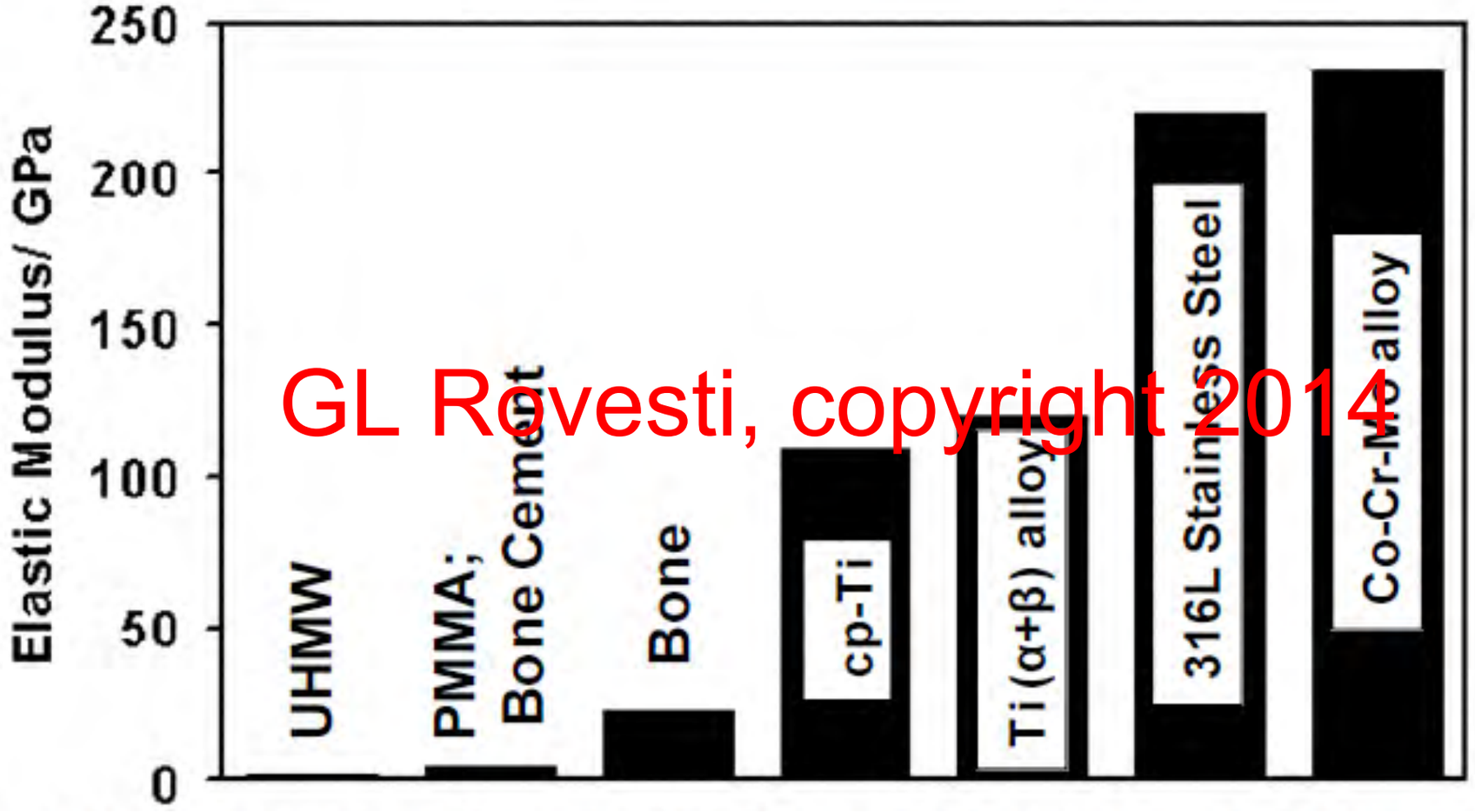


stress shielding	equilibrium	hipertrofia of bone tissue	Necrosis





MAIN BIOMATERIALS ELASTICITY



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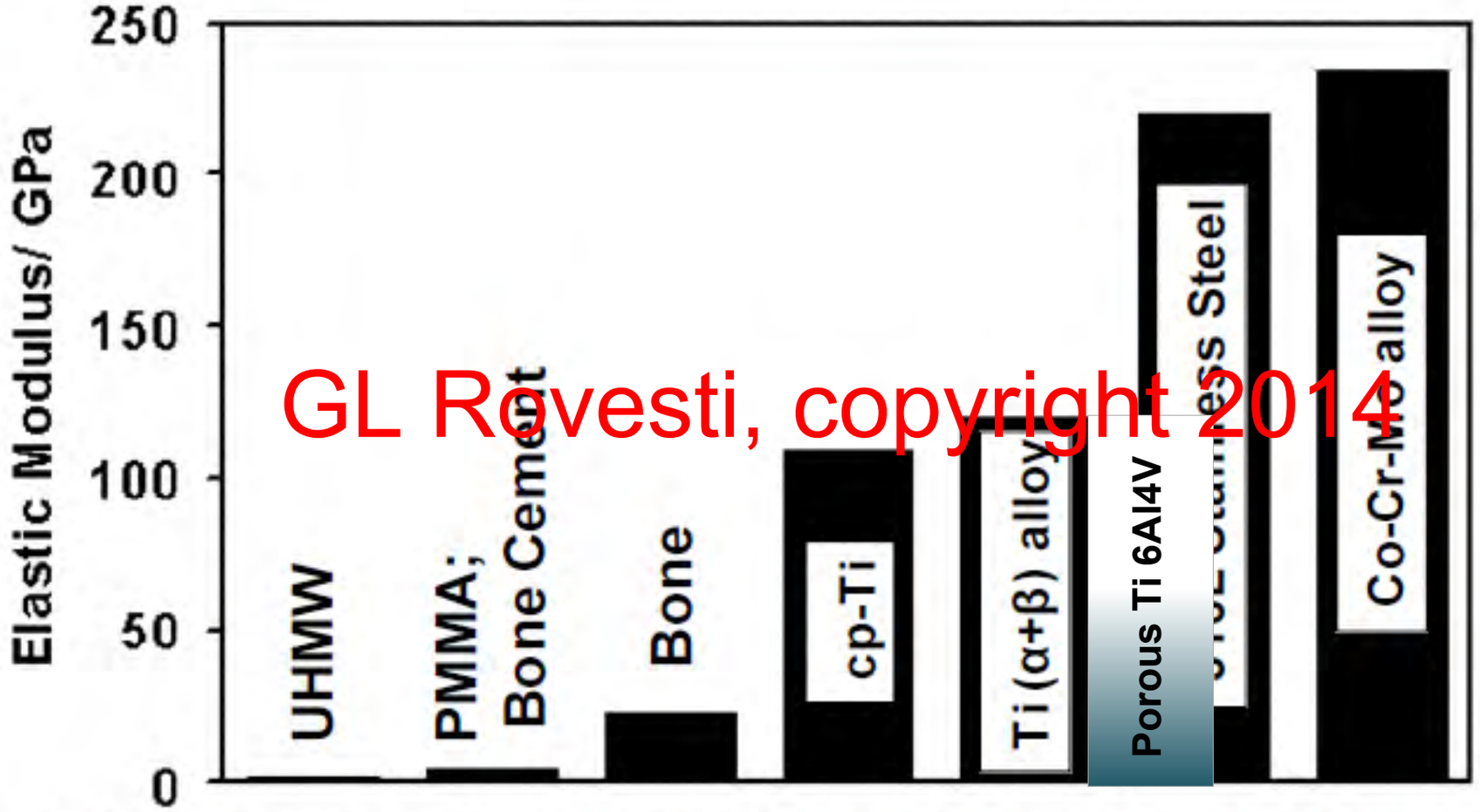
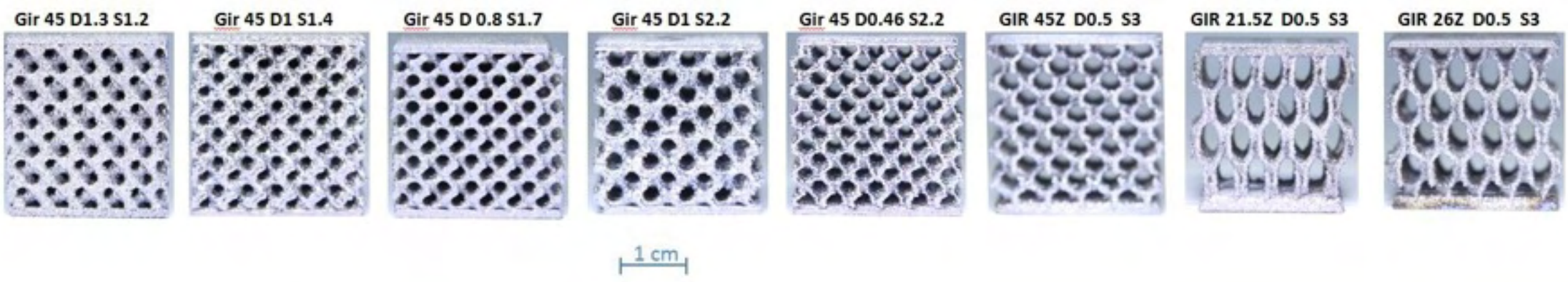
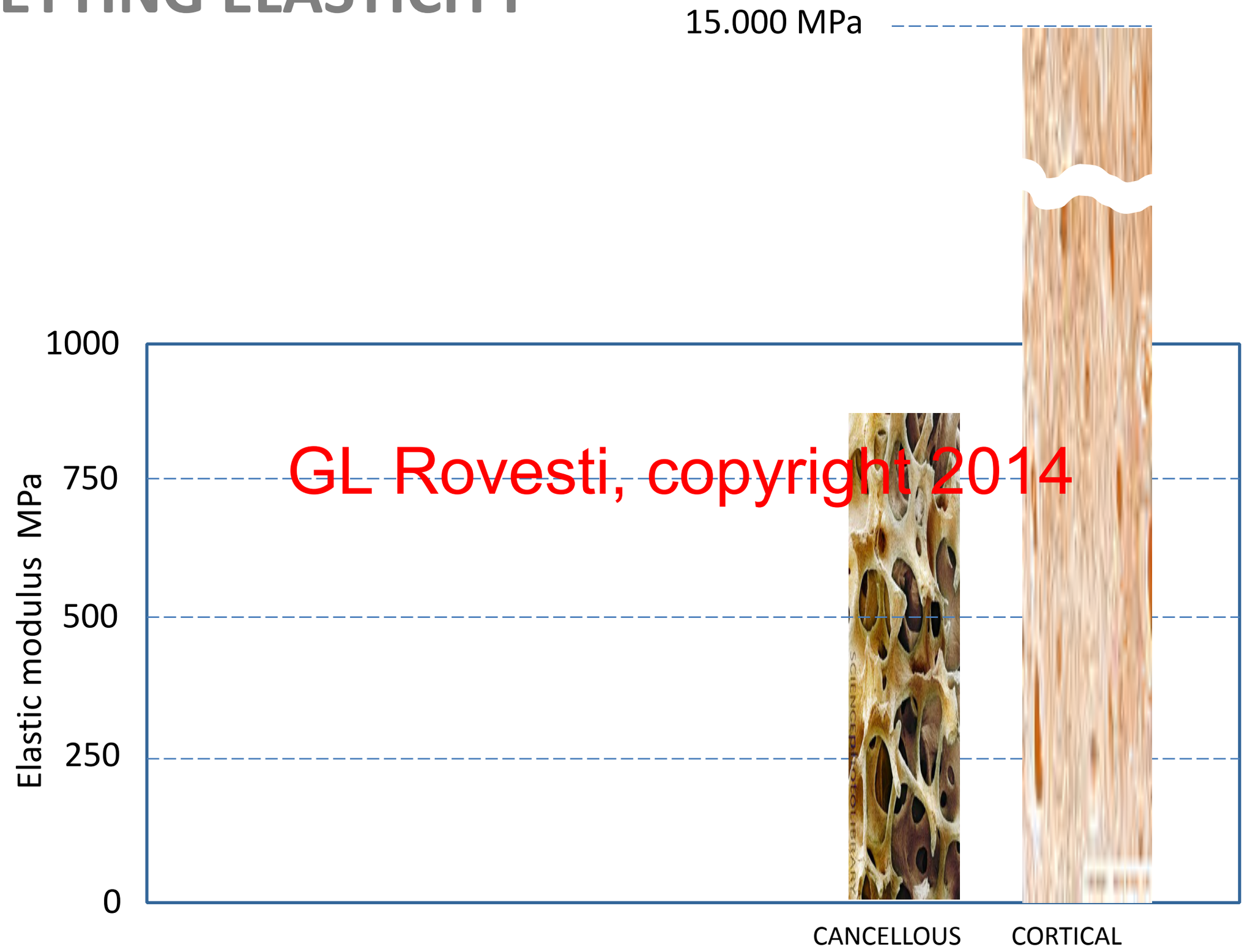
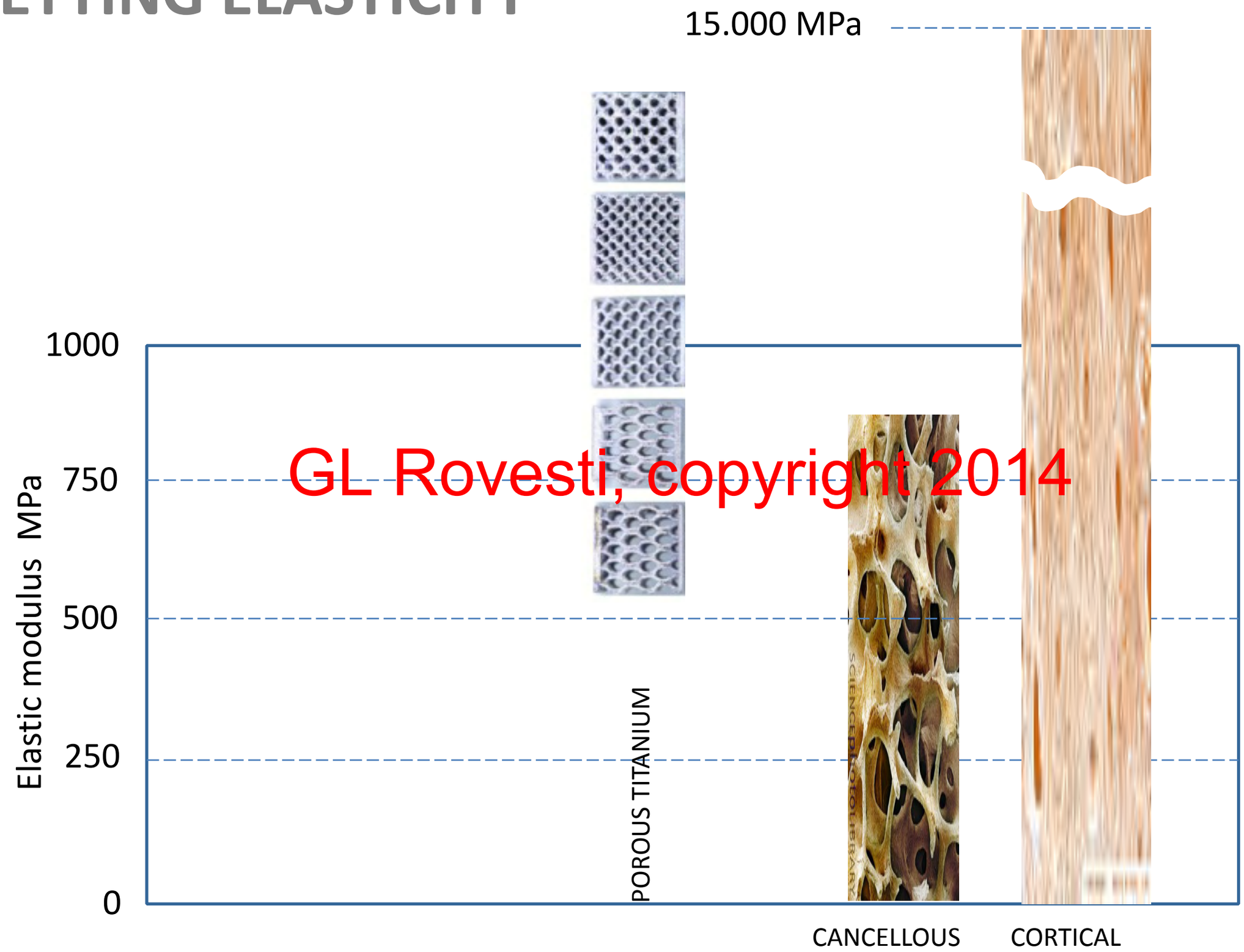




SETTING ELASTICITY



SETTING ELASTICITY



ELECTRON BEAM MELTING

A REVOLUTIONARY MANUFACTURING PROCESS

FOR A NEW IMPLANT GENERATION

EBM COMPETITIVE ADVANTAGES

- FREE SHAPE no geometric limitations
- ADDITIVE melting metal just where you need it
- DIRECT from CAD to printing, no tooling
- NEW PERFORMANCES anisotropic
- SHORT PRODUCTION TIME
- FLEXIBLE
- AFFORDABLE COSTS

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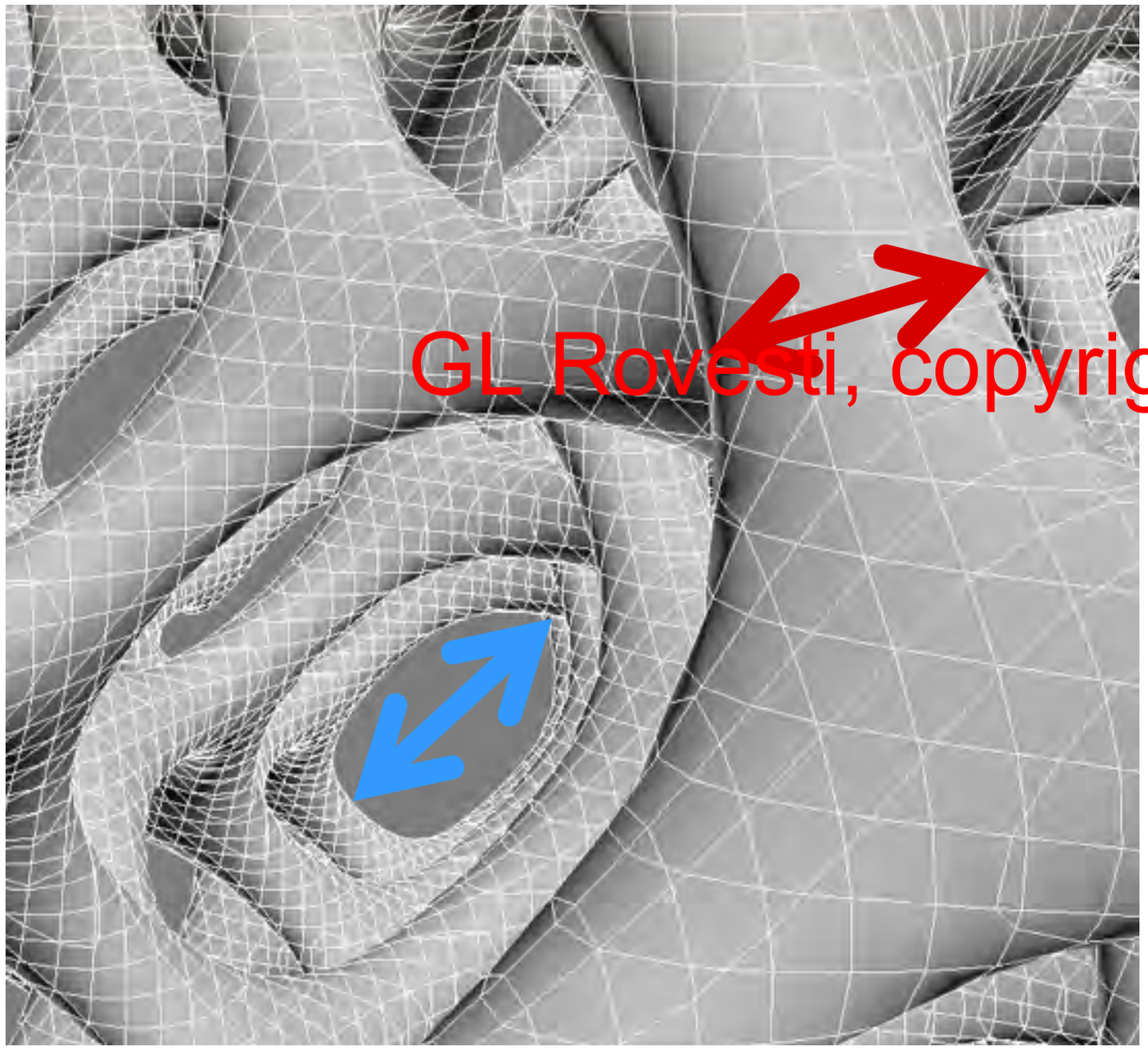
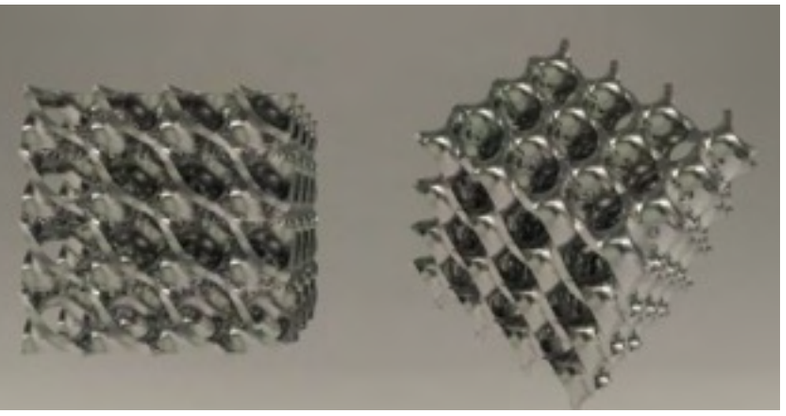
PERFECT FOR ORGANIC GEOMETRIES

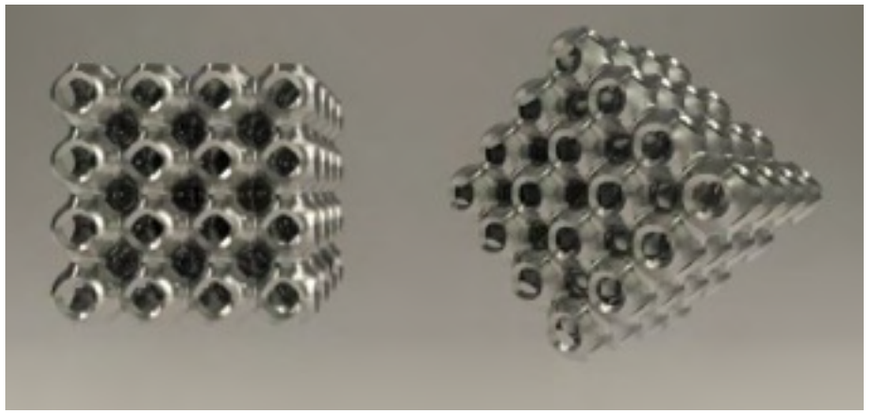
SOME DIMENSIONAL LIMITATIONS

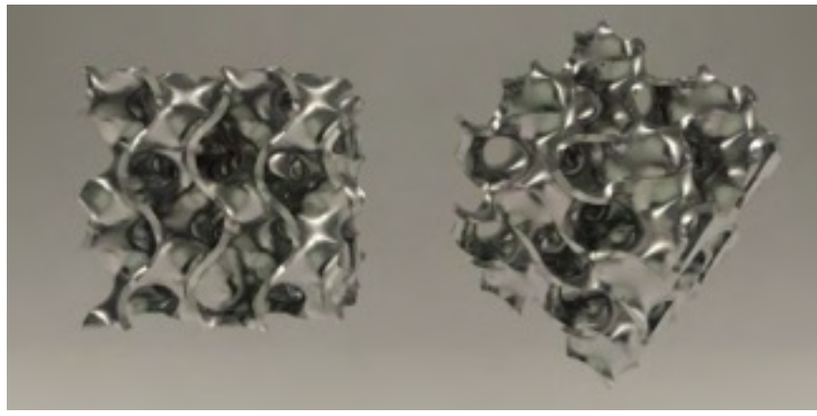
Ti6Al4V ELI

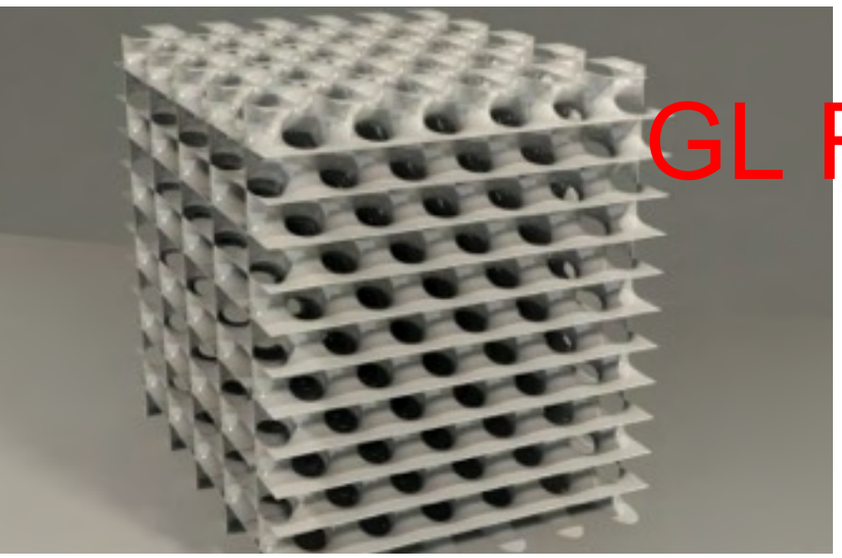


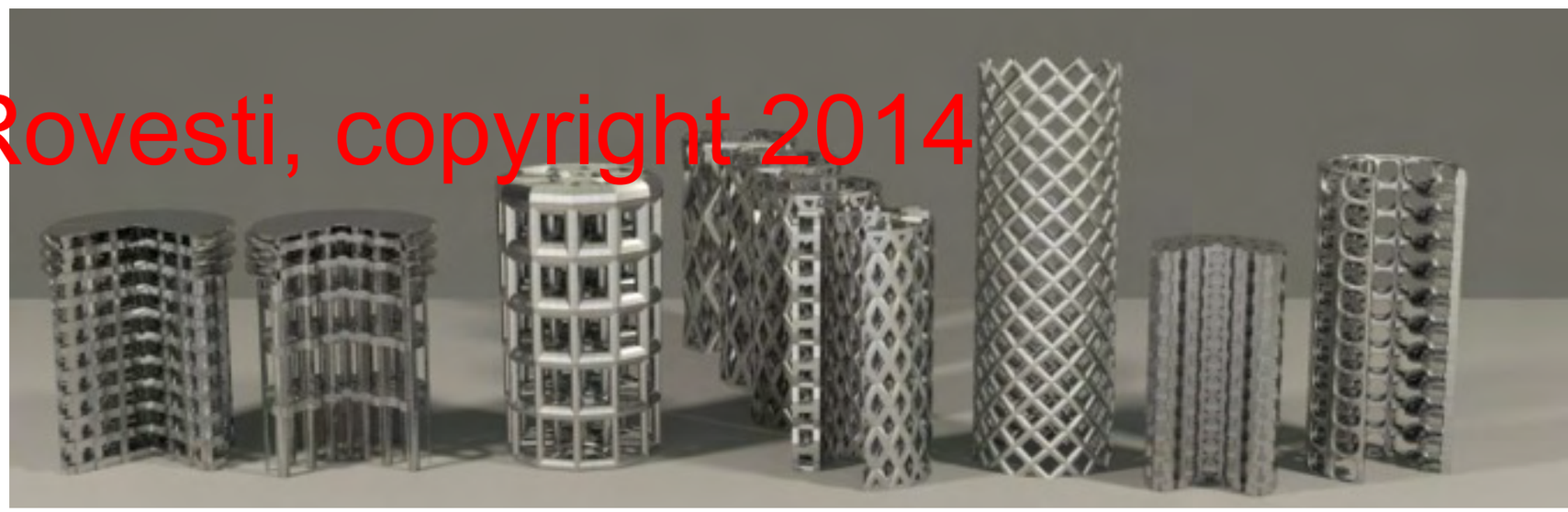
Brain storming of possible geometries

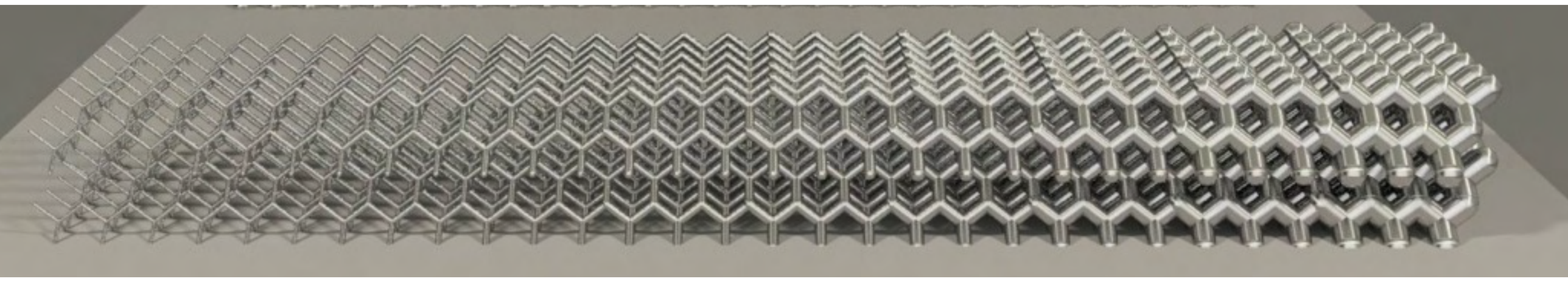










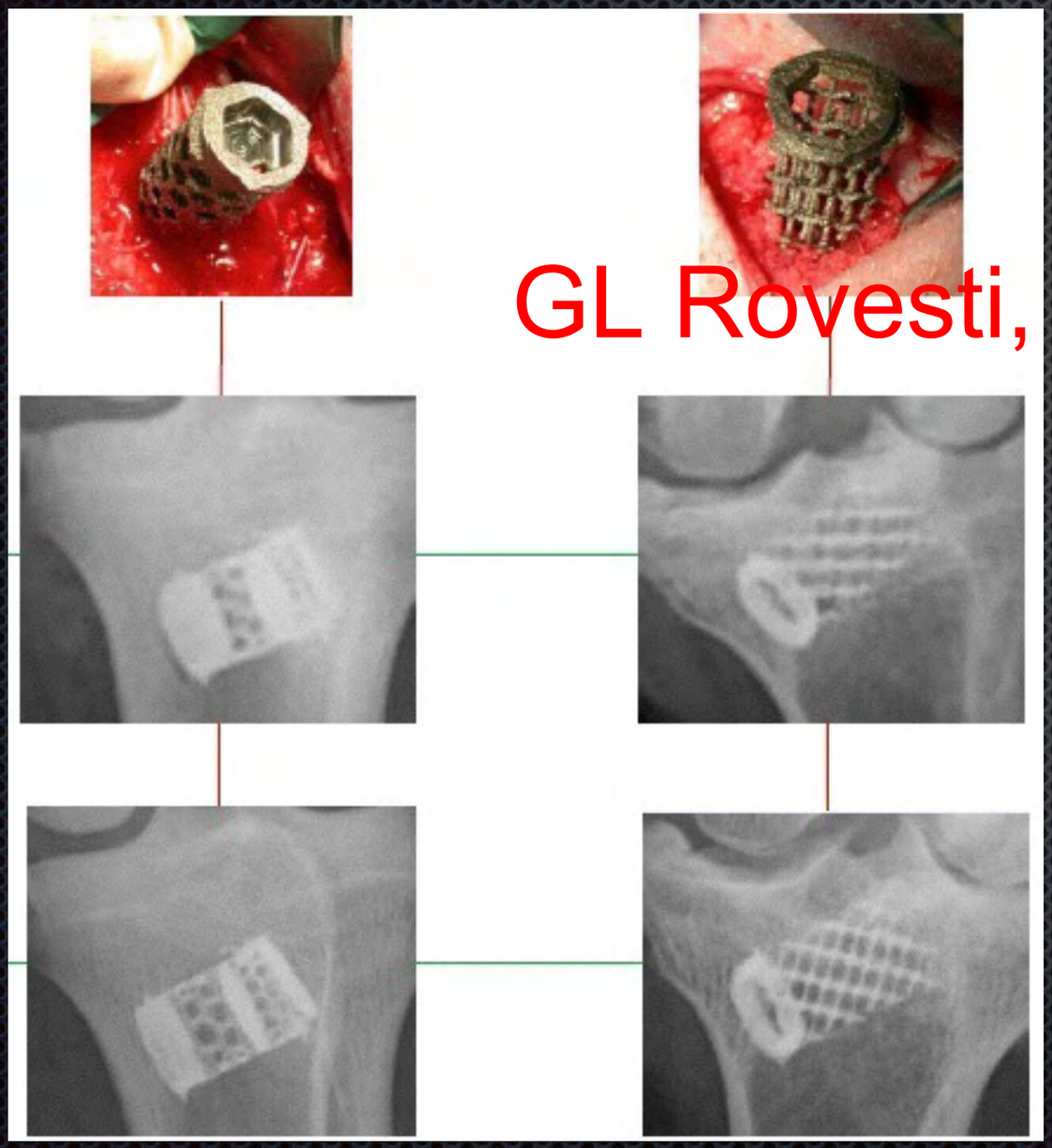


Experimental background

Prof. Antonio Crovace - Bari, Italy

Experimental background

Prof. Antonio Crovace - Bari, Italy



Experimental background

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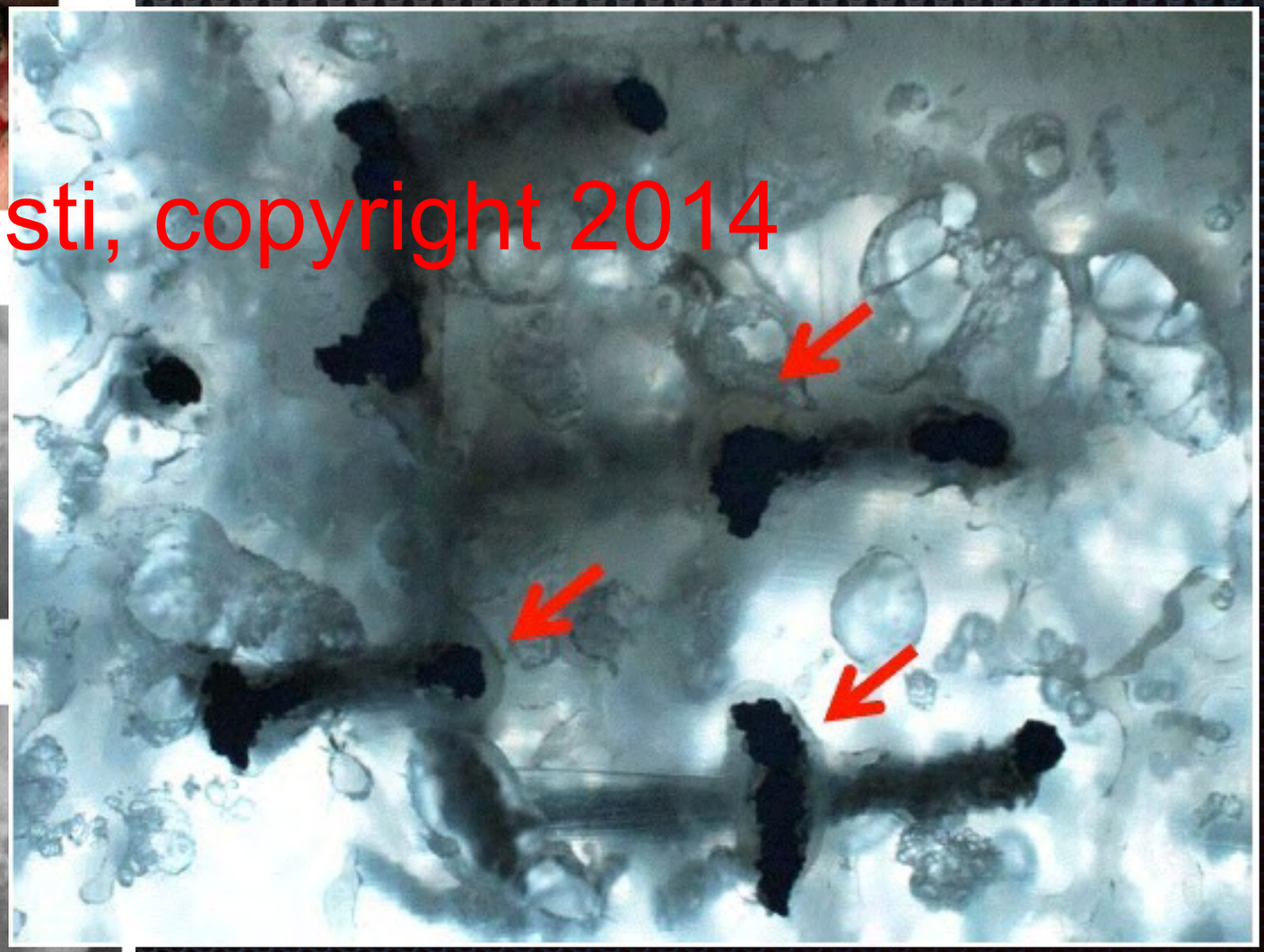


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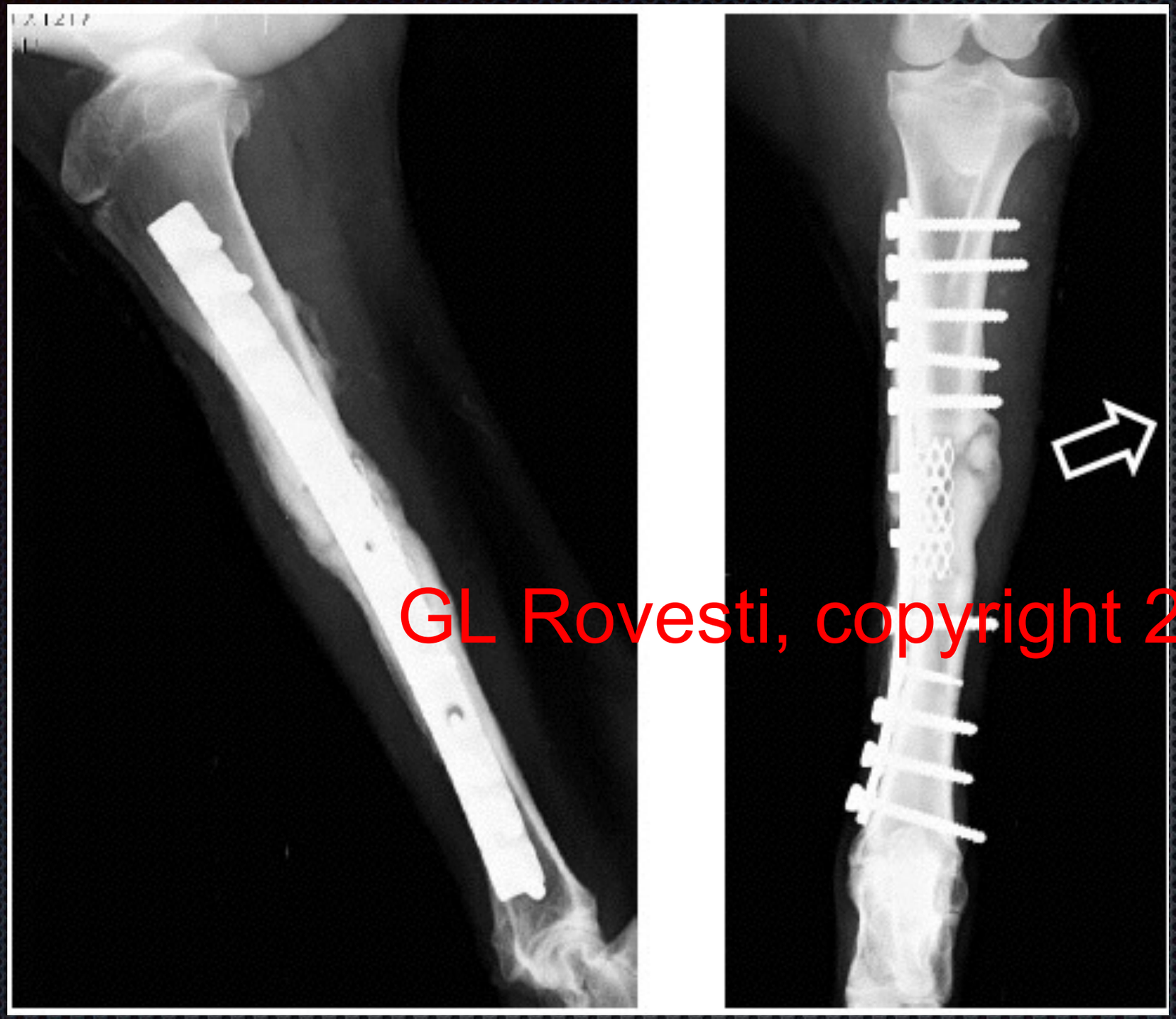

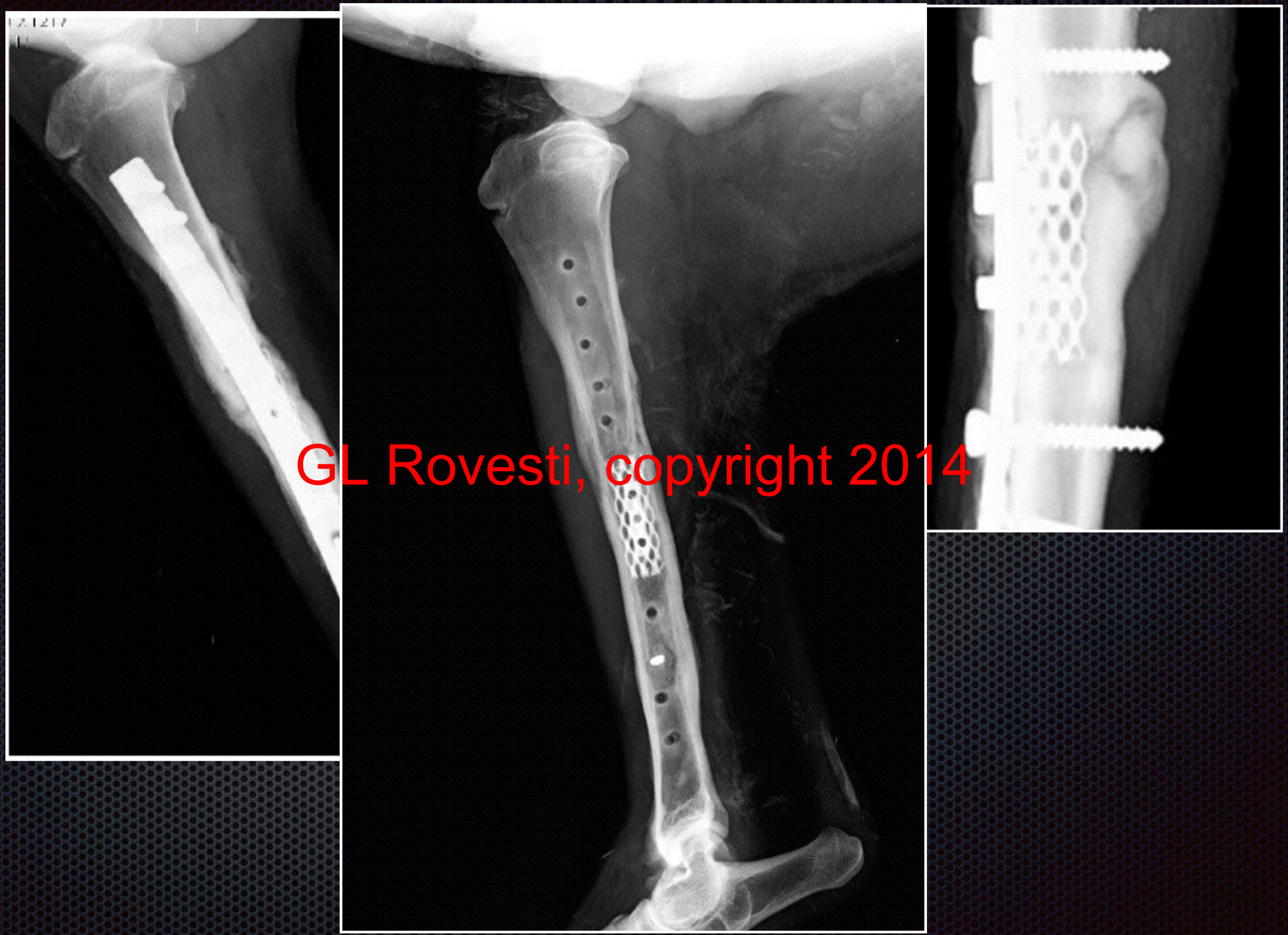

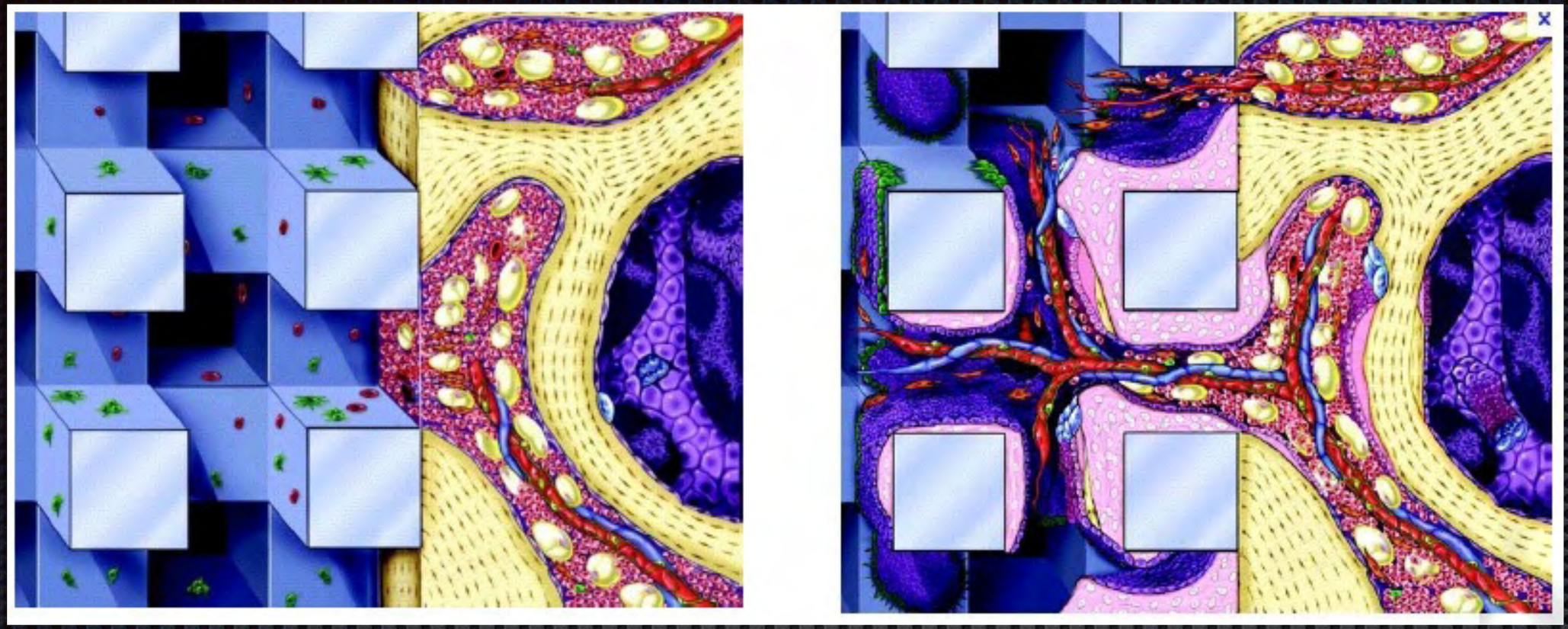

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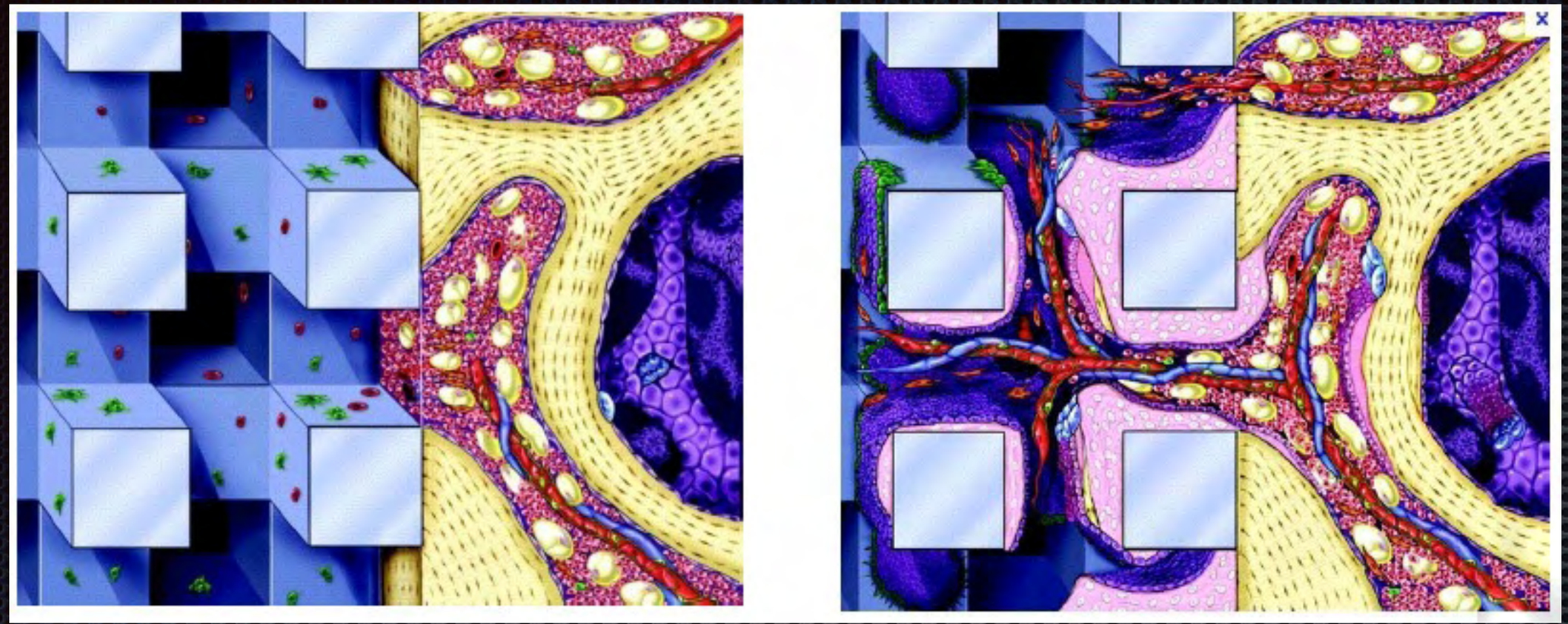
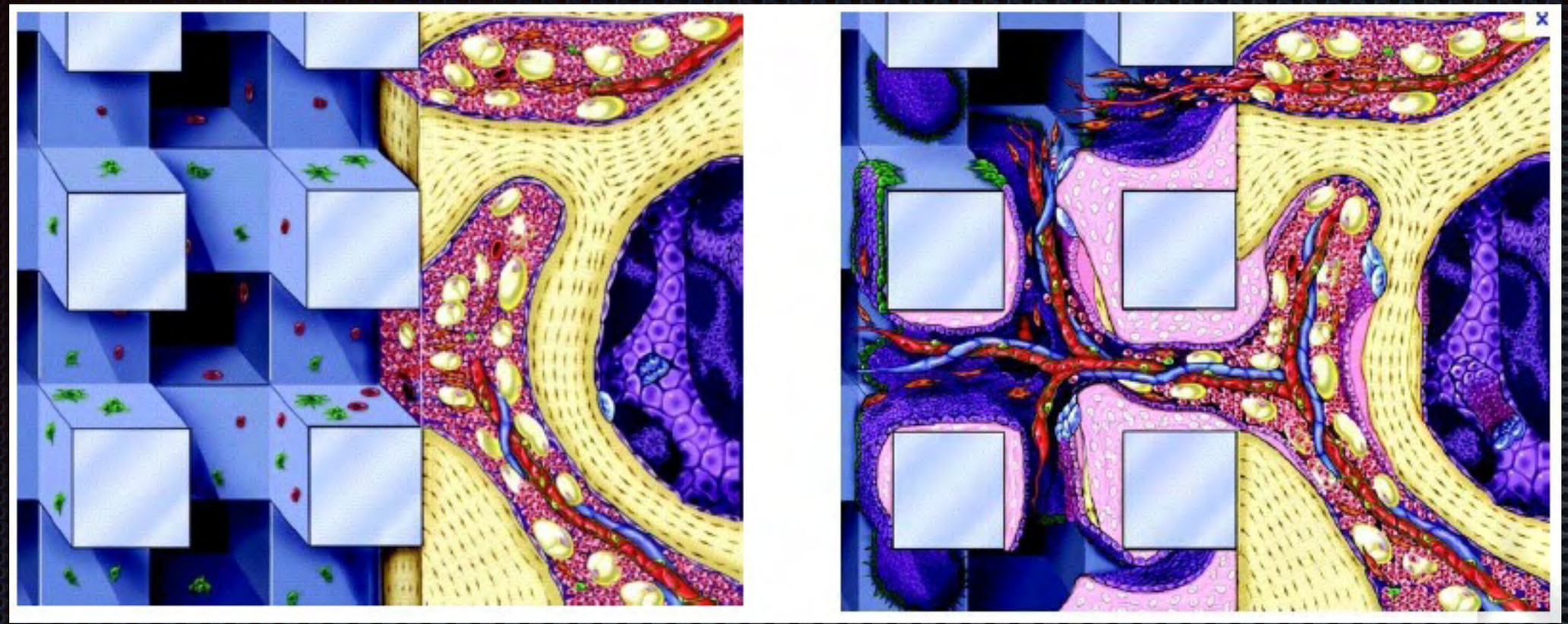




It doesn't happen w/out weight bearing: why?

Plate or cerclage?

Plate or cerclage?

Why not a plate that behaved like a cerclage?

Plate or cerclage?

Why not a plate that behaves like a cerclage?

Plate or cerclage?

Why not a plate that behaves like a cerclage?

Plate or cerclage?

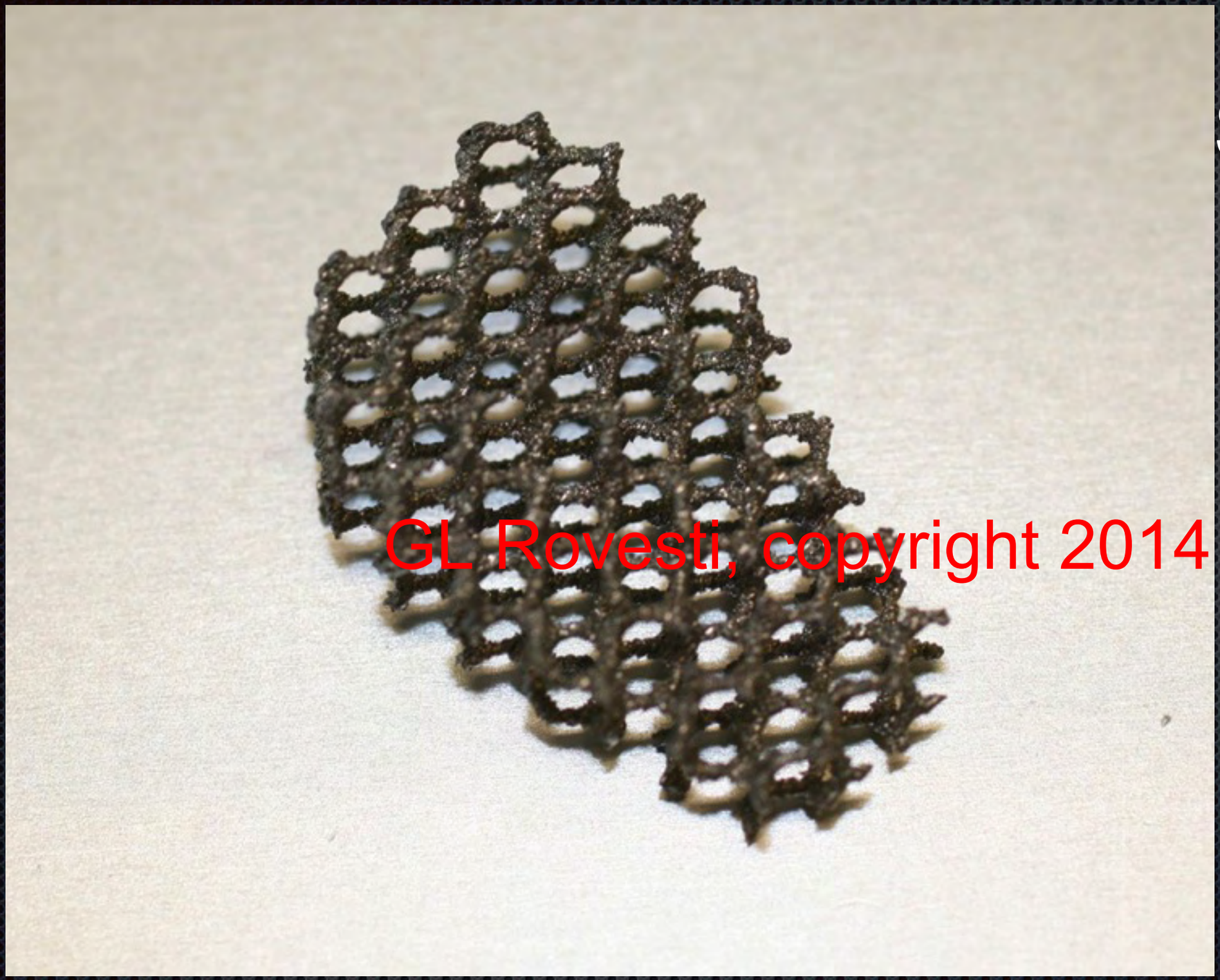
Why not a plate that behaves like a cerclage?

Plate or cerclage?

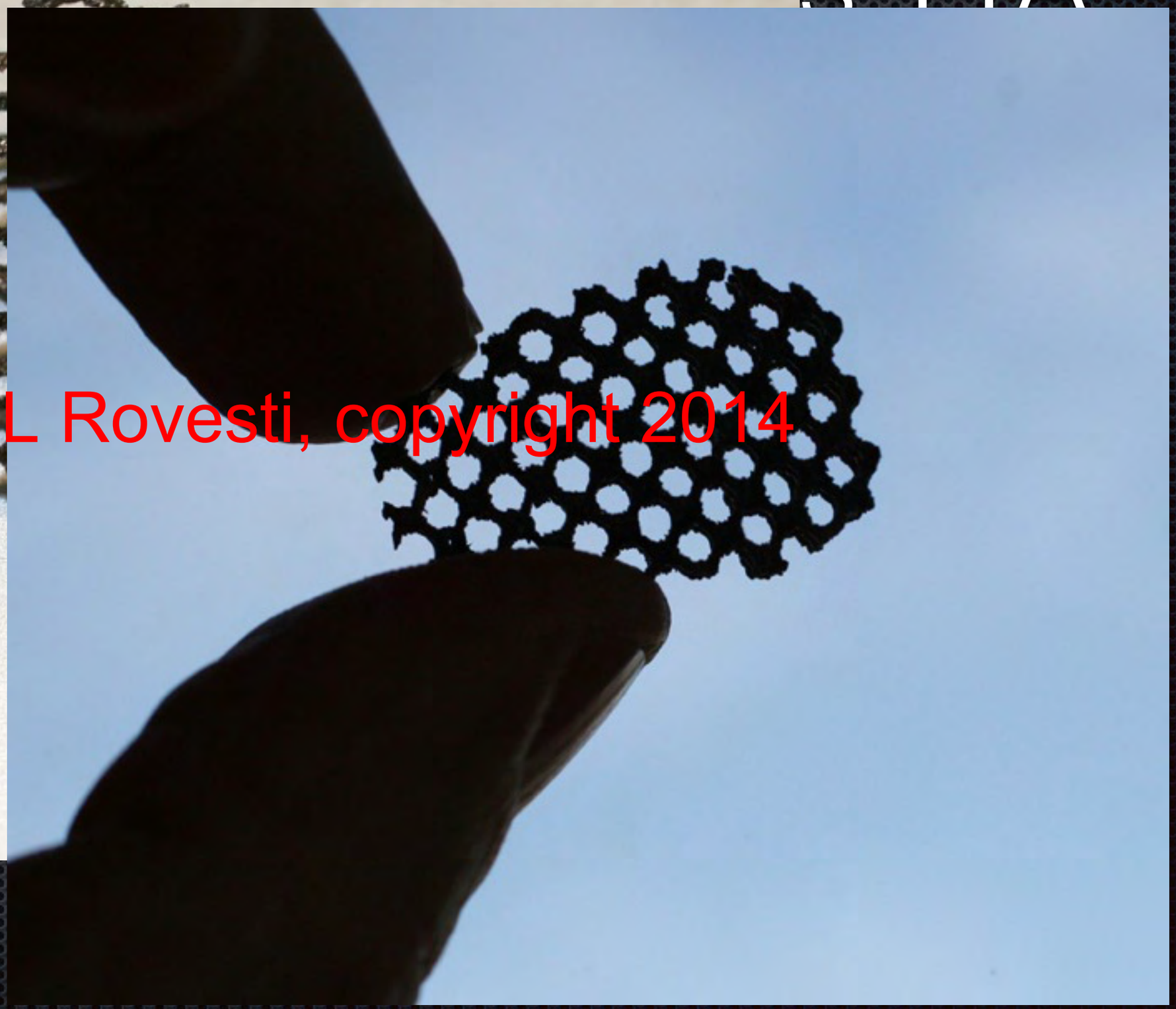
Why not a plate that behaves like a cerclage?

Third generation porous TTA

s TTA



s TTA



Diagnostic algorythm for the CCL-deficient stifle
(personal, not published and debatable)

Stable stifle

Stable stifle

↓

TPA >30°

Stable stifle

TPA >30°

TPLO

Stable stifle

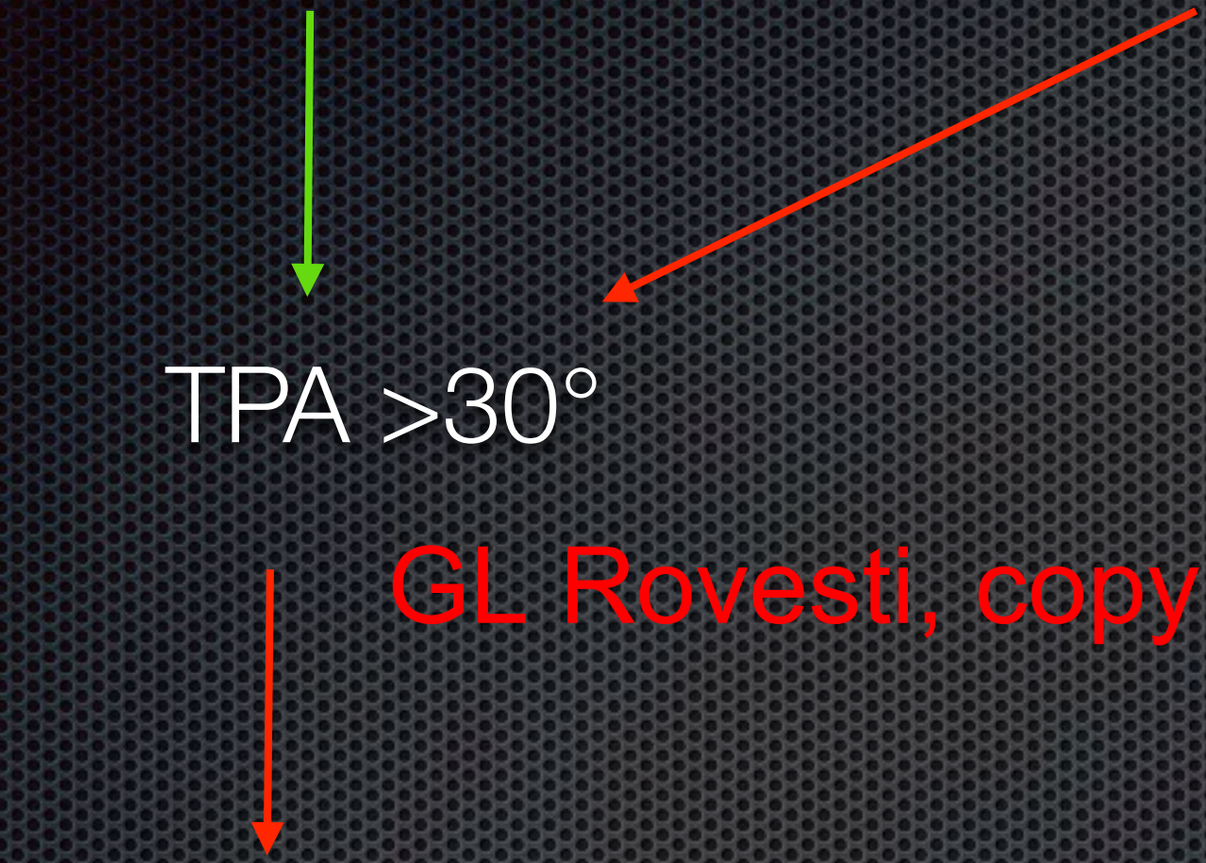
Unstable stifle

TPA >30°

TPLO

Stable stifle

Unstable stifle



TPA >30°

TPLO

Stable stifle

Unstable stifle

TPA >30°

TPA <30°

TPLO

Stable stifle

Unstable stifle

TPA >30°

TPA <30°

TPLO

TTA

Stable stifle

Unstable stifle

TPA >30°

TPA <30°

TPLO

TTA

Stable stifle

Unstable stifle

TPA >30°

TPA <30°

Caudal meniscal lesion

TPLO

TTA

Stable stifle

Unstable stifle

TPA >30°

TPA <30°

Caudal meniscal lesion

TPLO

TTO

TTA

Stable stifle

Unstable stifle

TPA >30°

TPA <30°

Caudal meniscal lesion

TPLO

TTO

TTA

Stable stifle

Unstable stifle

TPA >30°

TPA <30°

Caudal meniscal lesion

TPLO

TTA

TTO

Stable stifle

Unstable stifle

TPA >30°

TPA <30°

Caudal meniscal lesion

TPLO

TTO

TTA

Extracapsular techniques?

Stable stifle

Unstable stifle

TPA >30°

TPA <30°

Caudal meniscal lesion

TPLO

TTA

Combination of techniques?

TTO

Extracapsular techniques?

Preop measurements

Preop measurements

Preop measurements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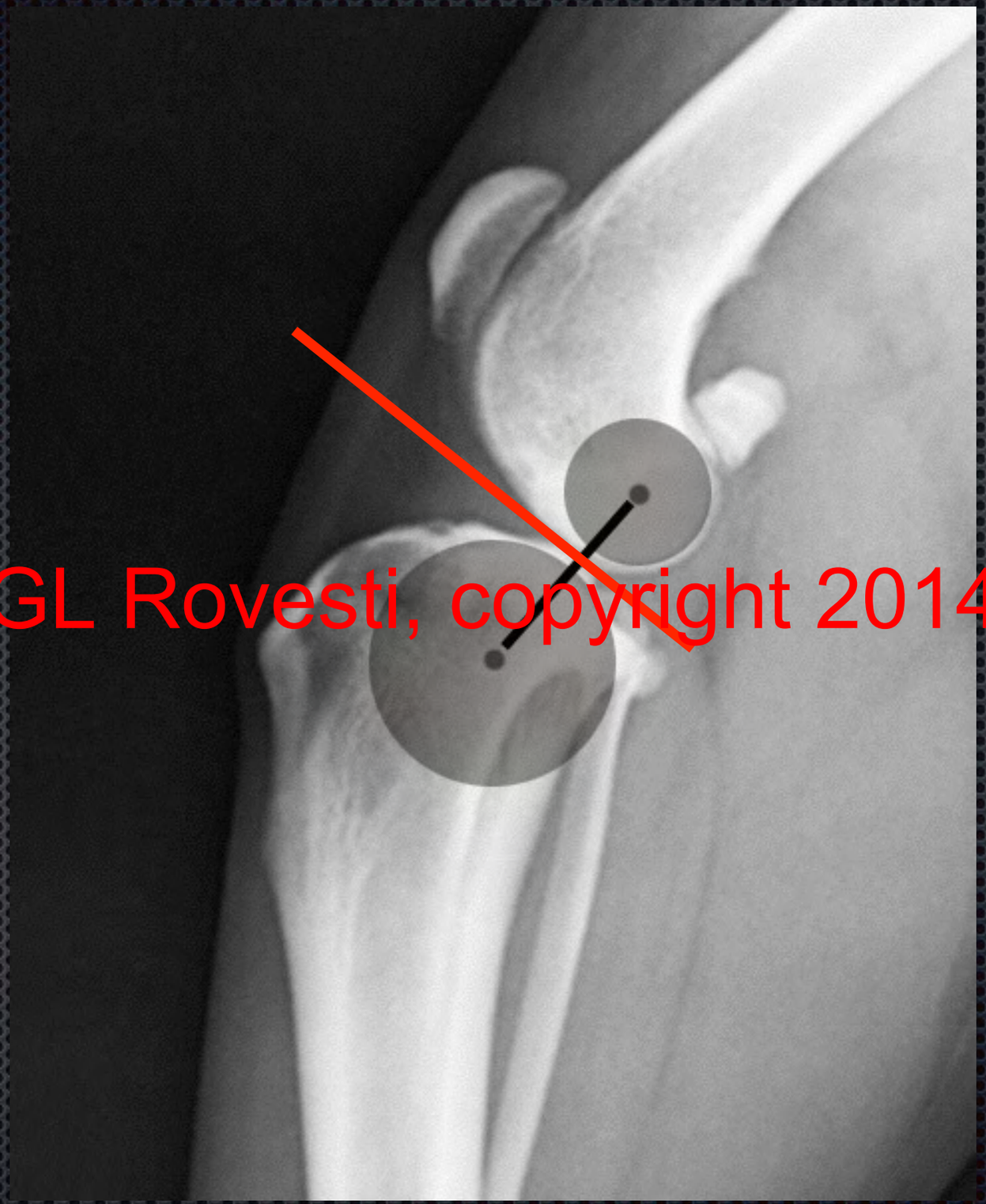
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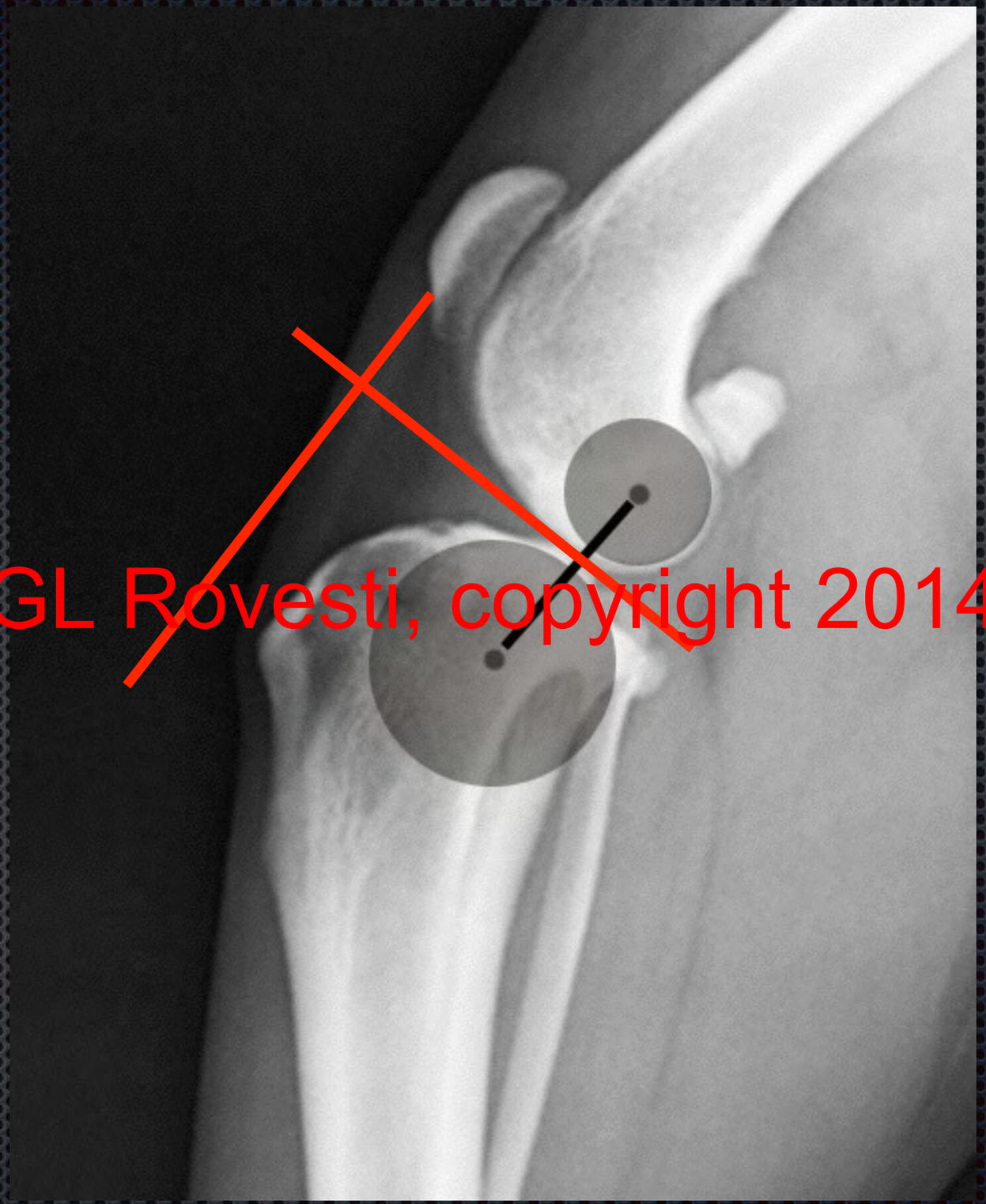
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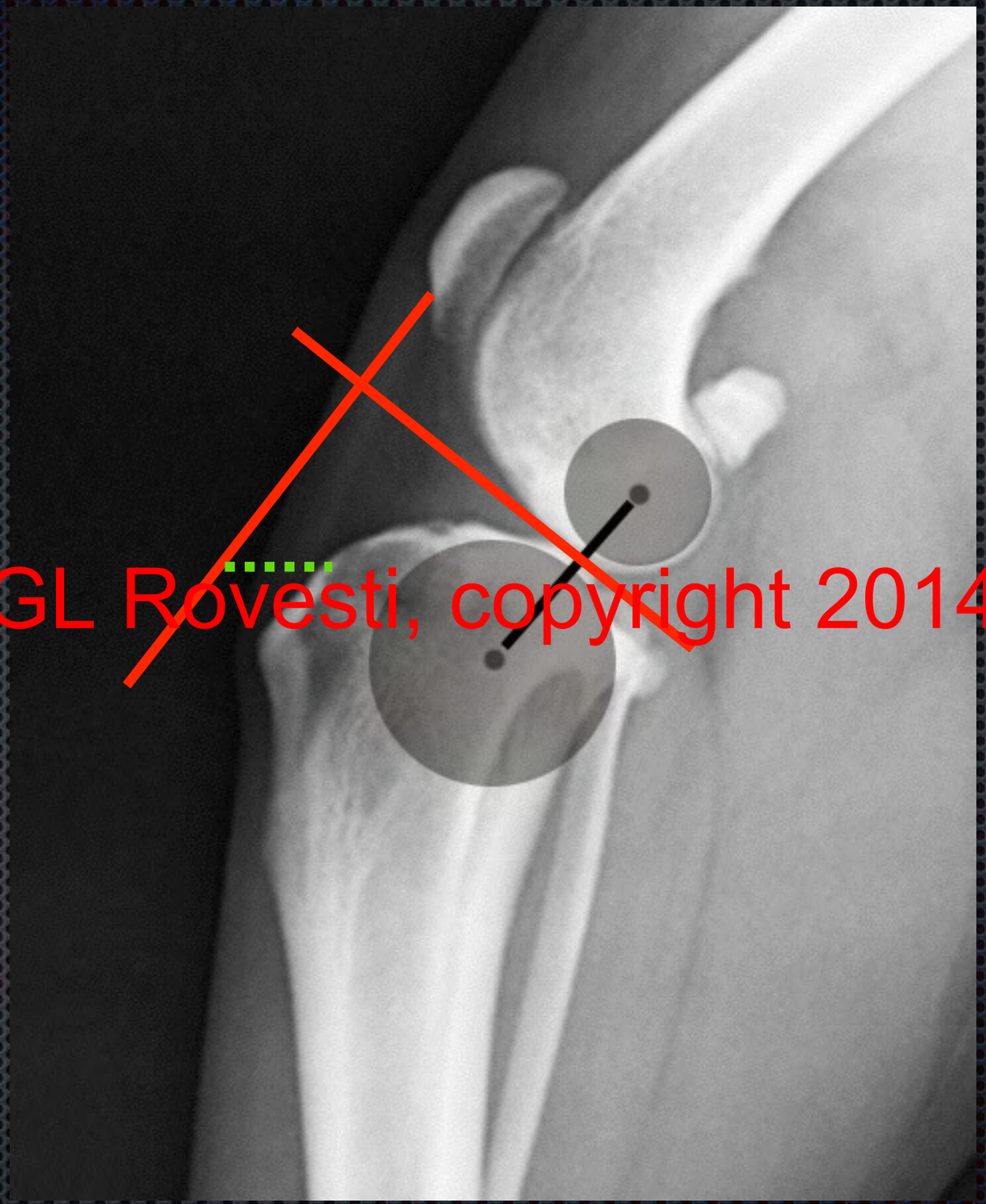
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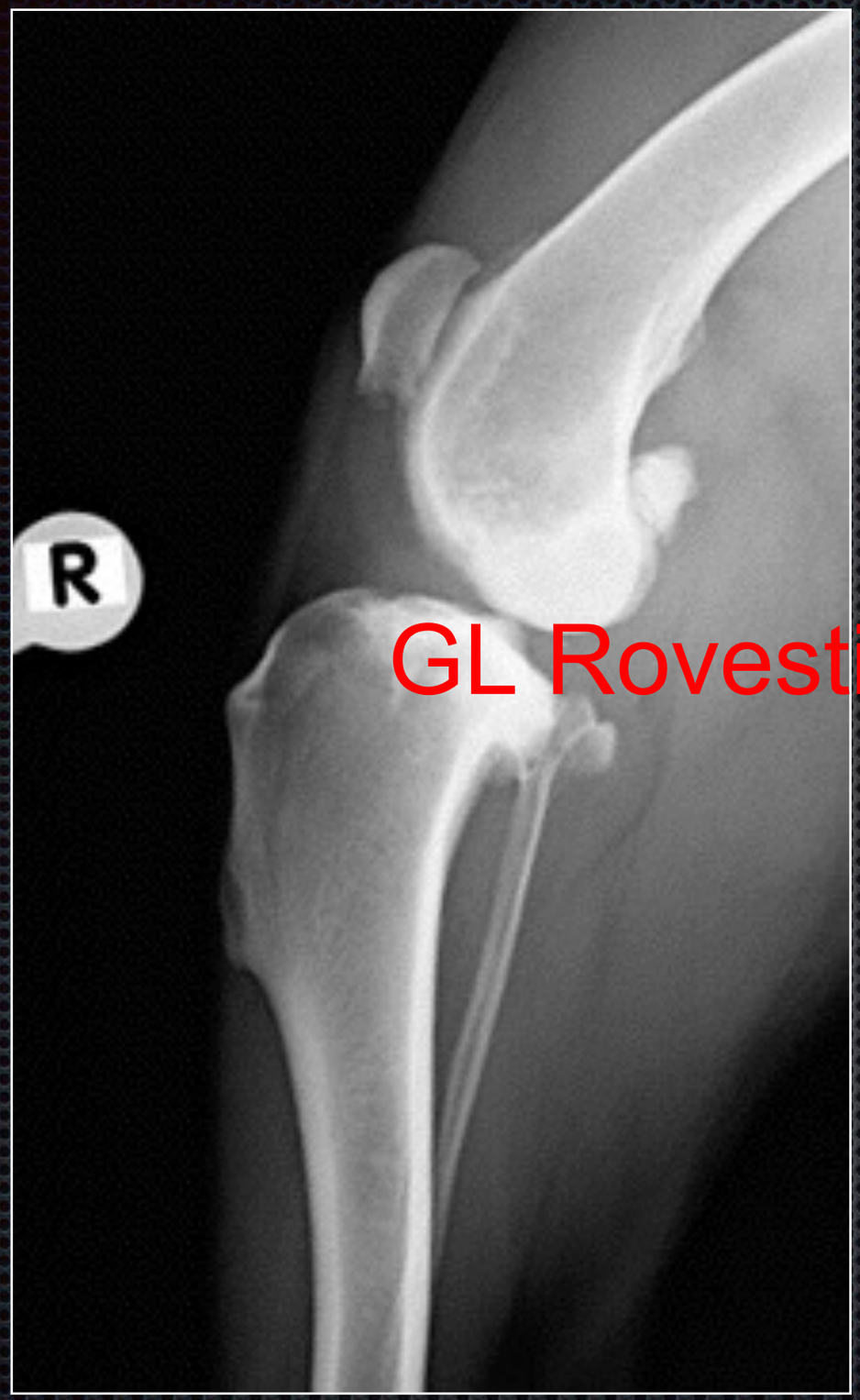

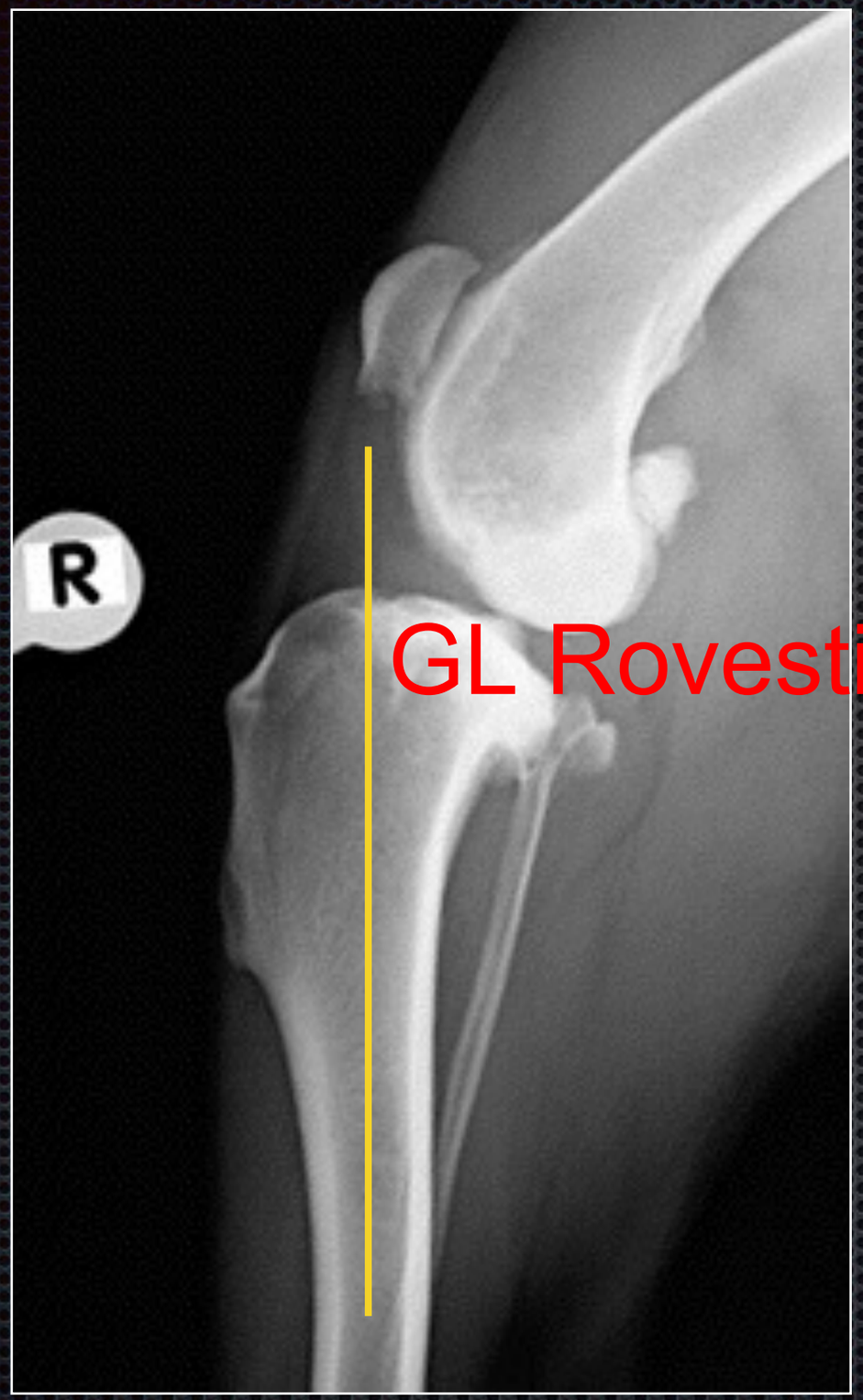

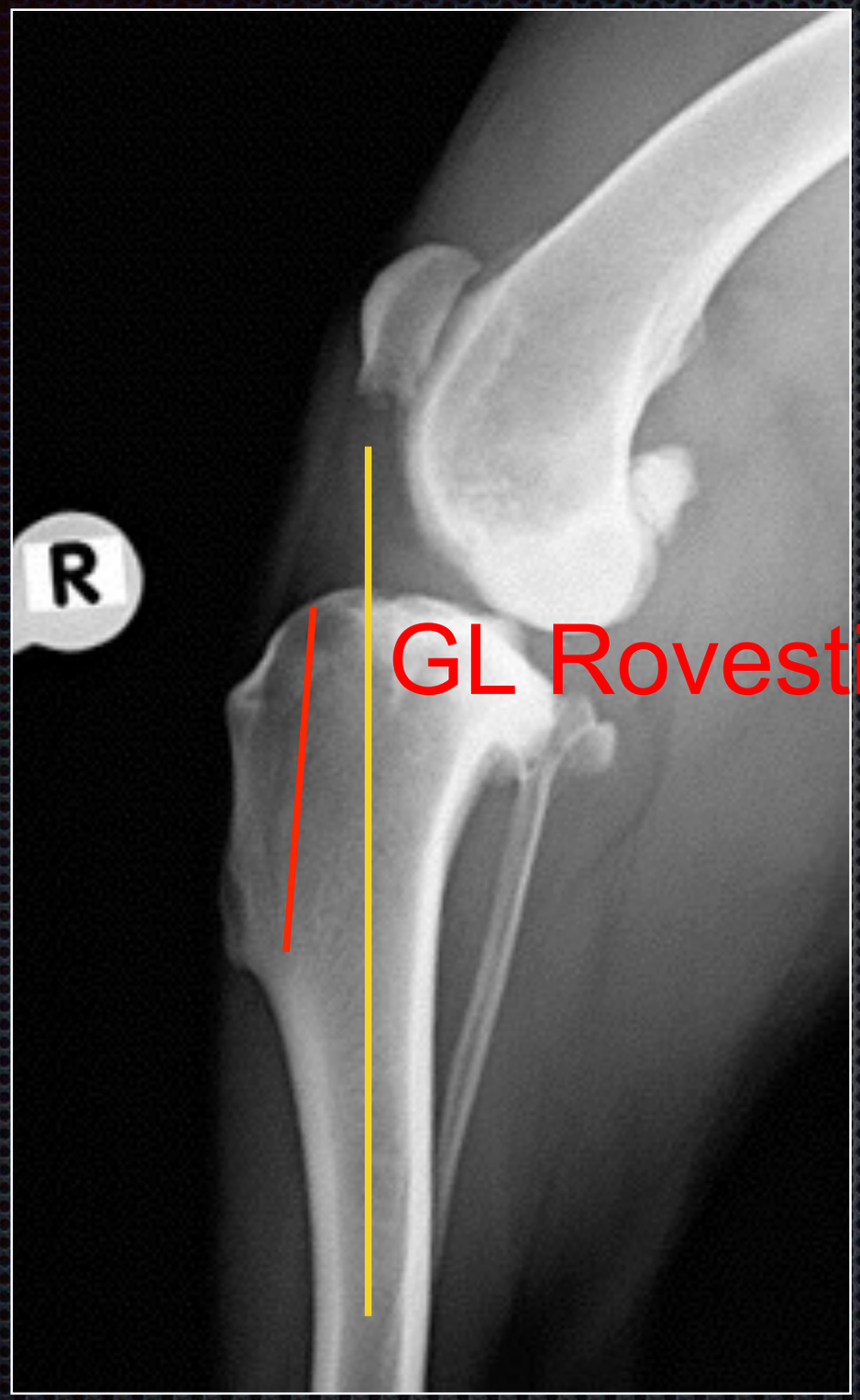

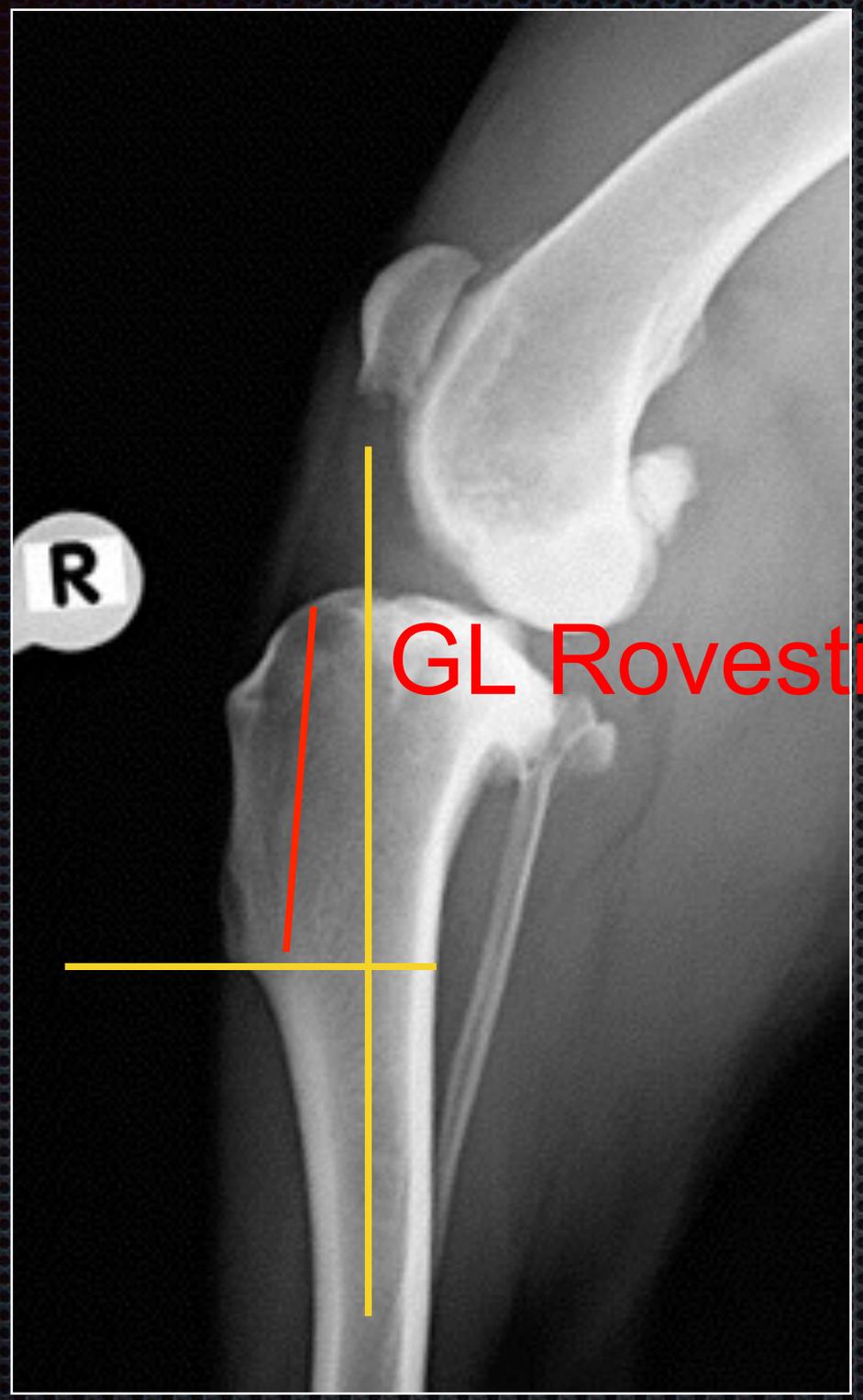

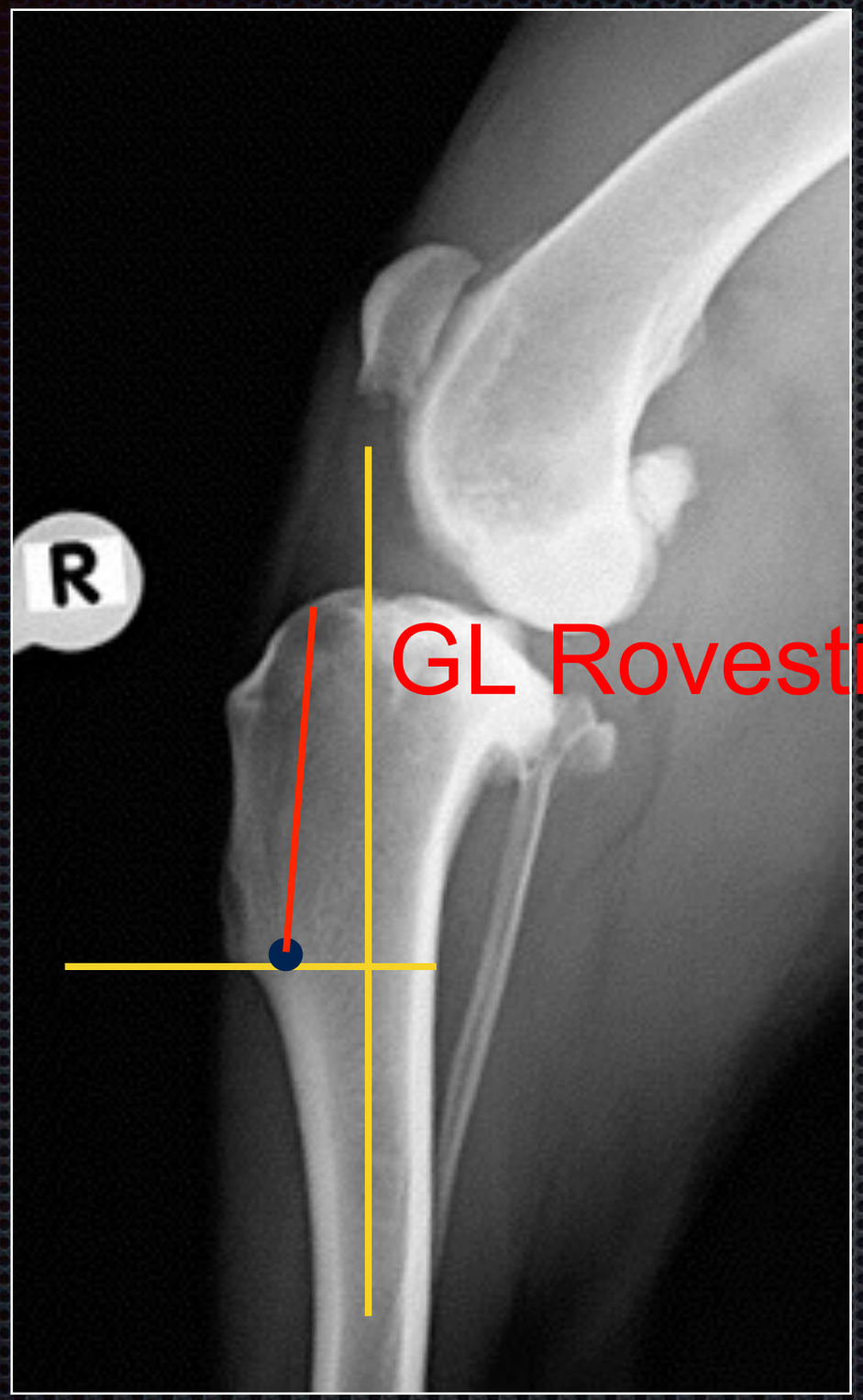

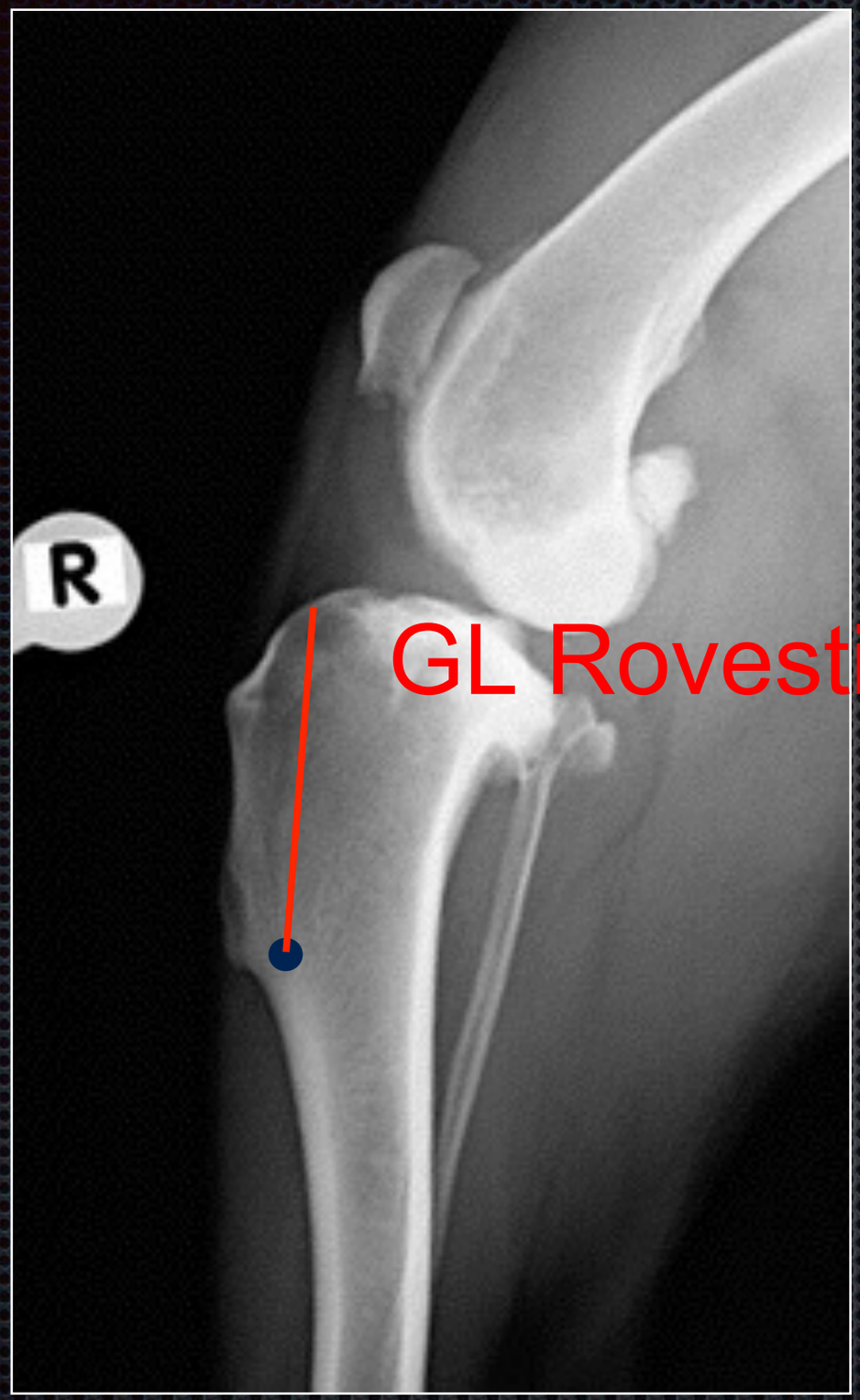
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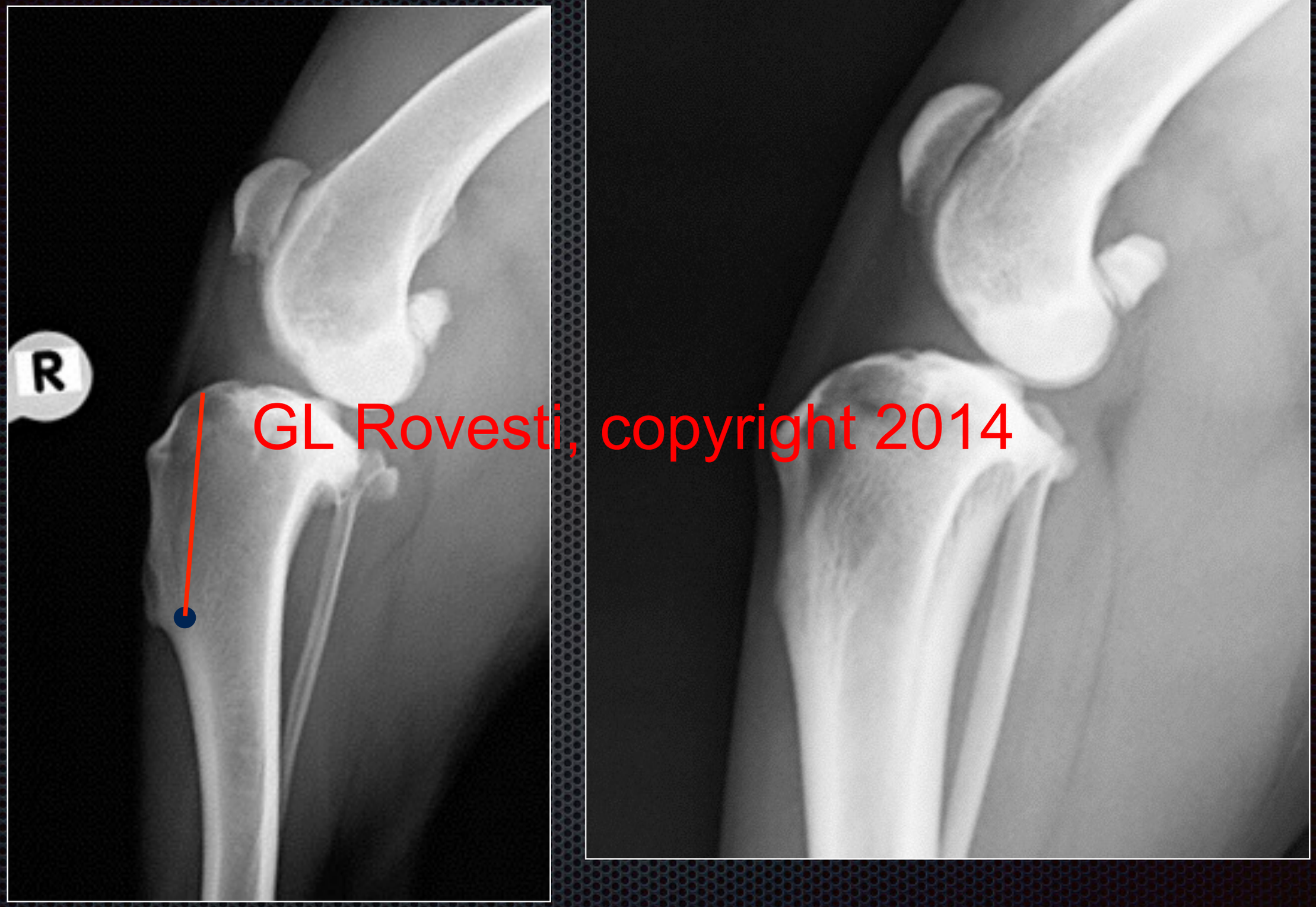

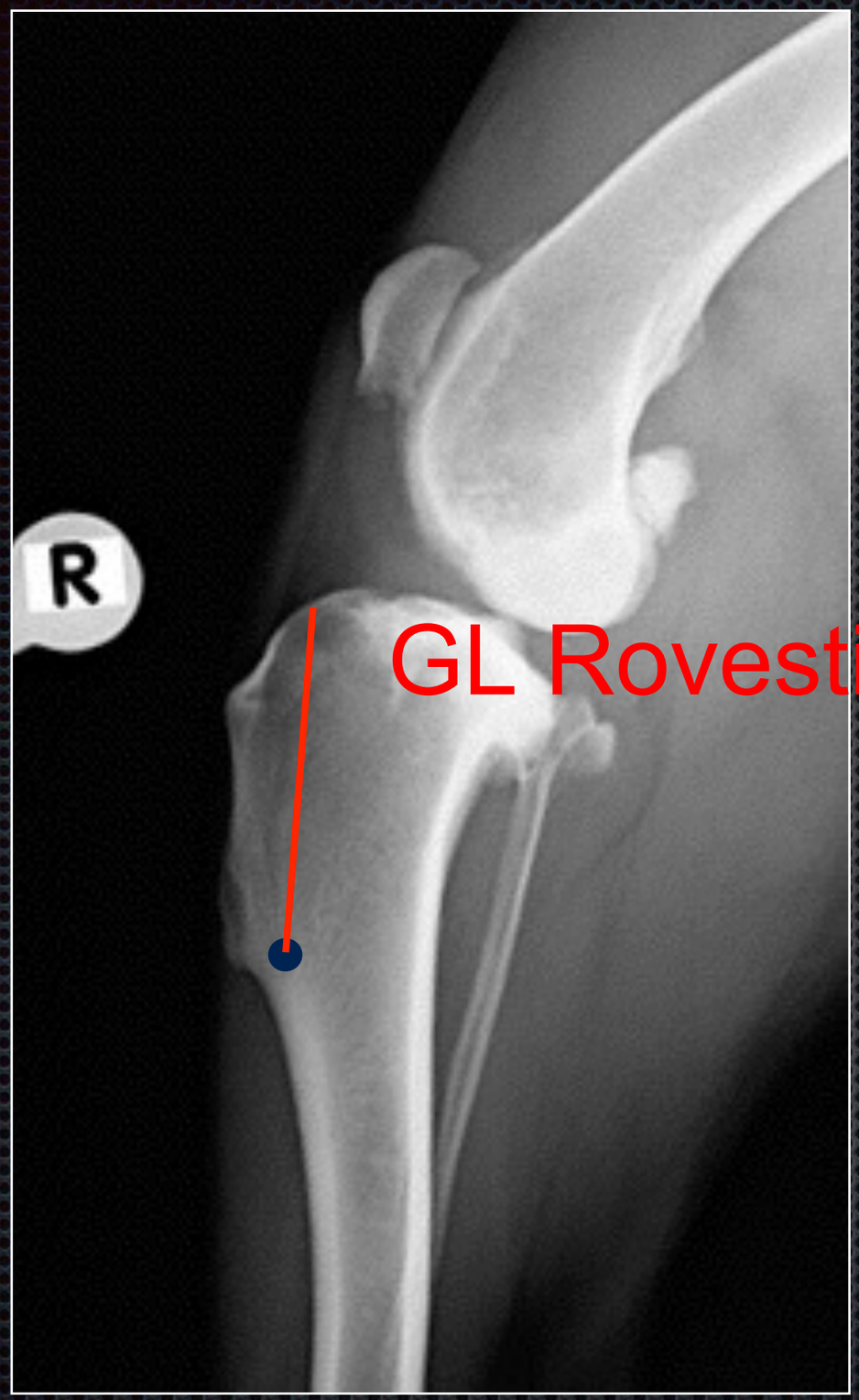

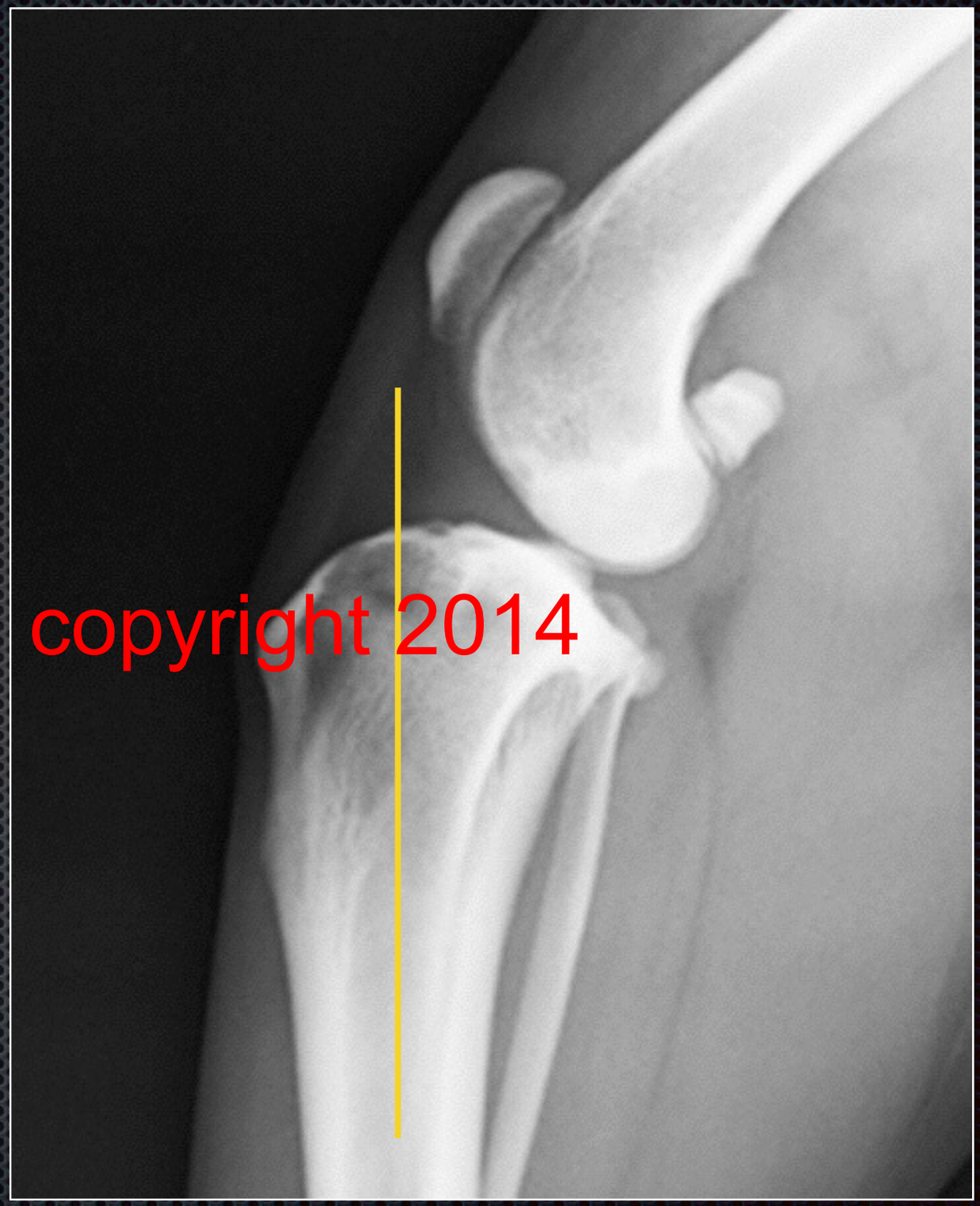

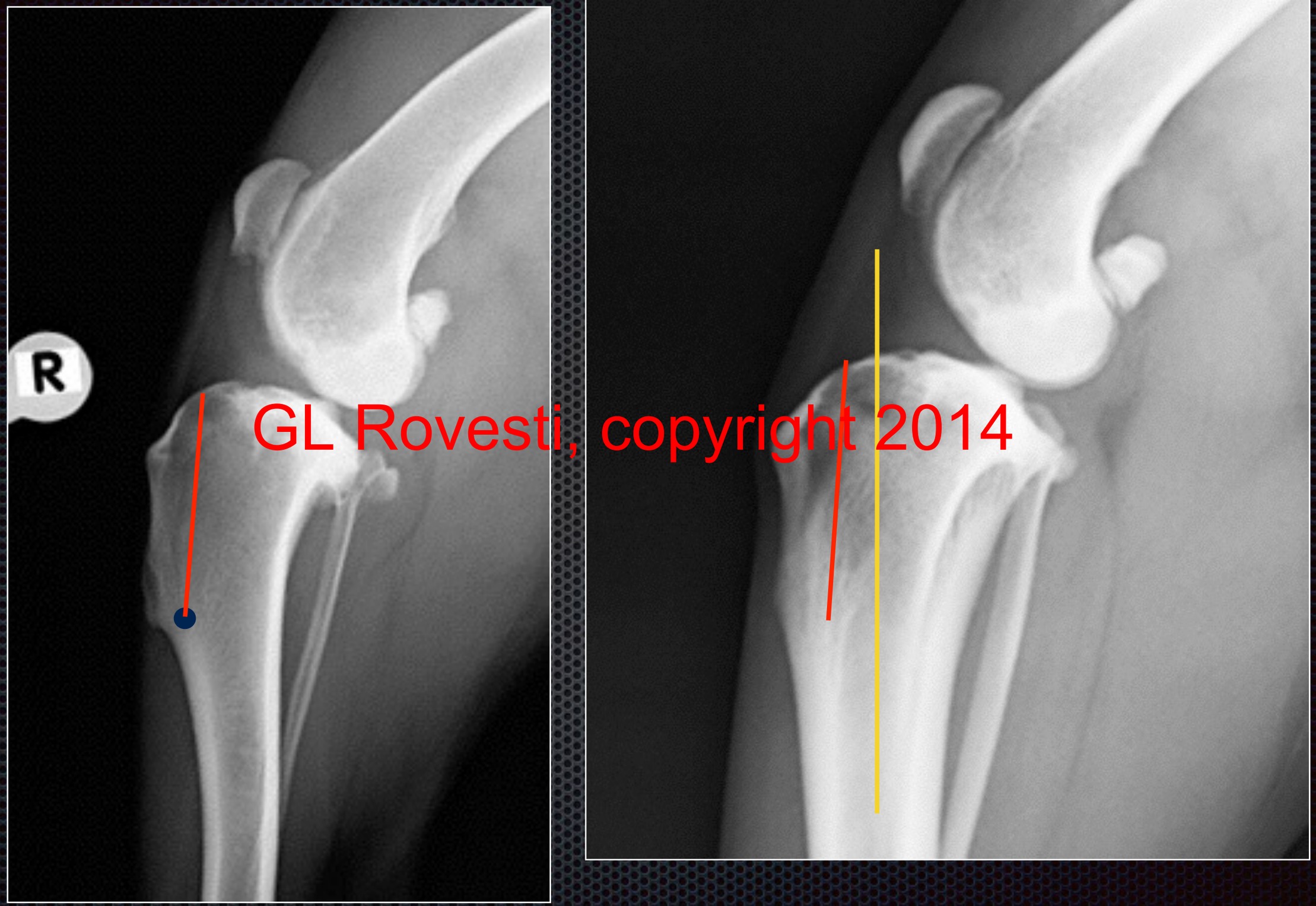

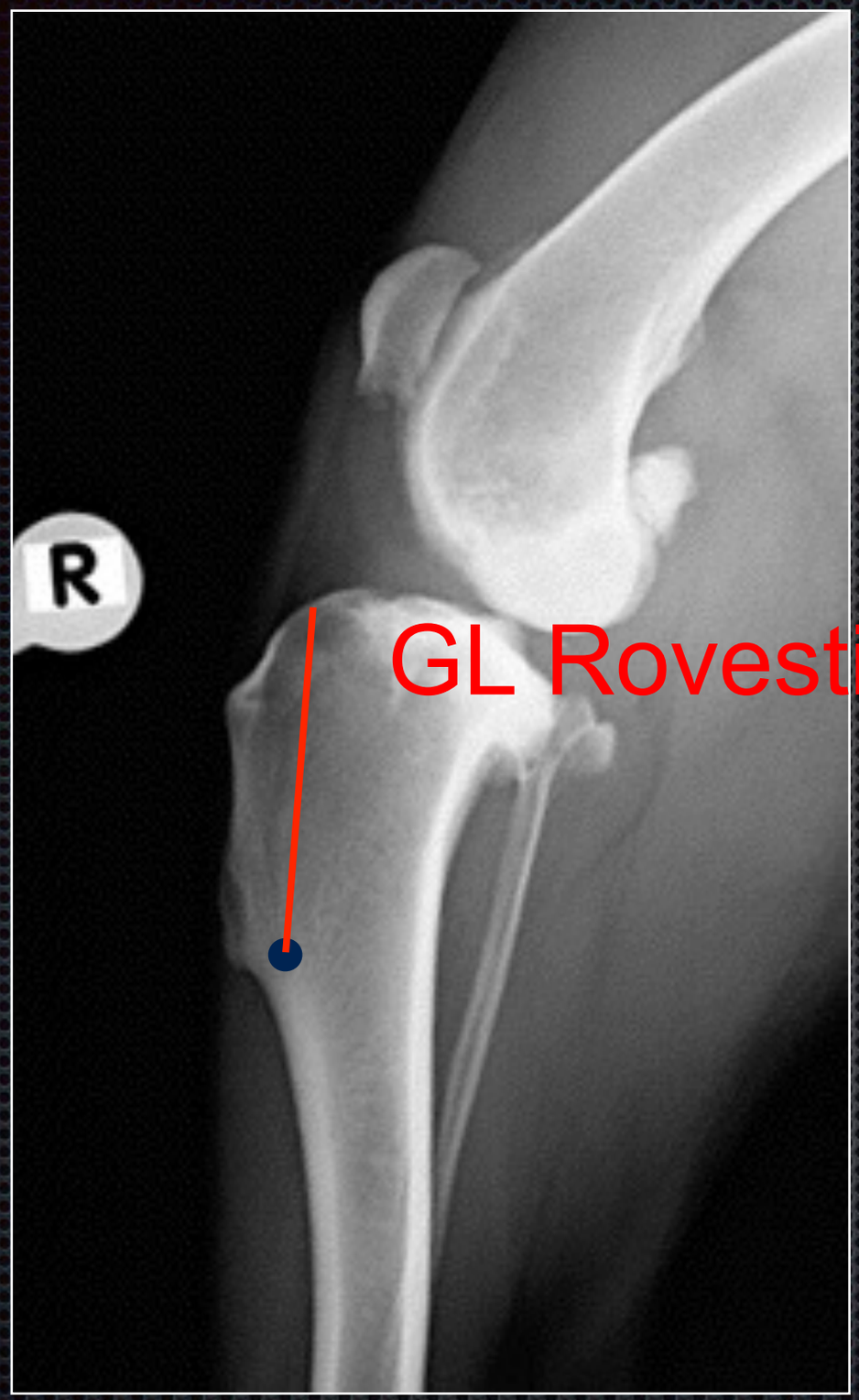

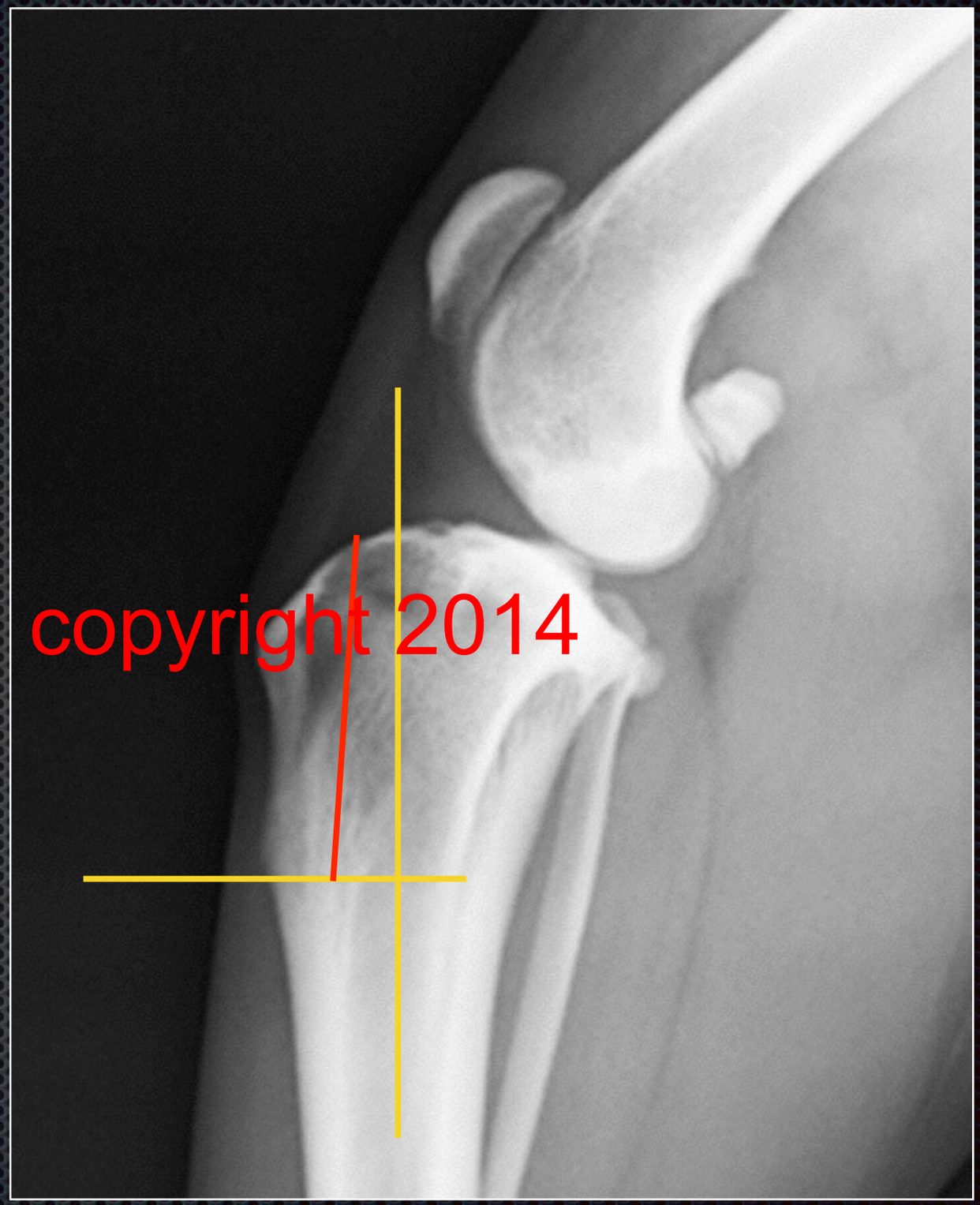

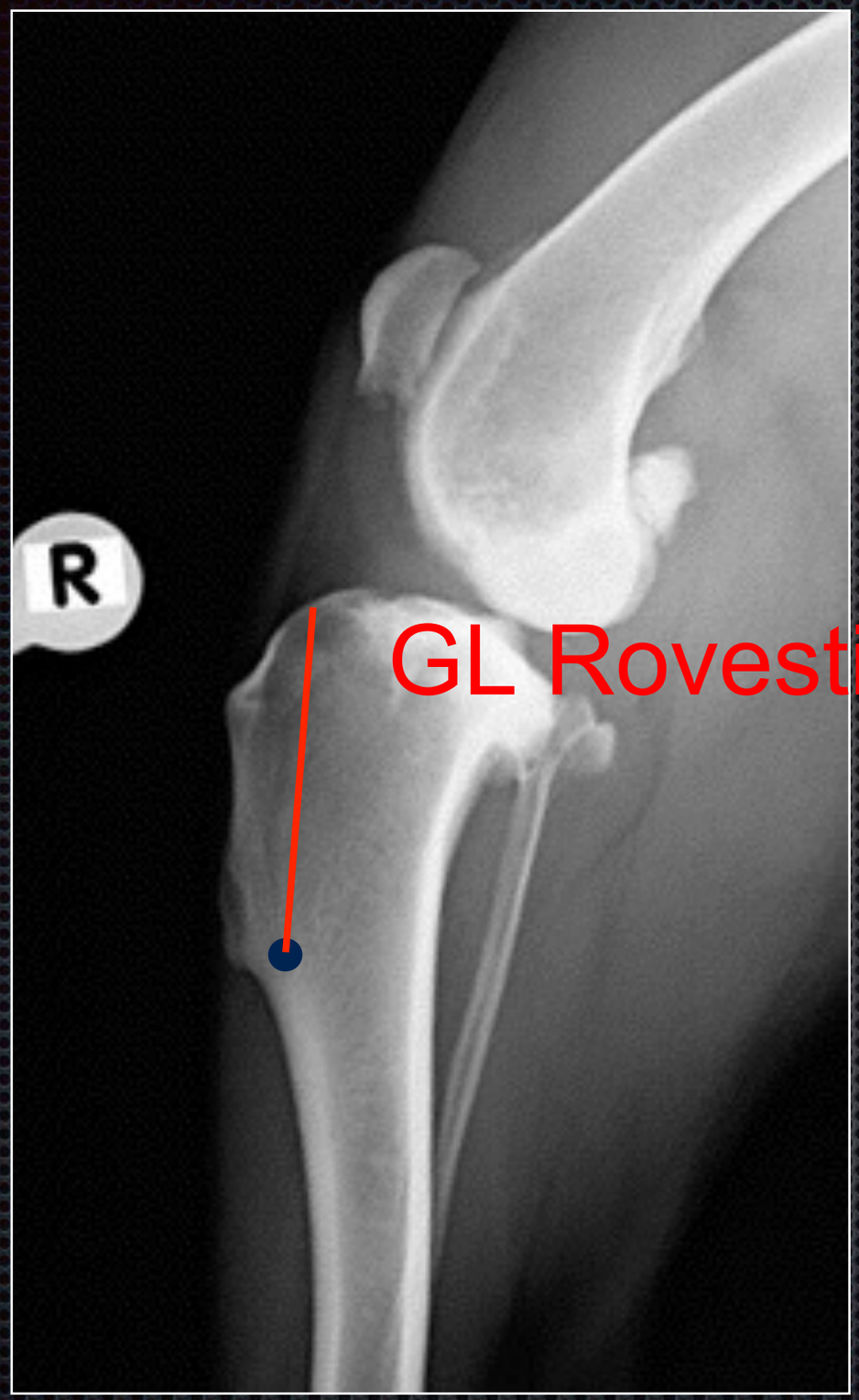

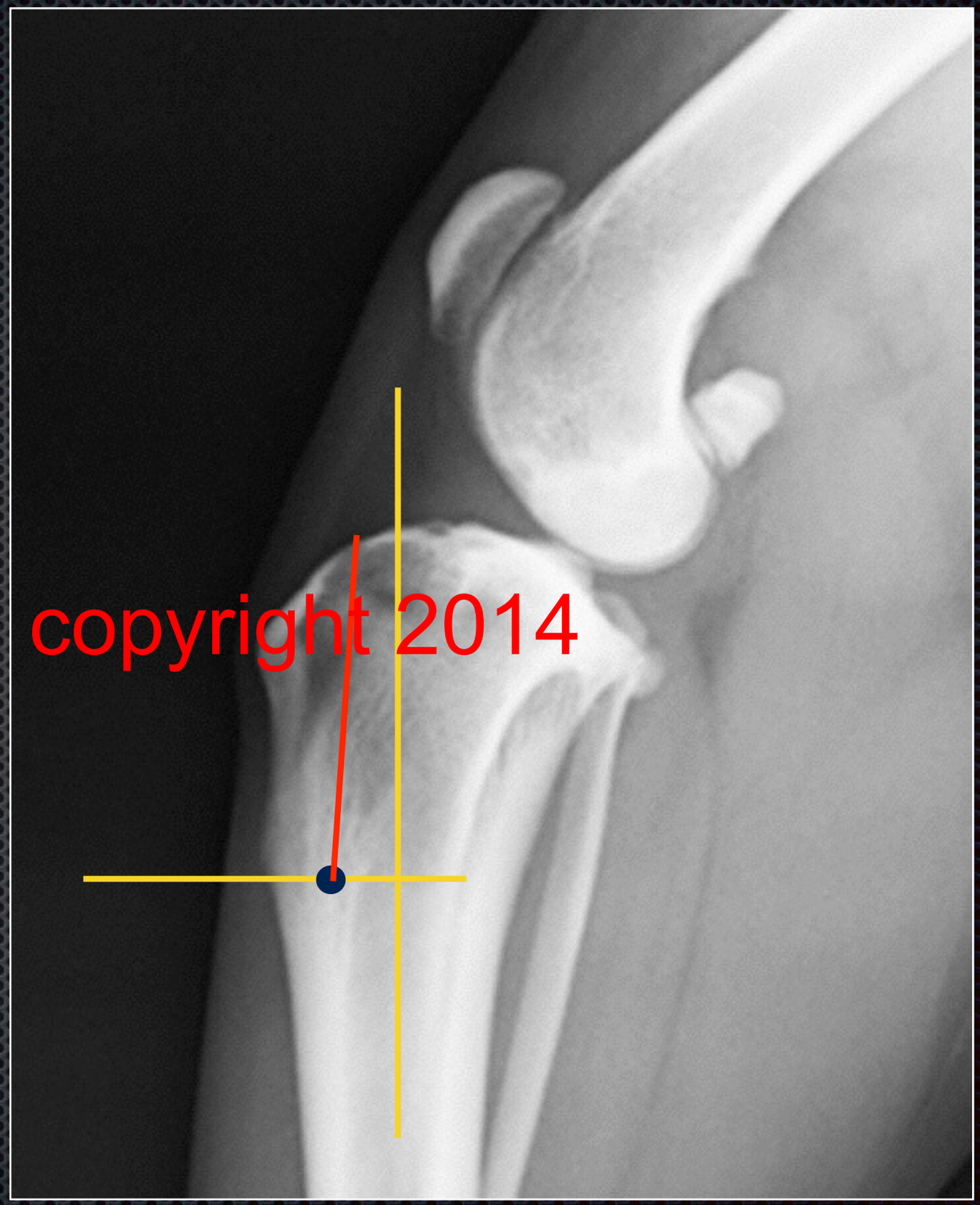

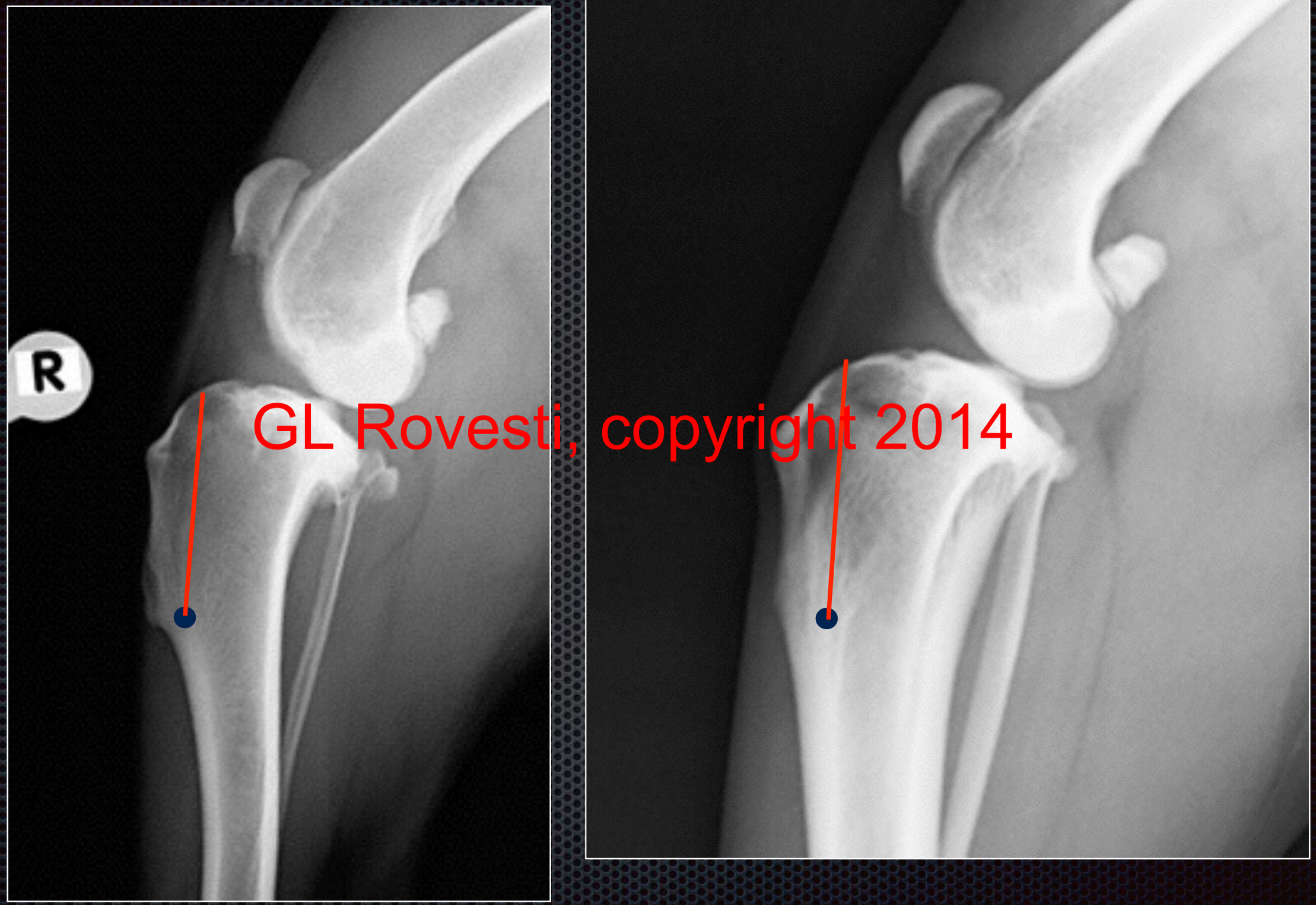
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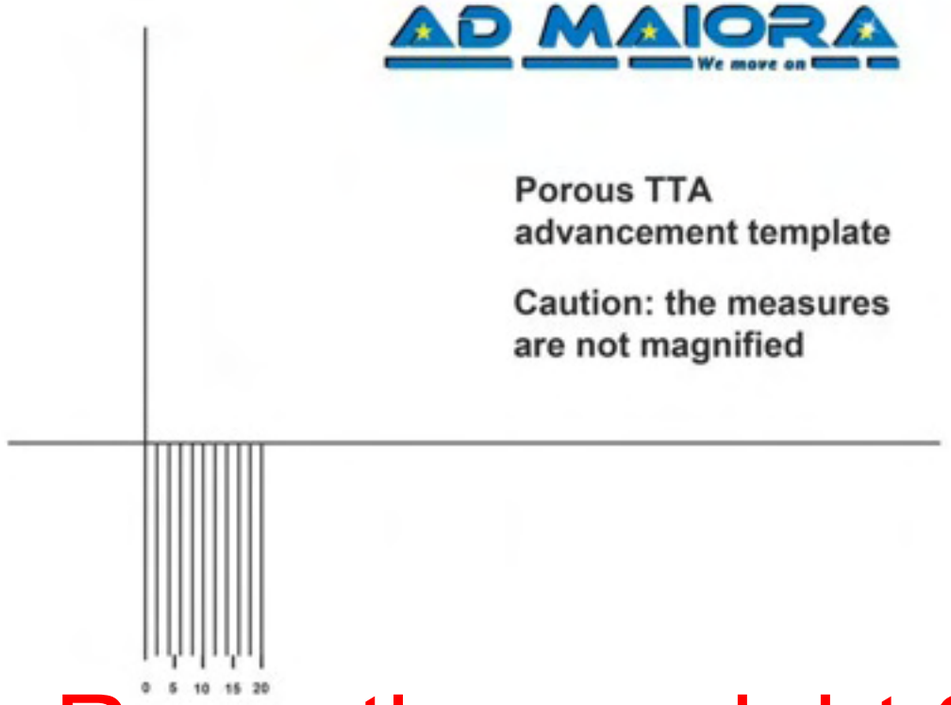
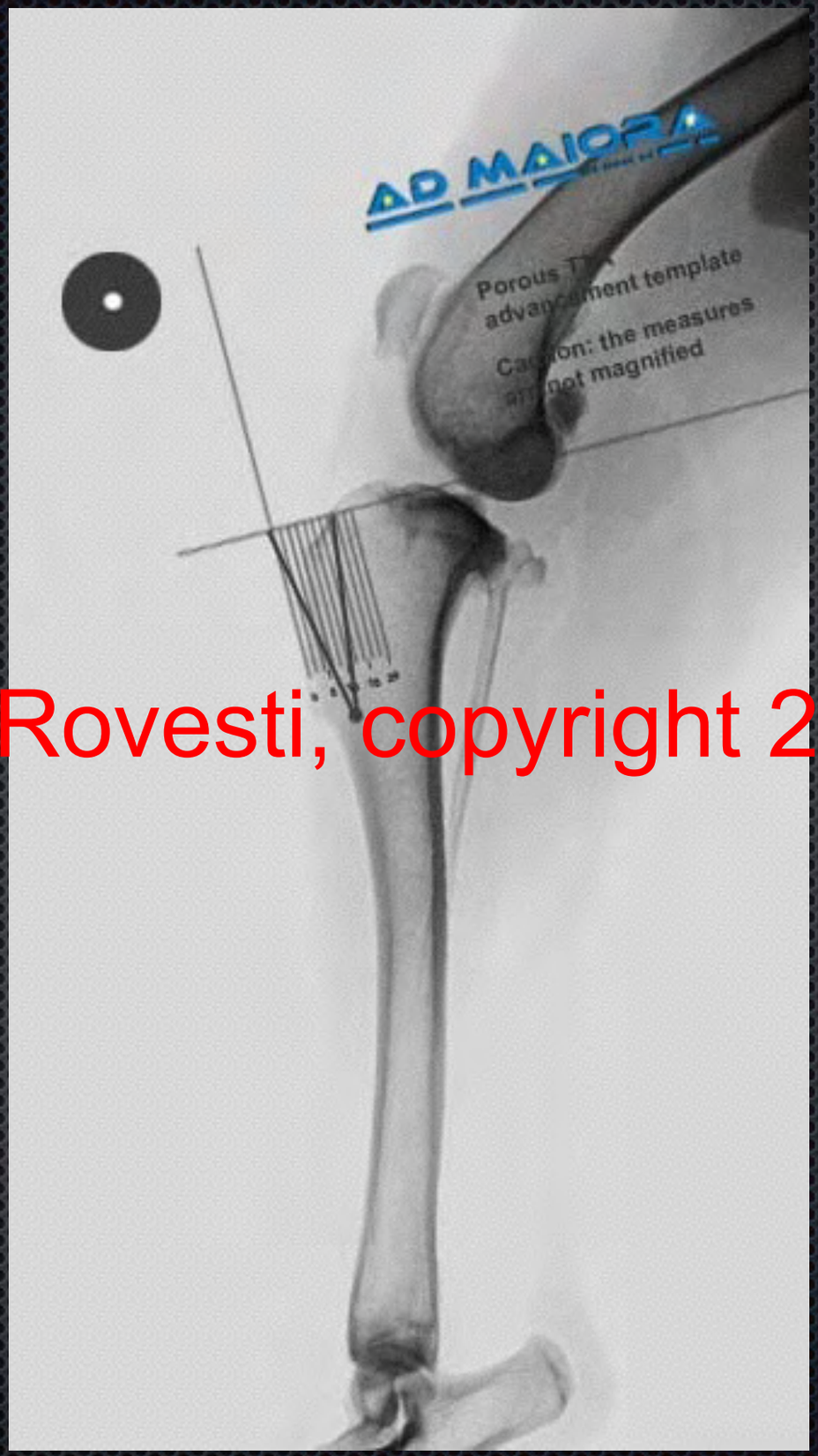
X-ray film

AD MAIORA
We move on

Porous TTA
advancement template

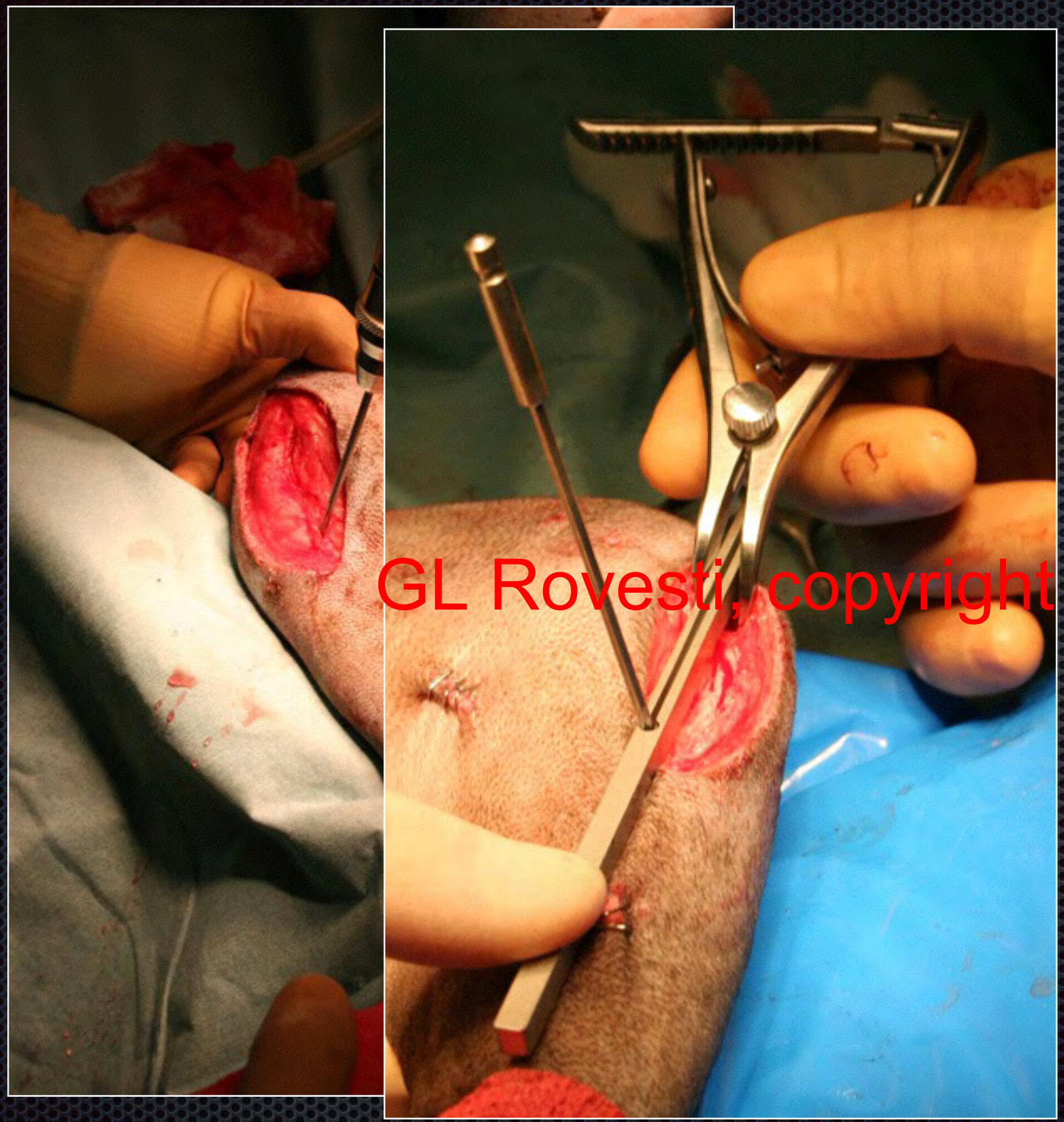
Caution: the measures
are not magnified





Surgical technique

nique

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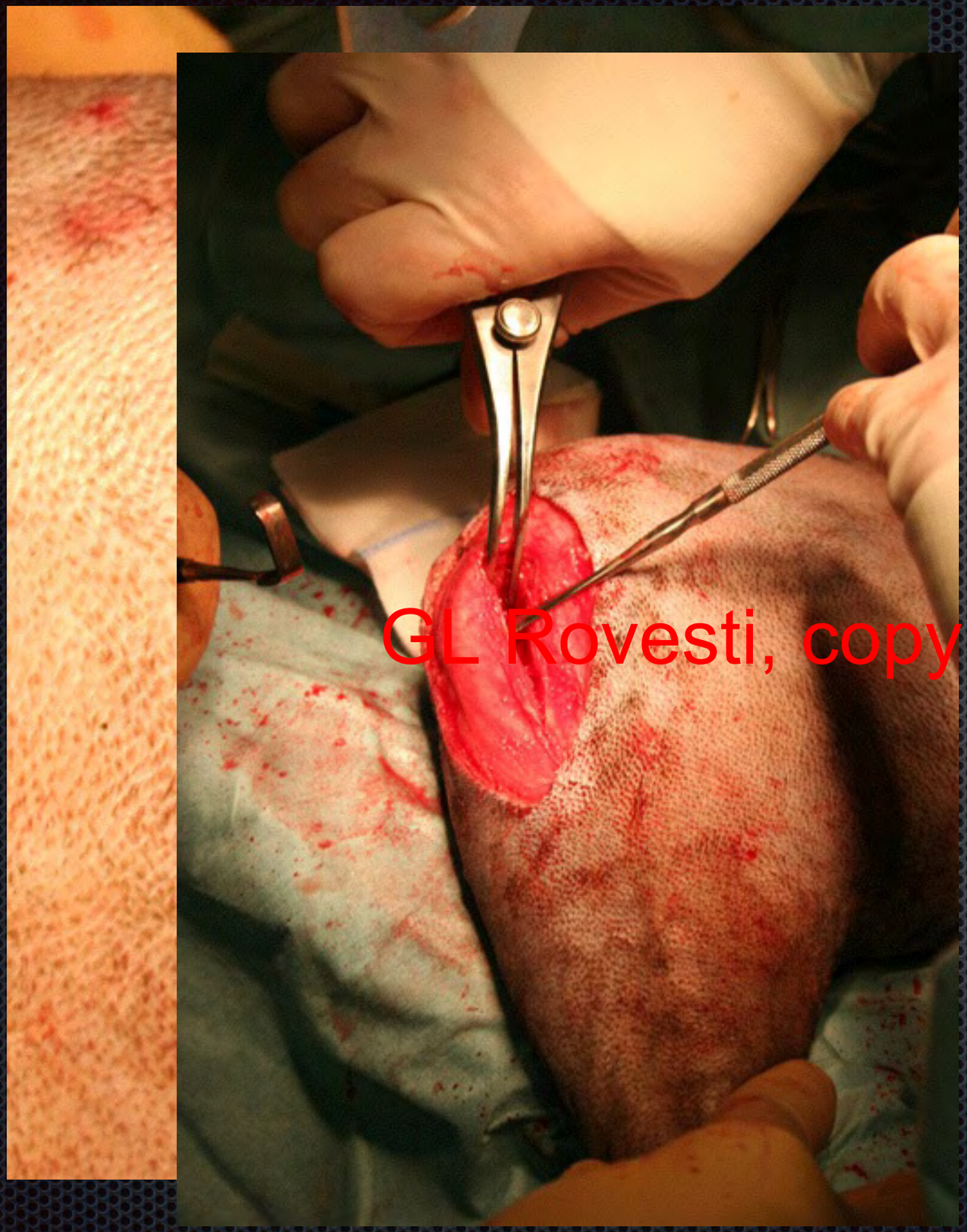


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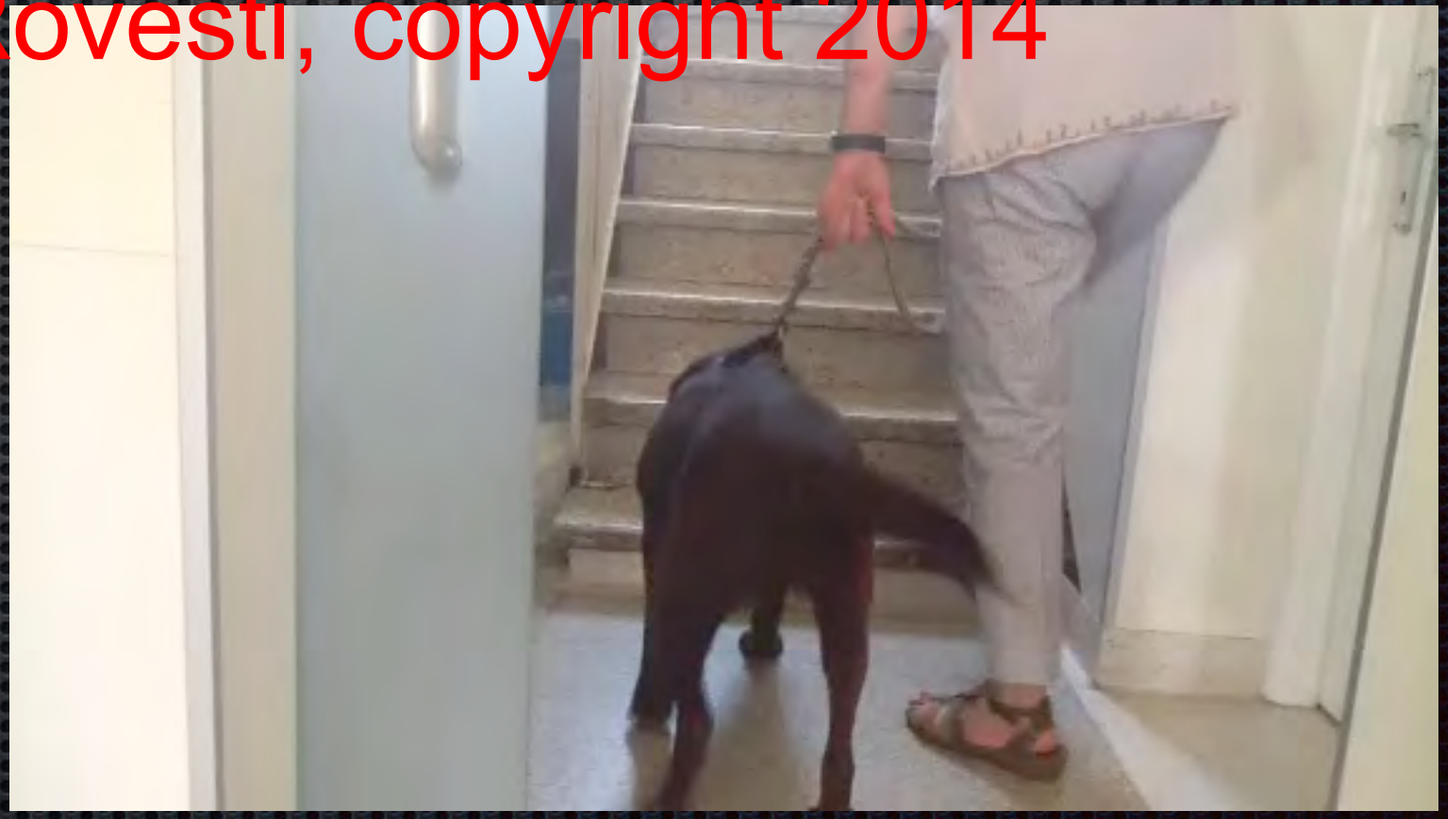
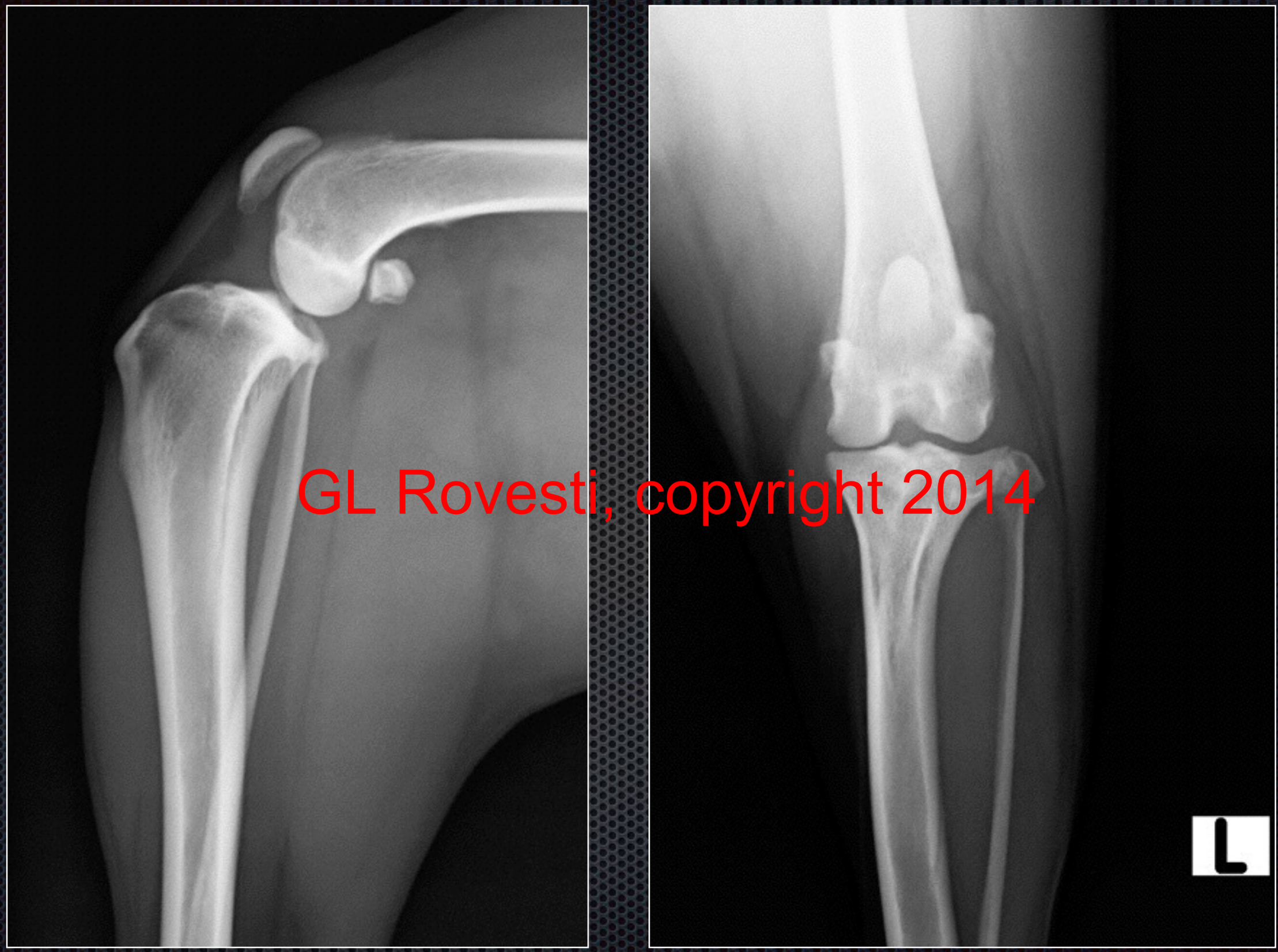
What are we expecting in standard cases?

- Clinical evaluation
- Radiographic evaluation

Labrador, female, 5 yo, 22 kg

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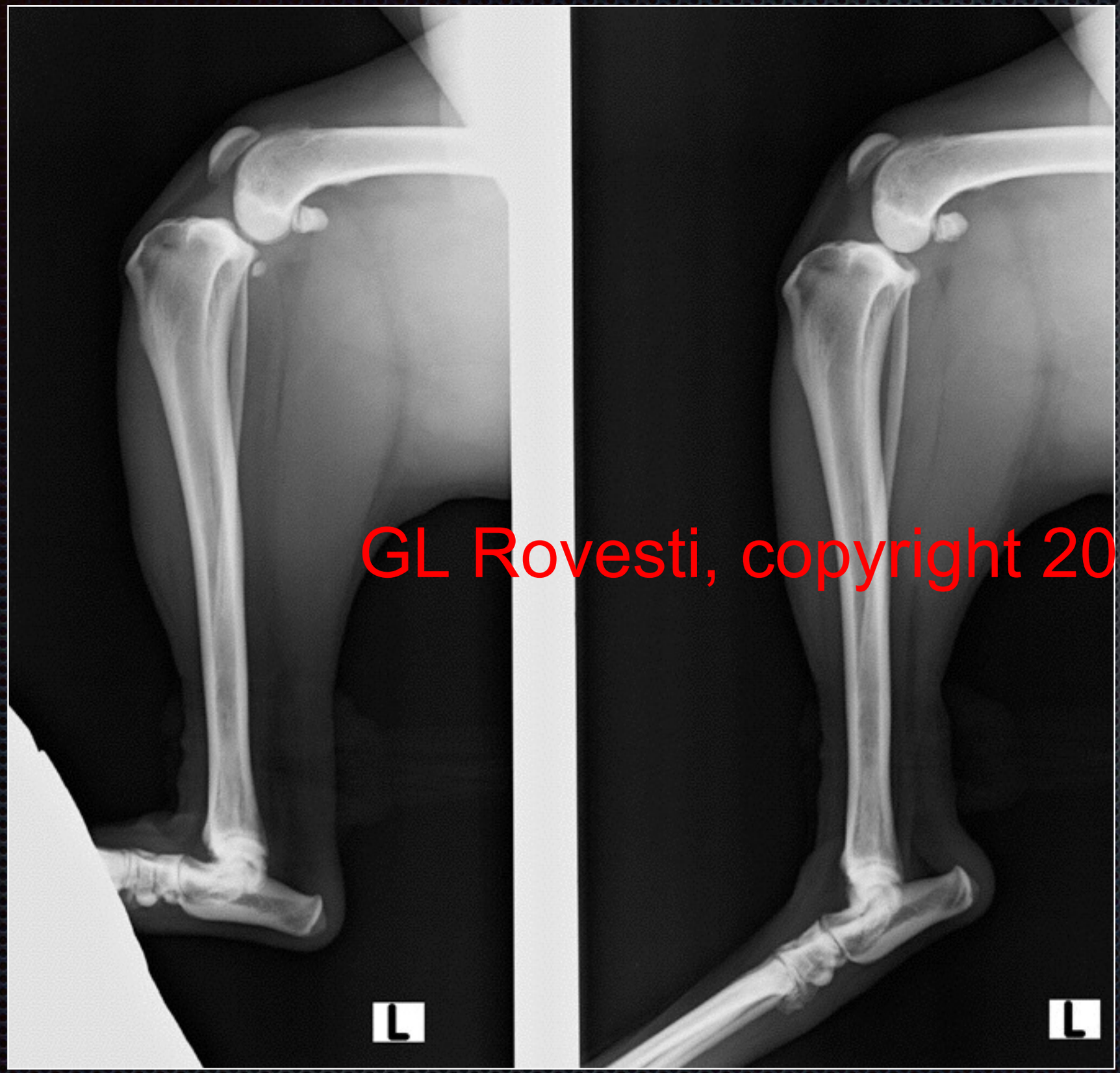
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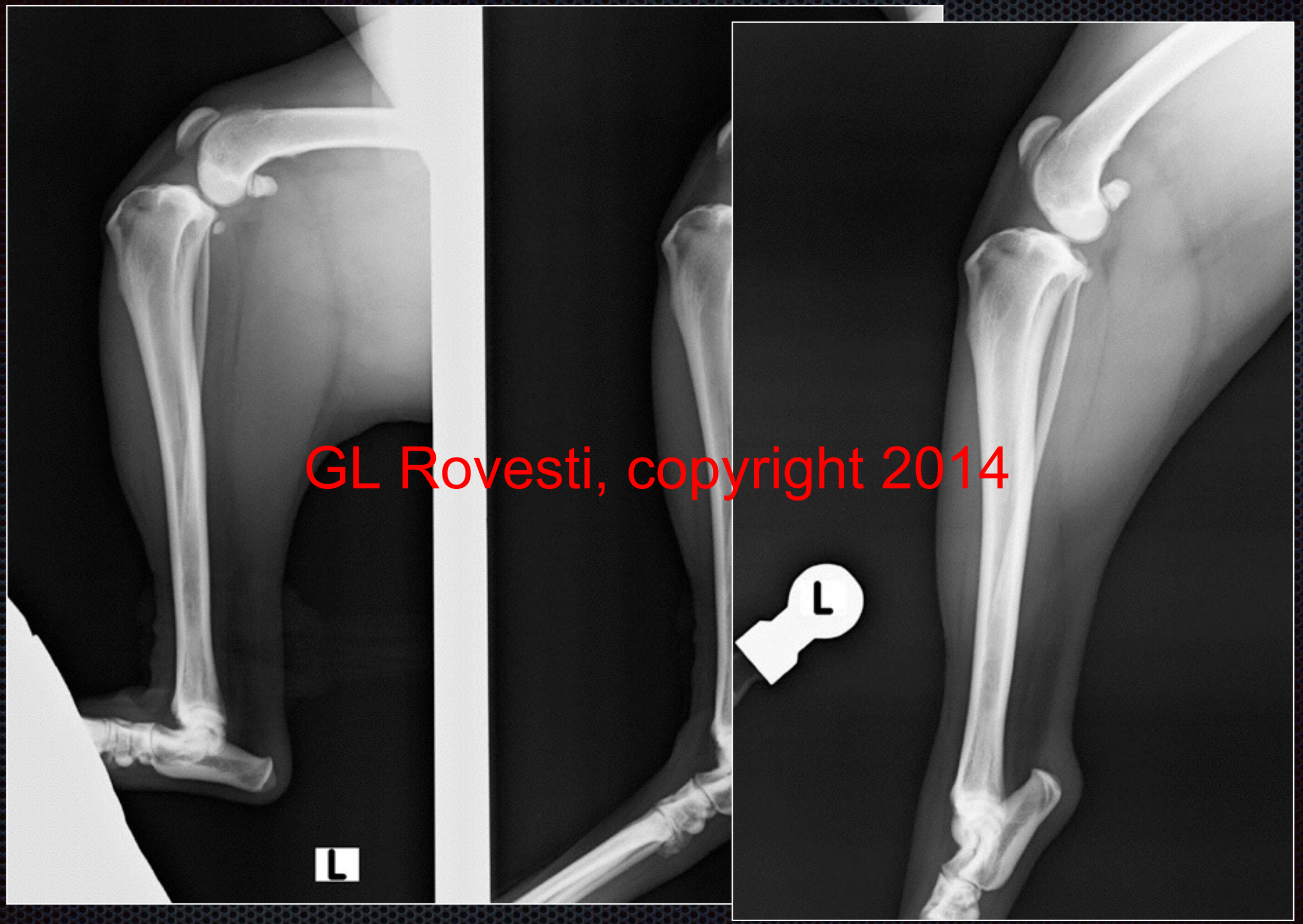

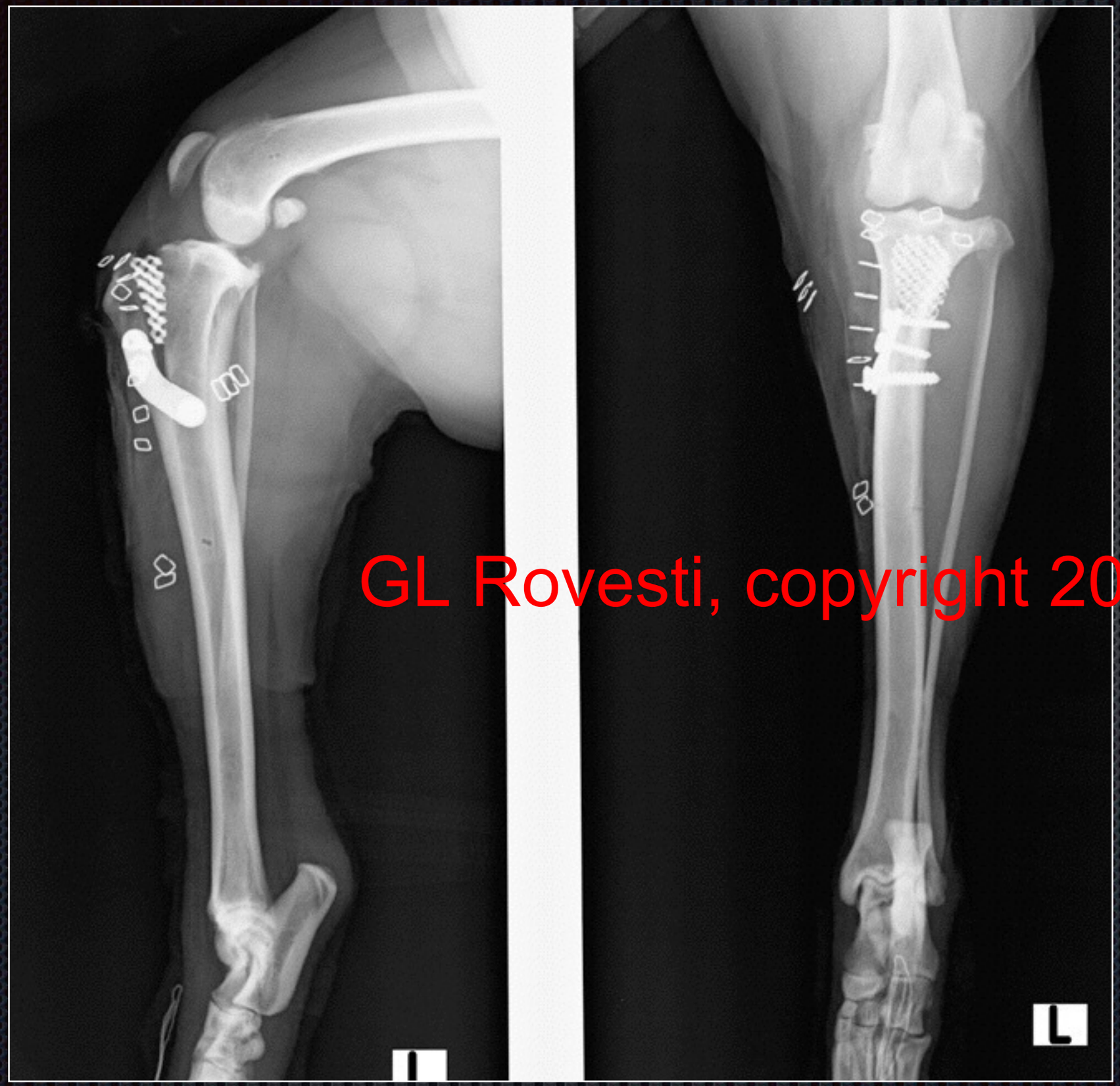
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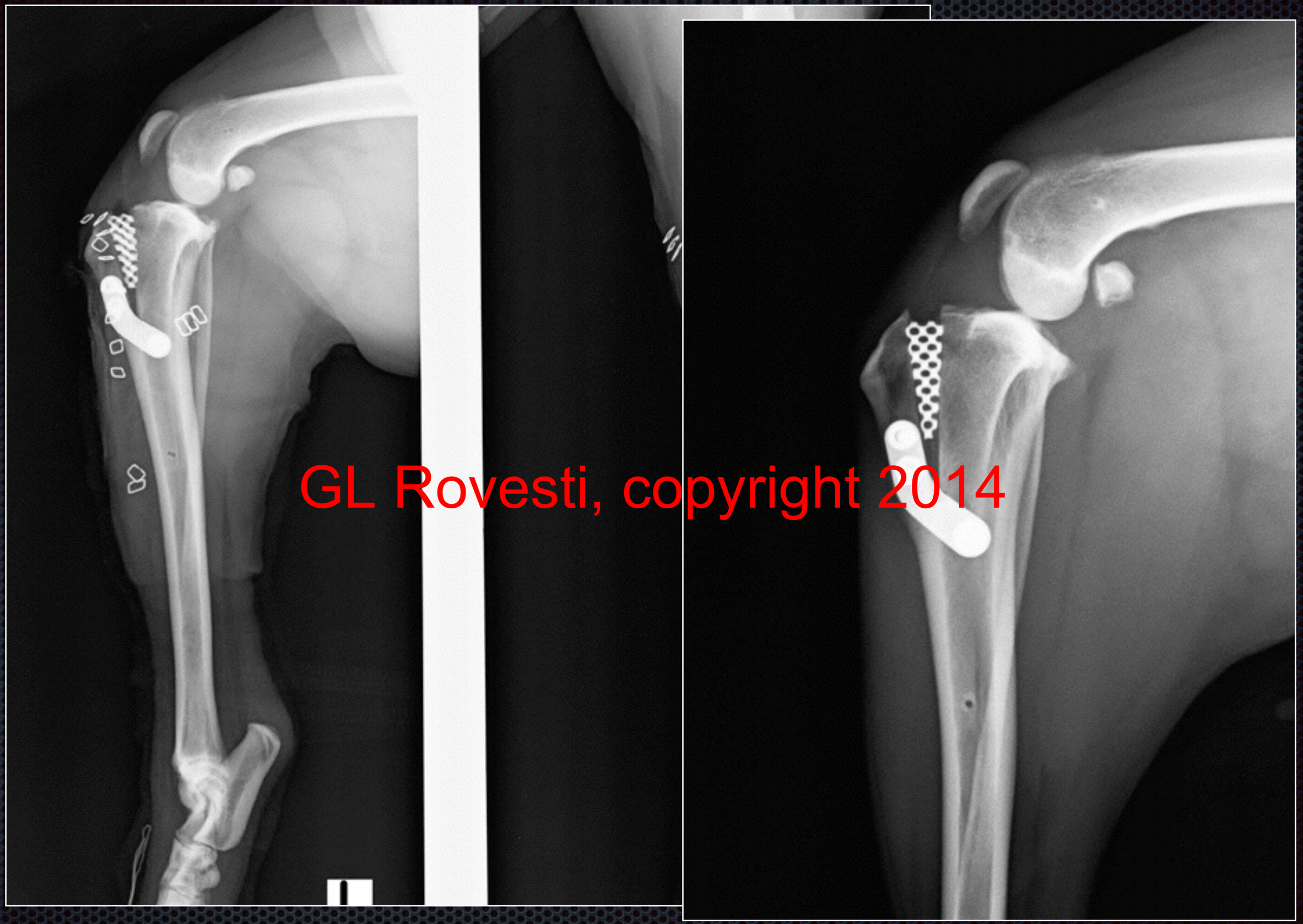
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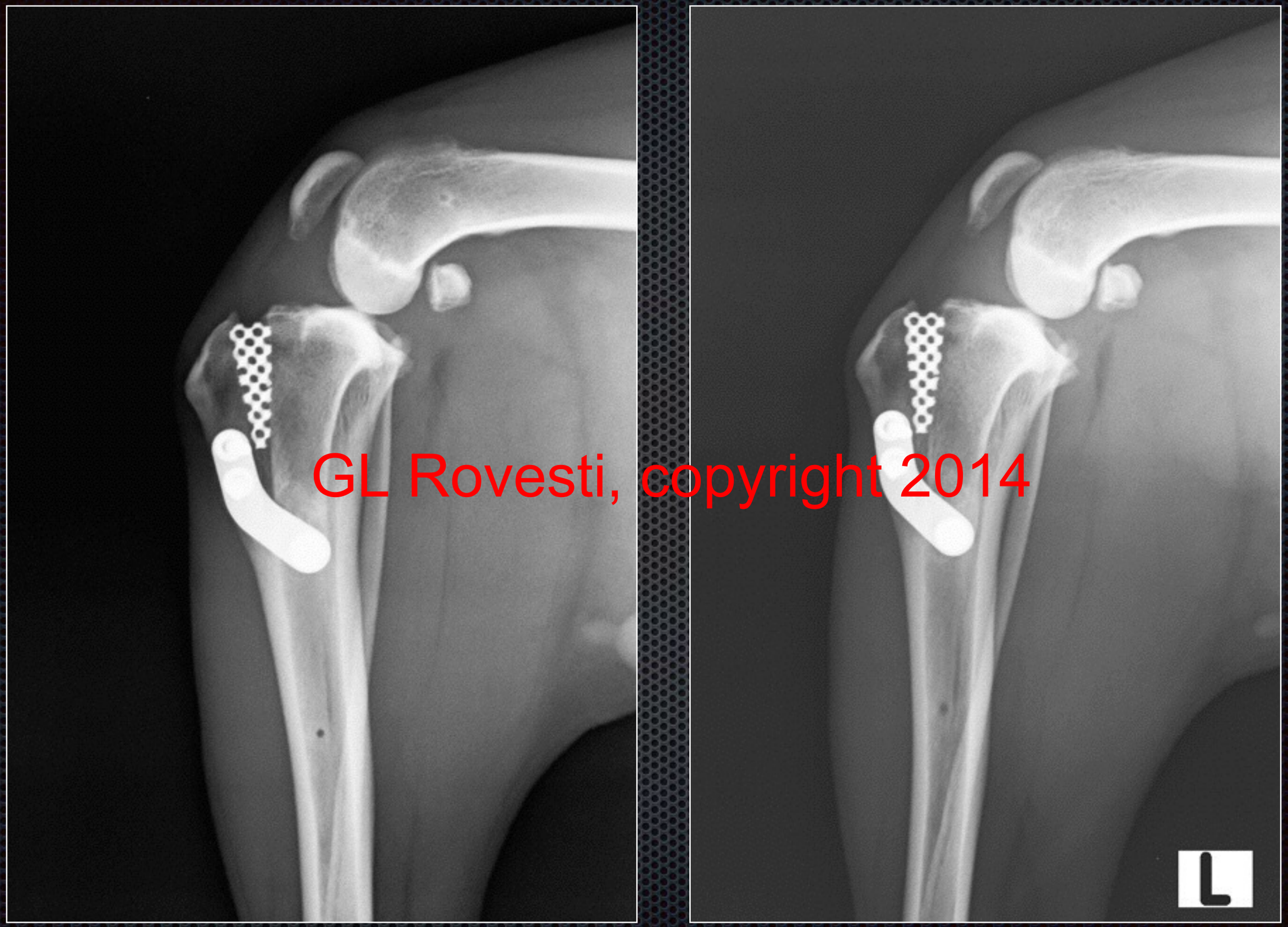
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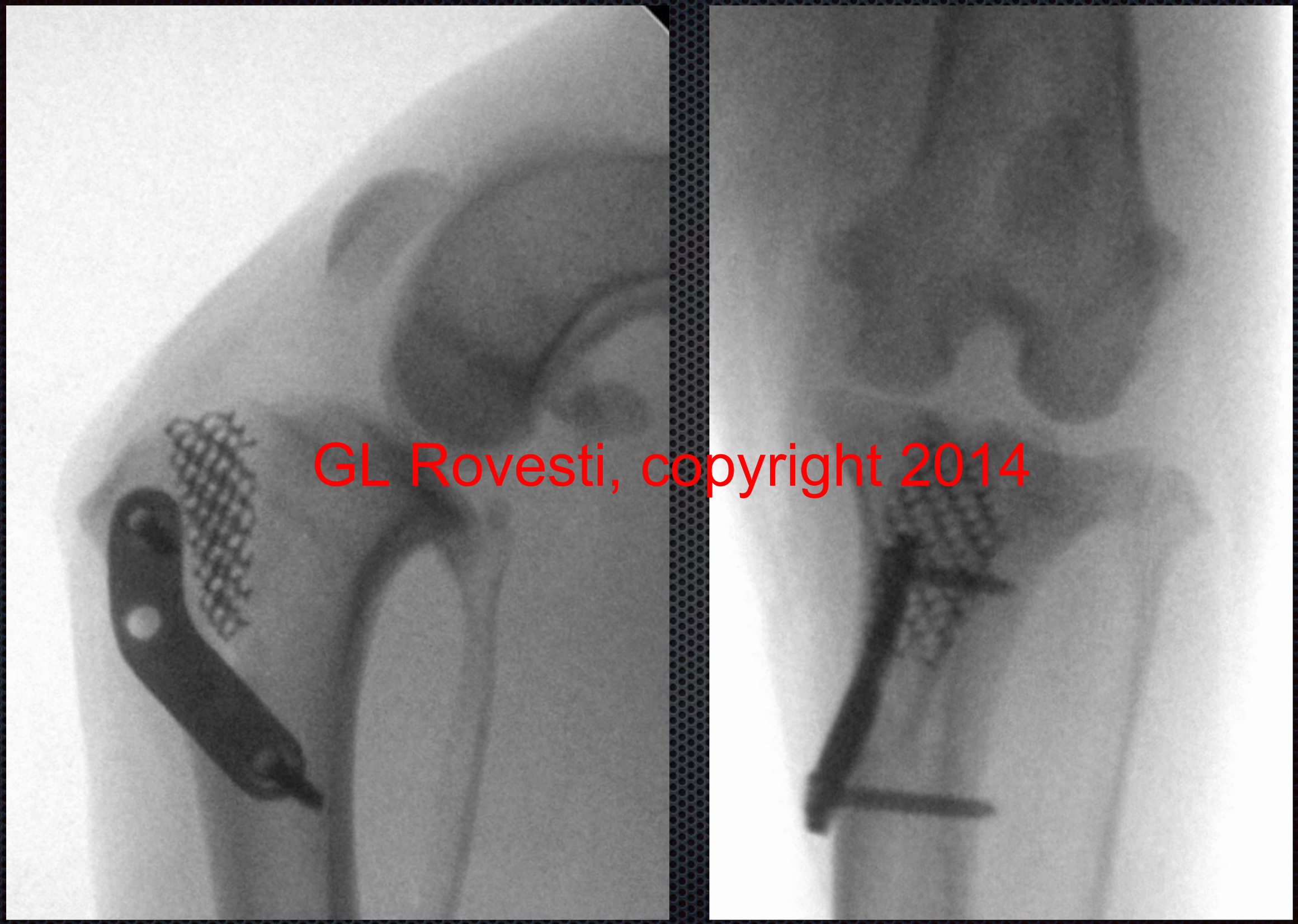
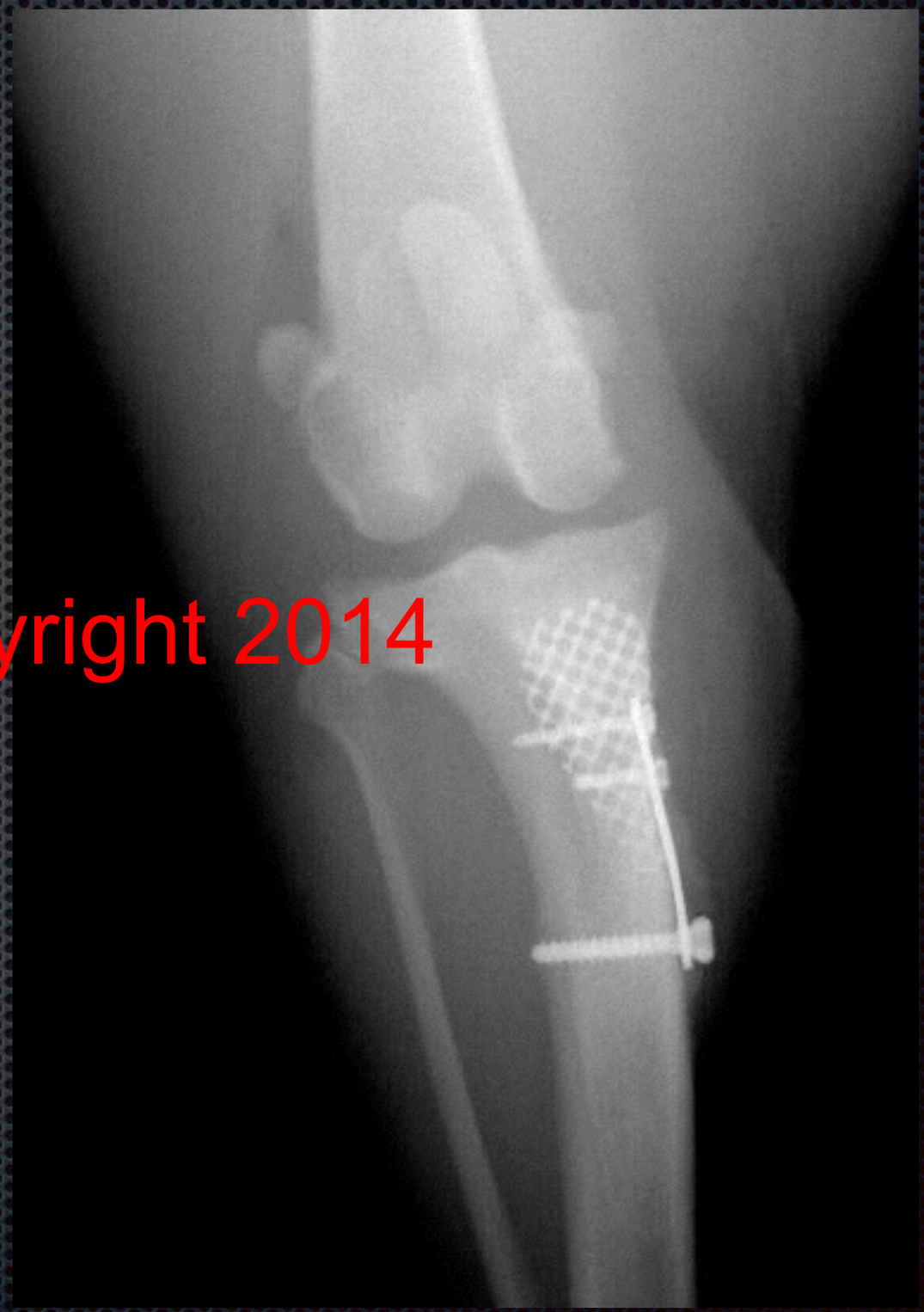
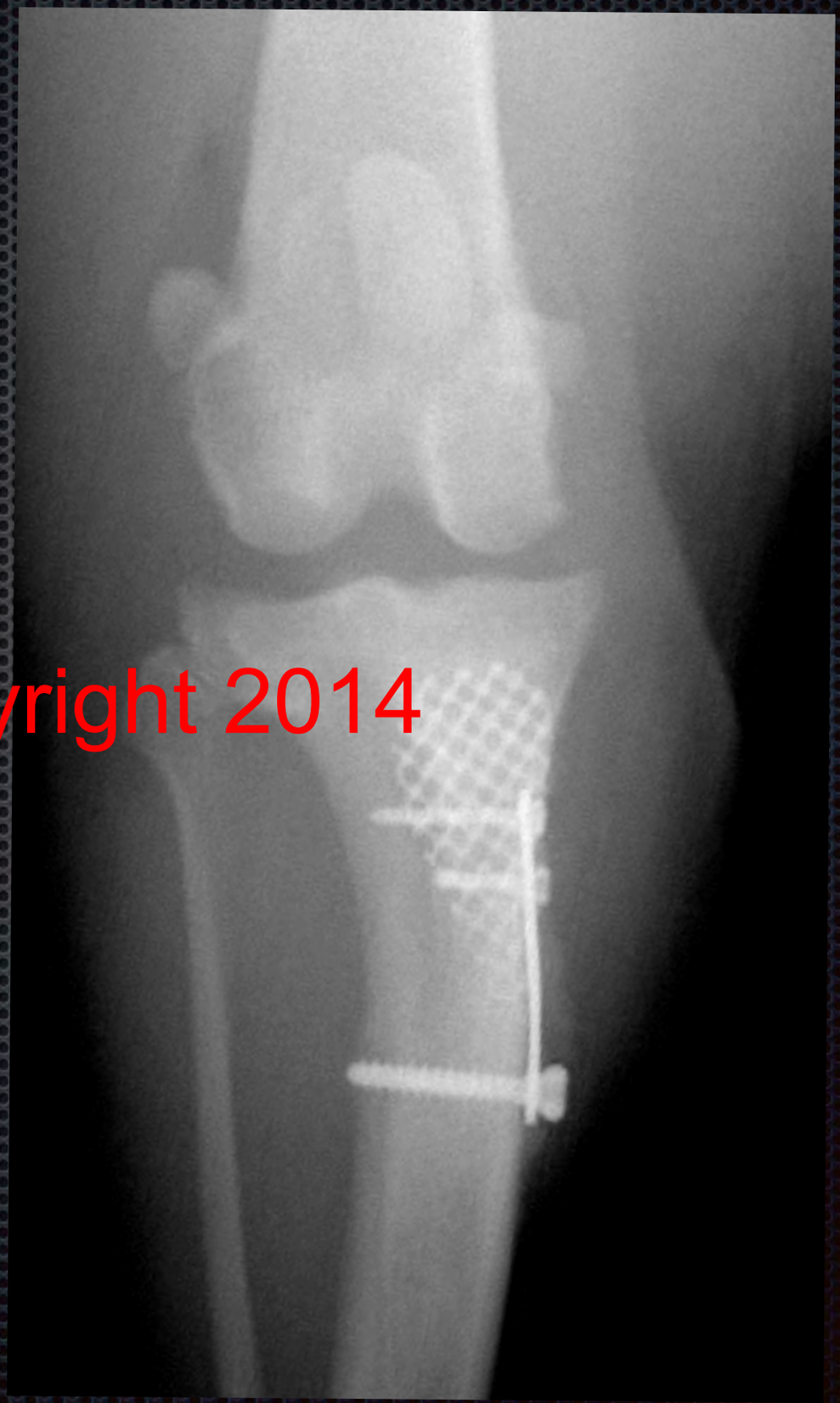
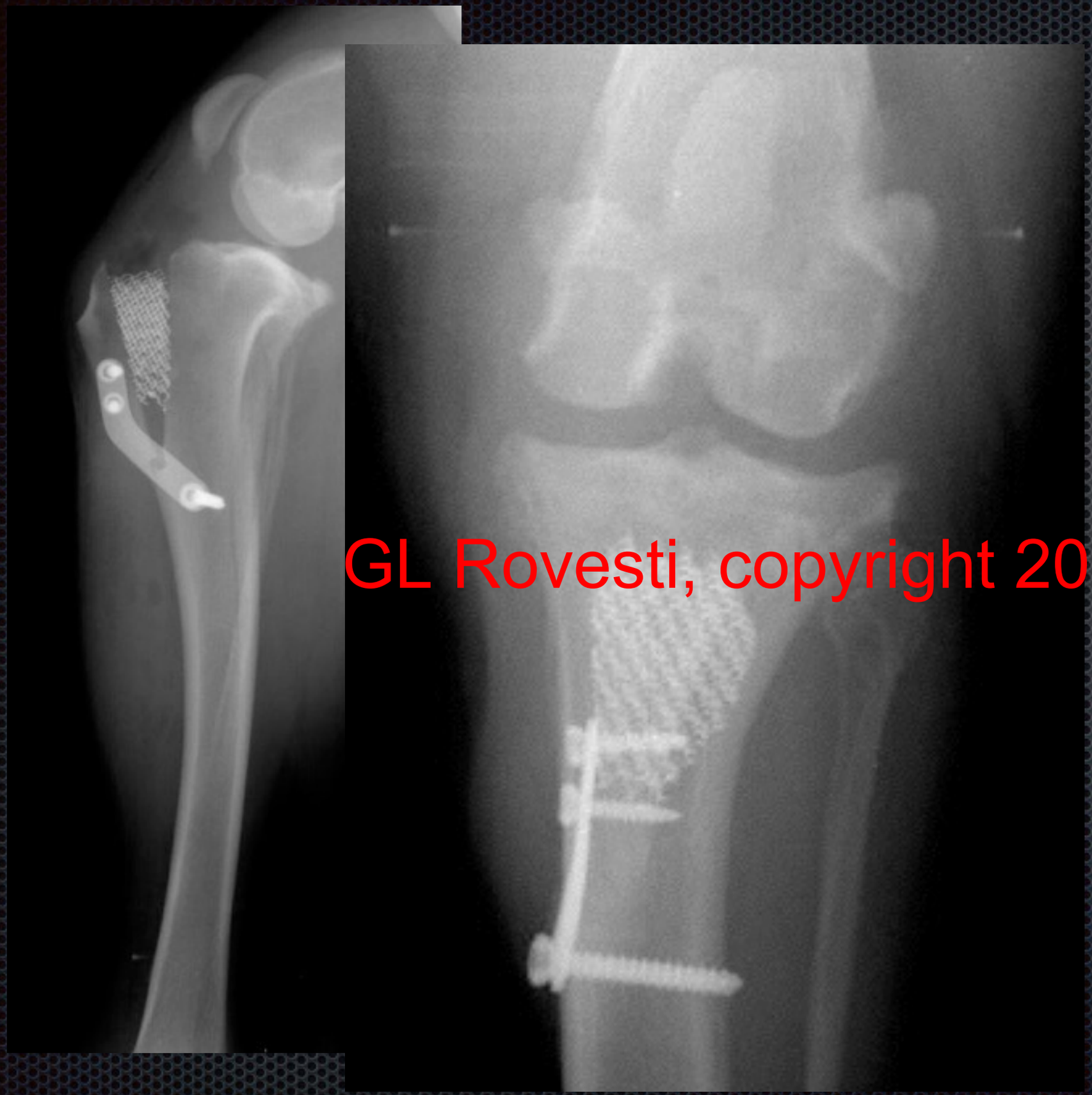
Variations





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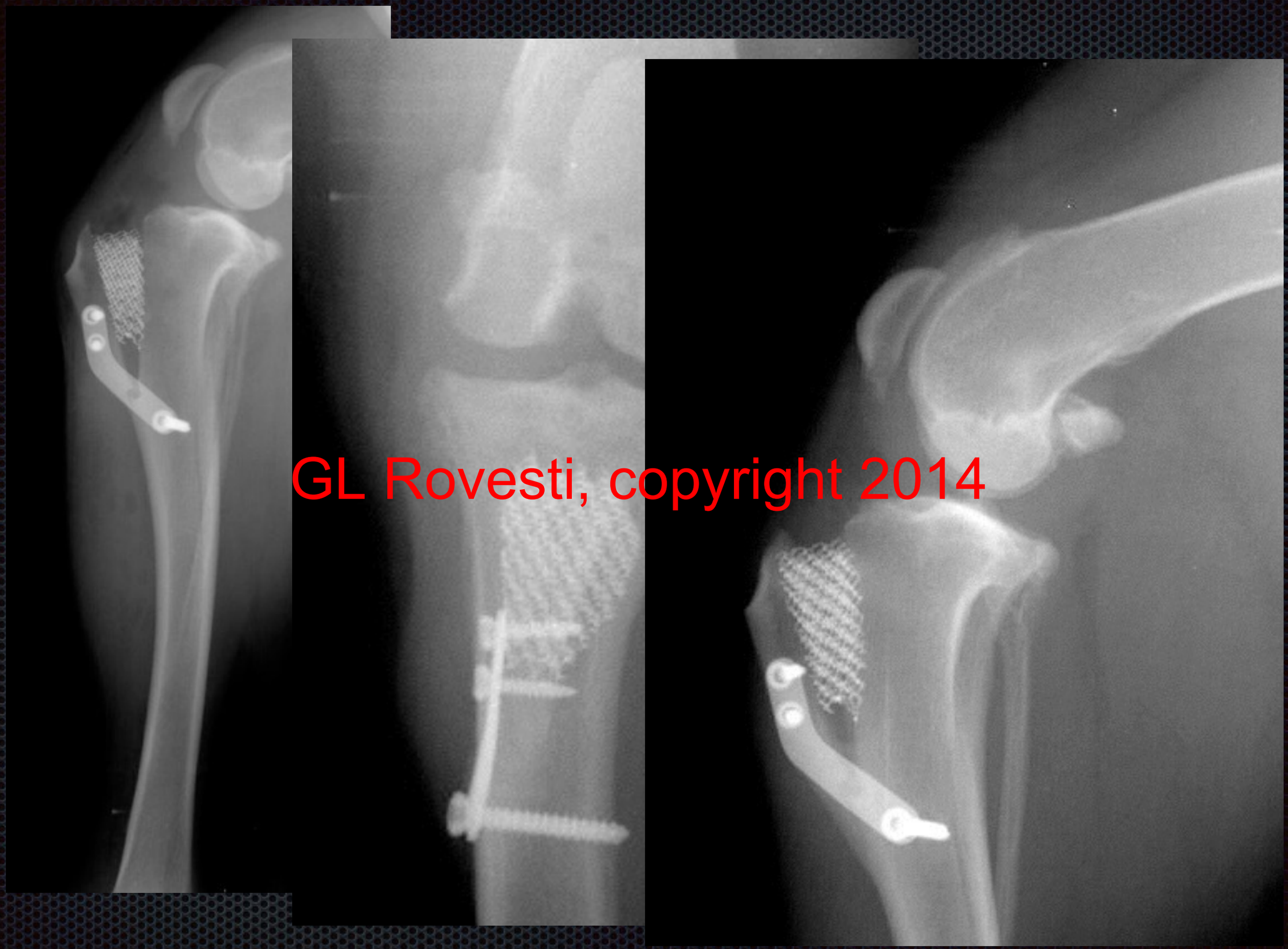
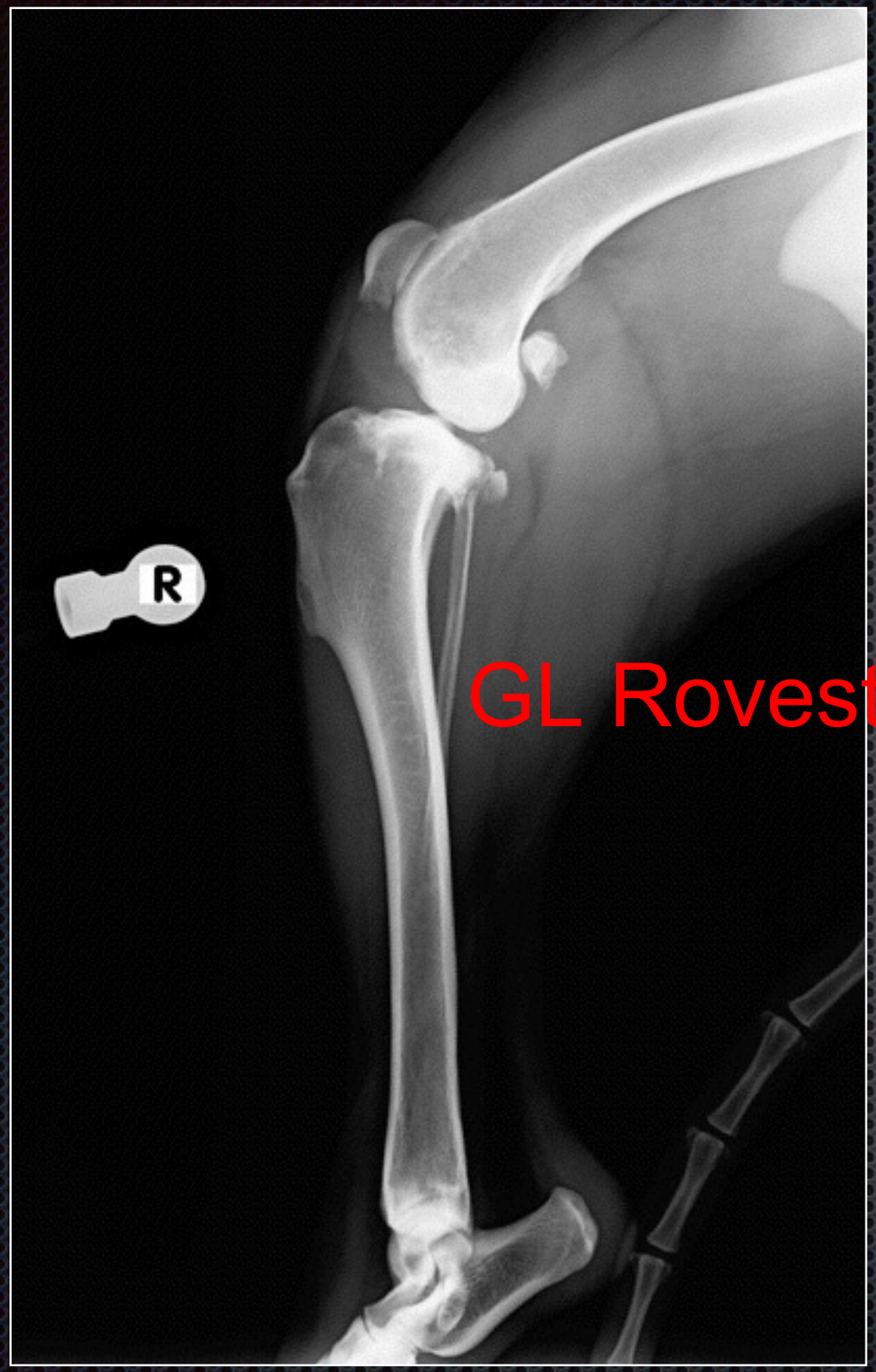
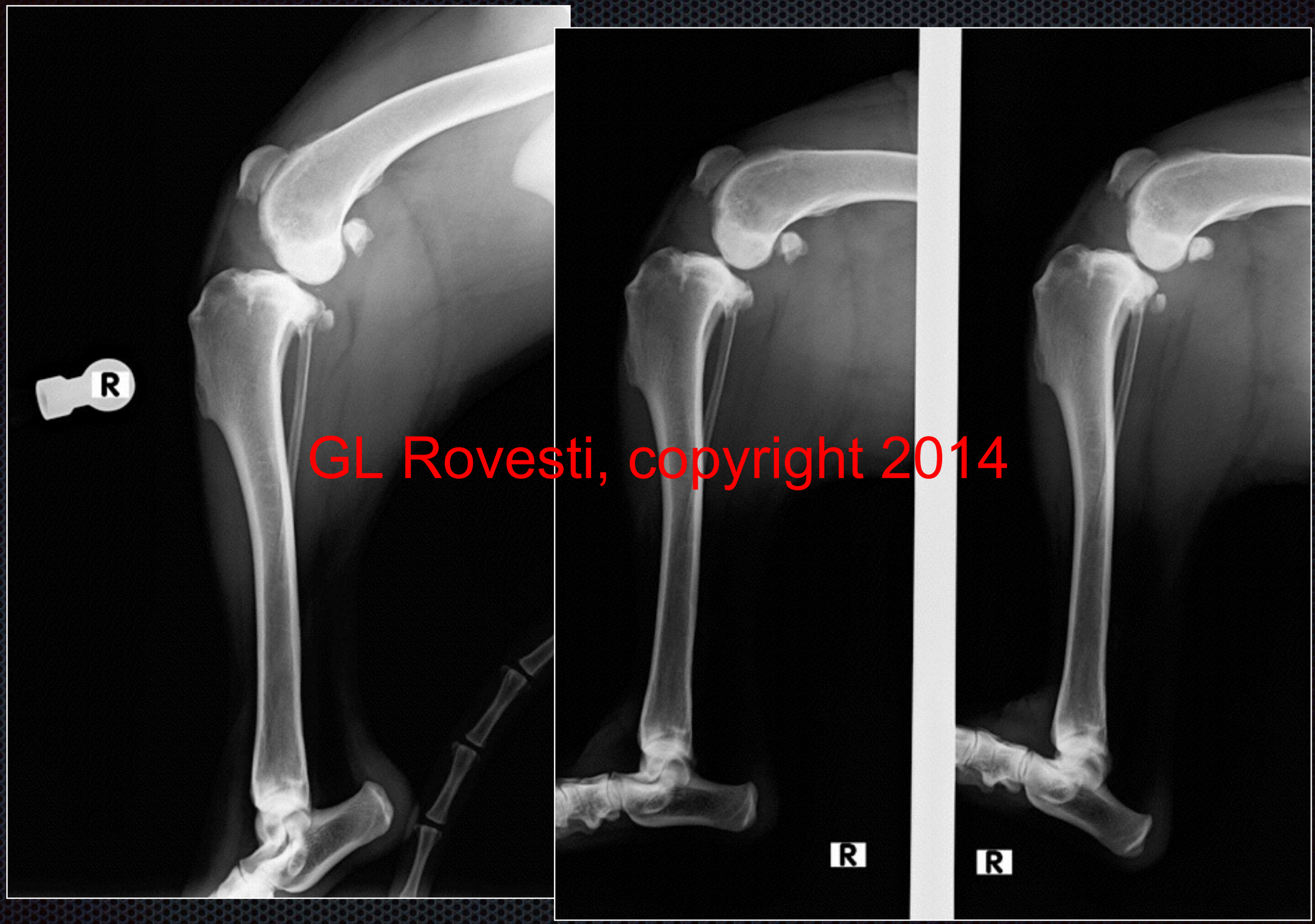
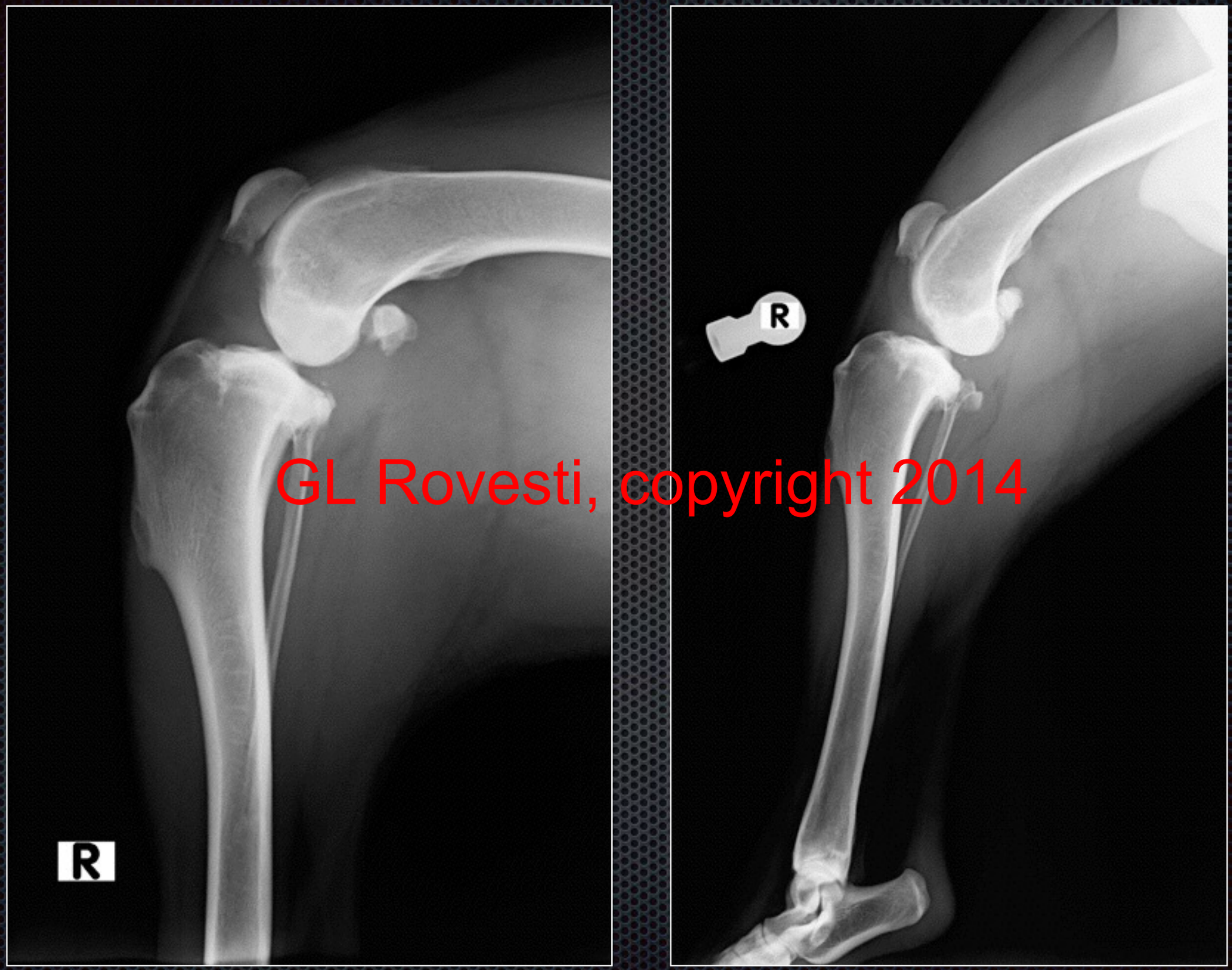


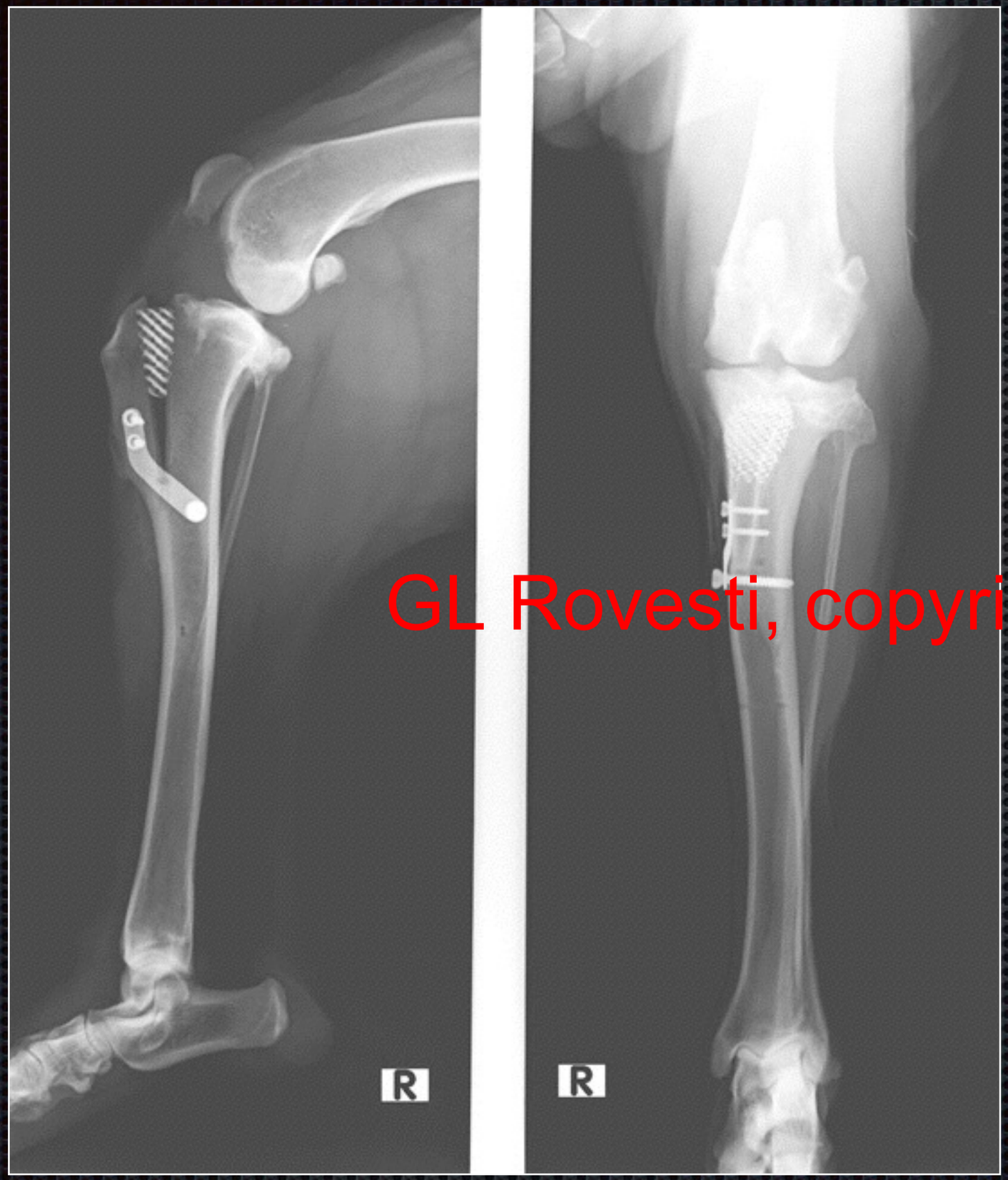
Complications

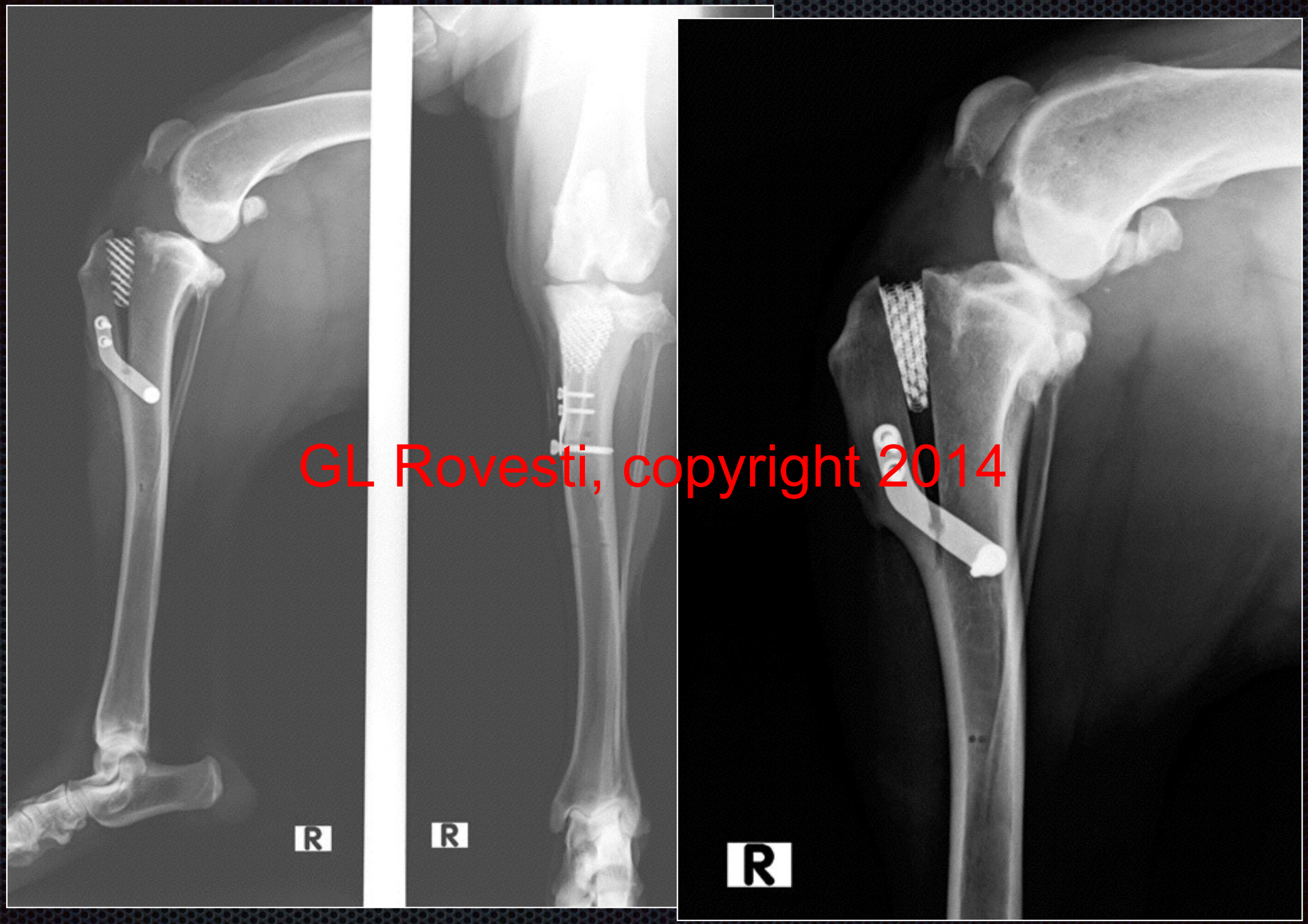
German Shepherd, female, 8 yo, 31 kg

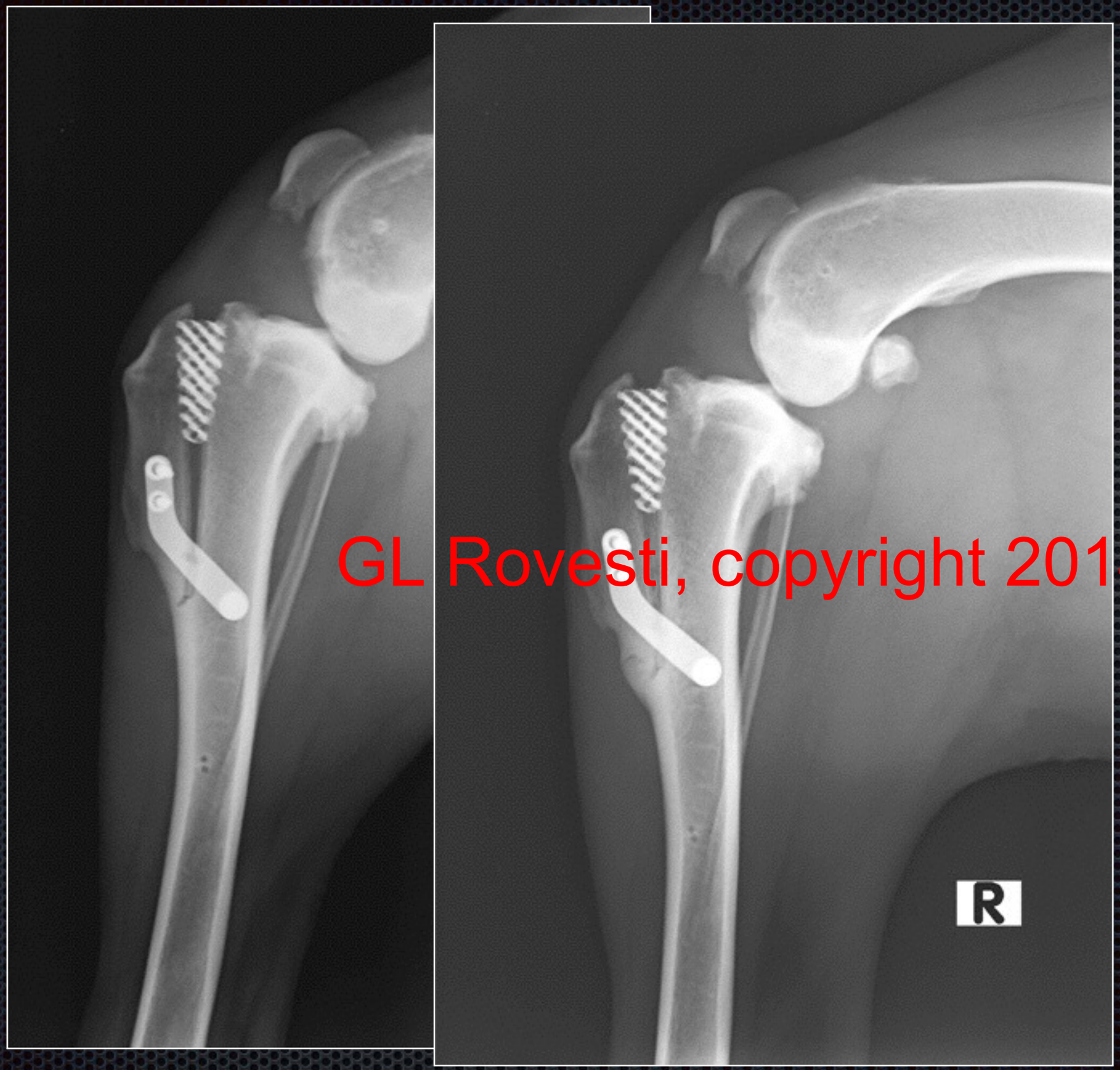


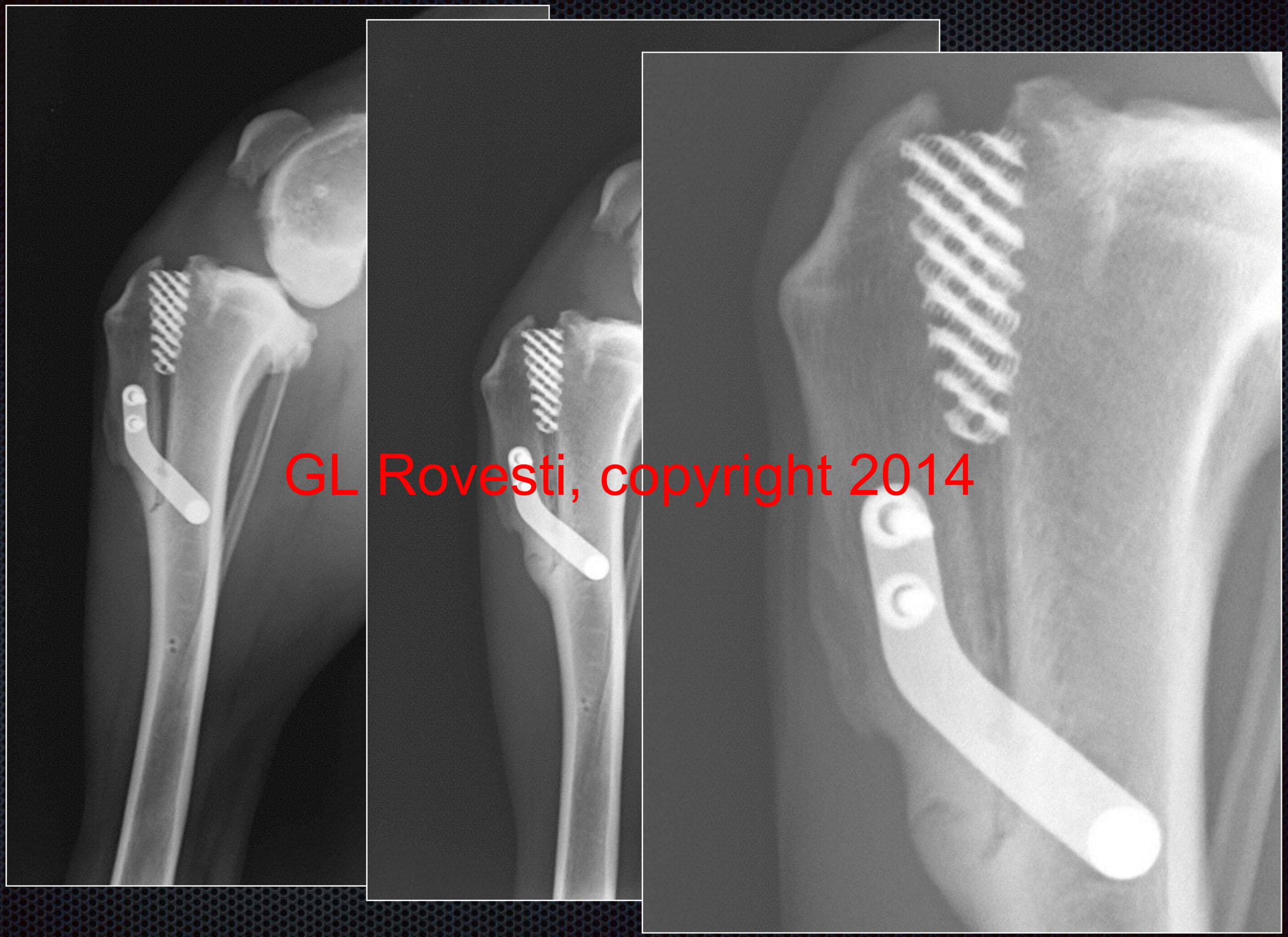








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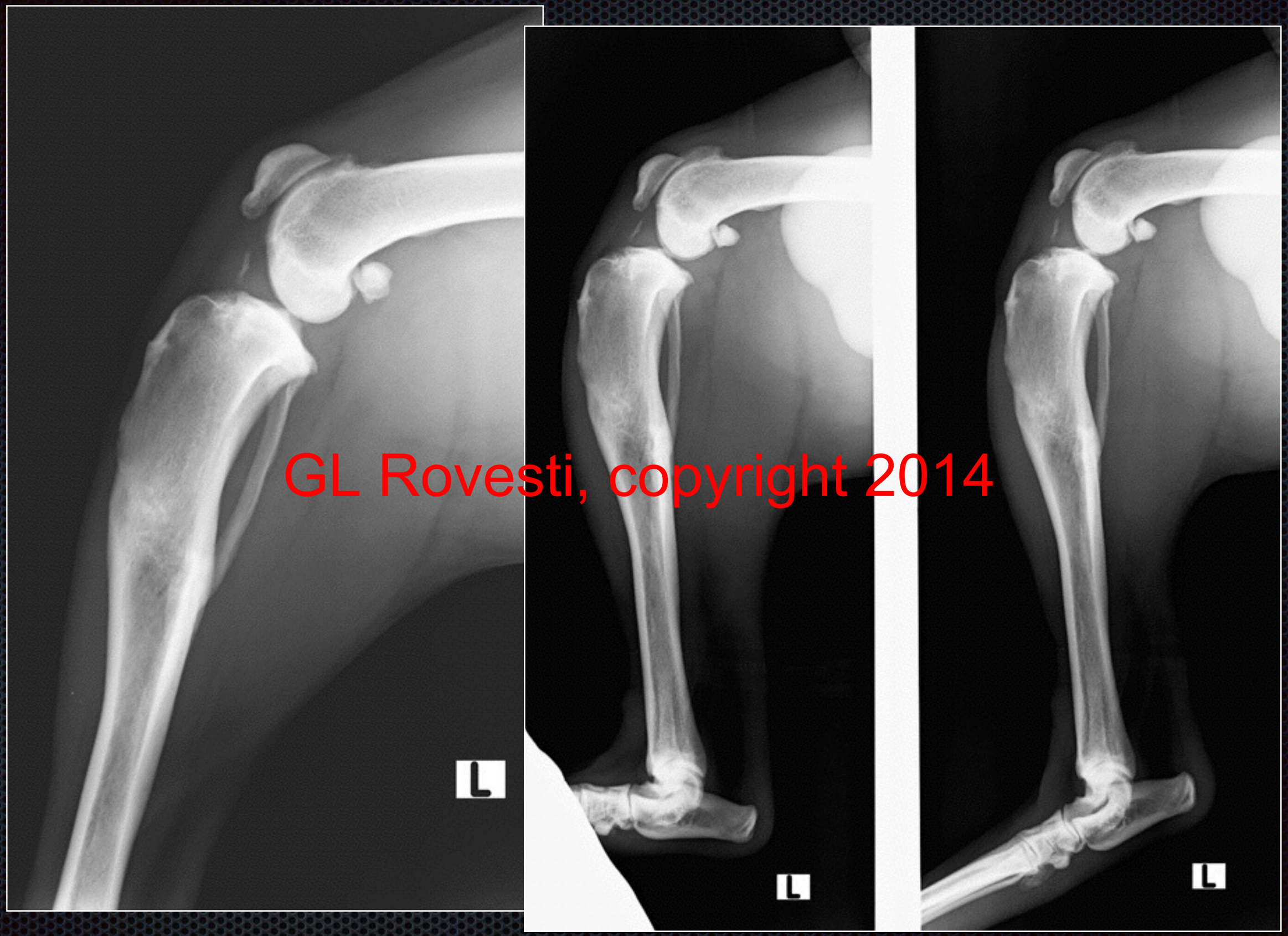
Labrador, male, 7 yo, 32 kg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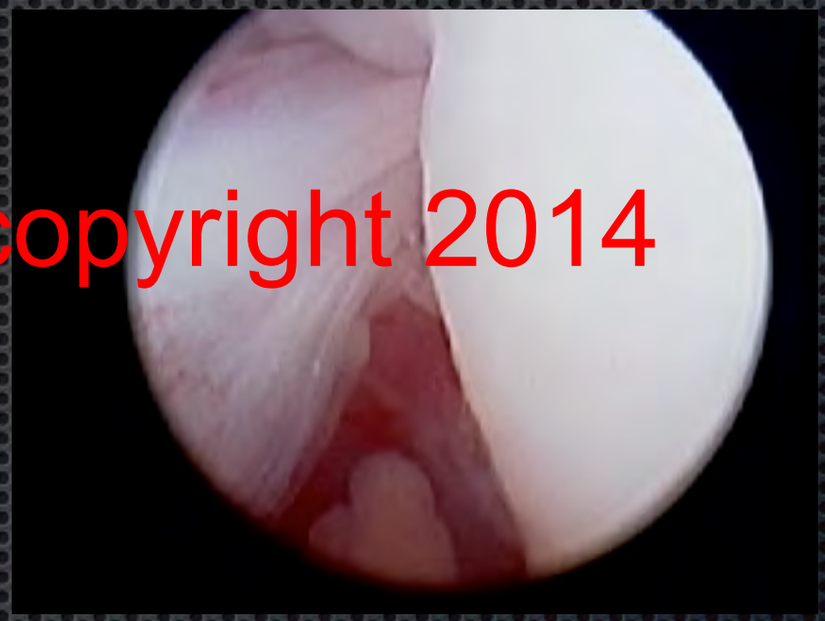
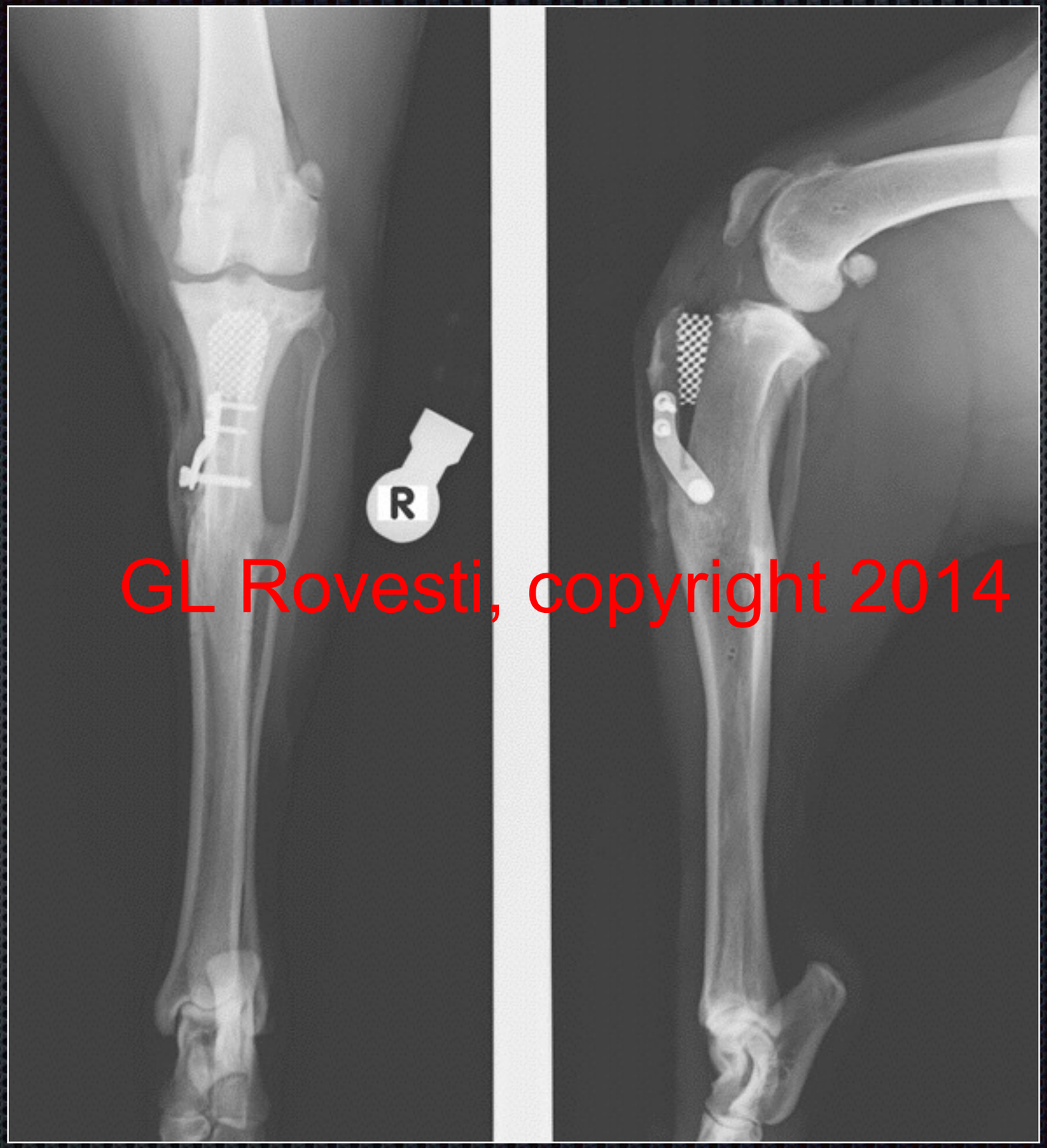
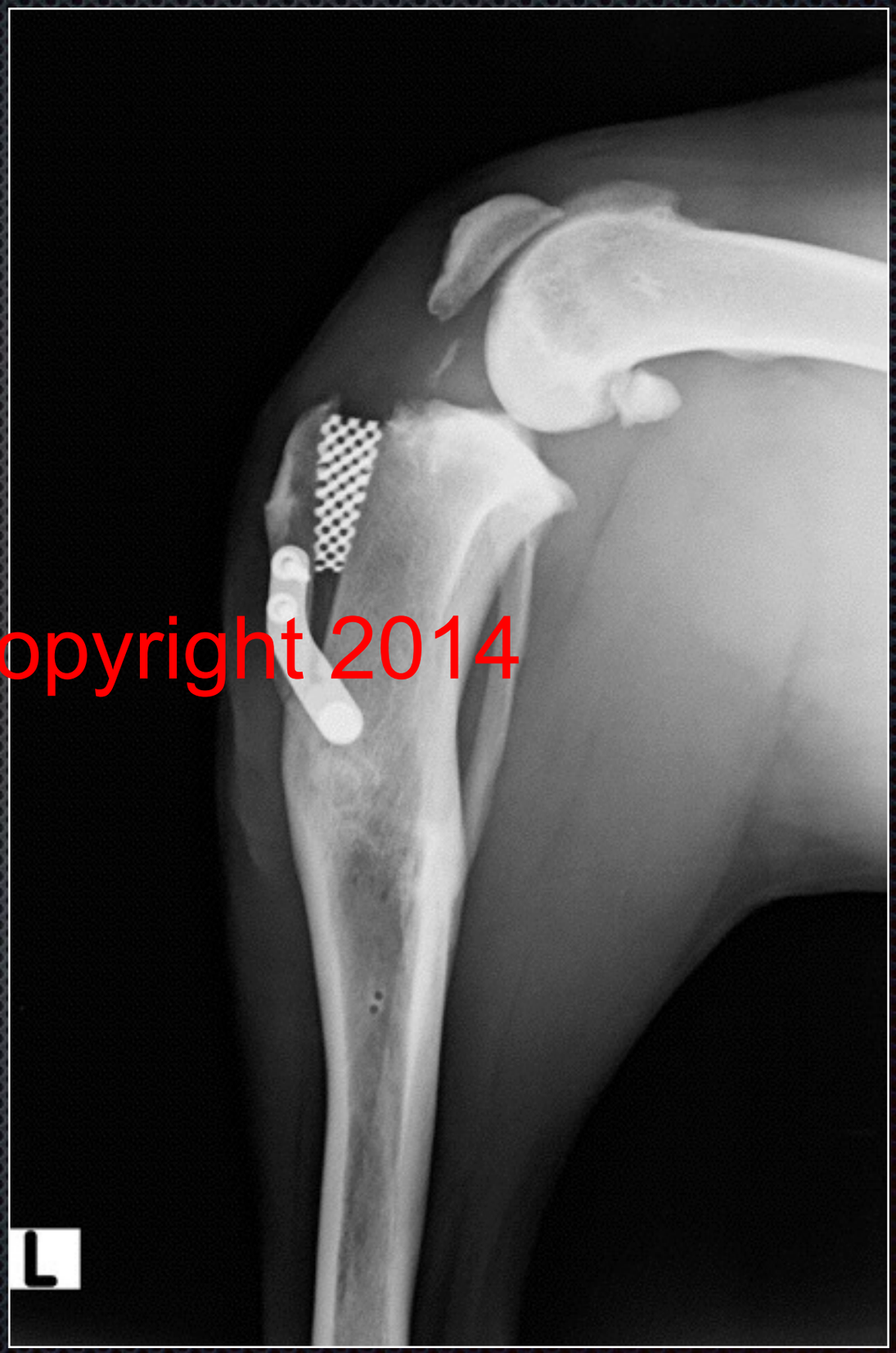
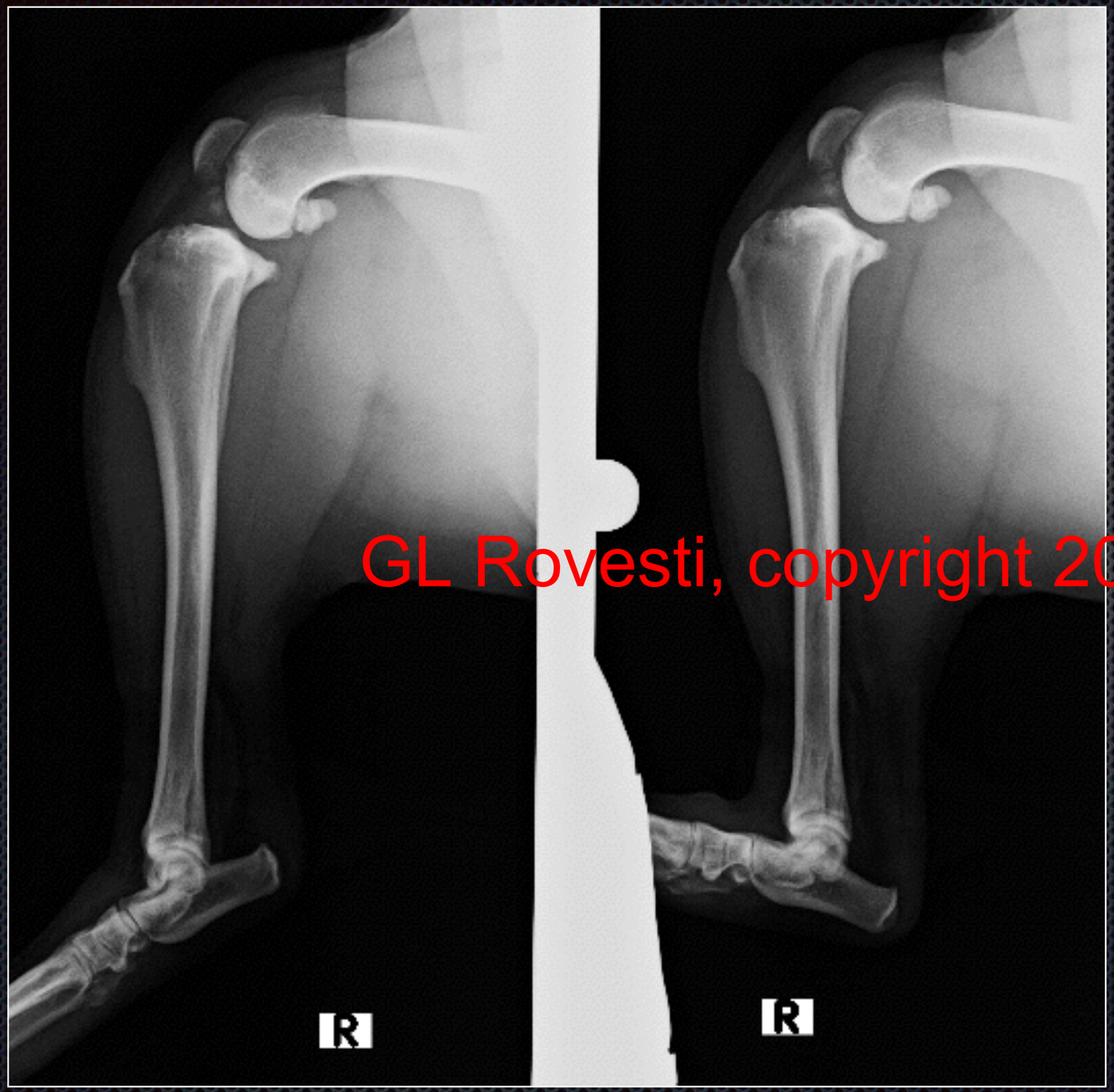






Labrador, female, 3 yo, 27 kg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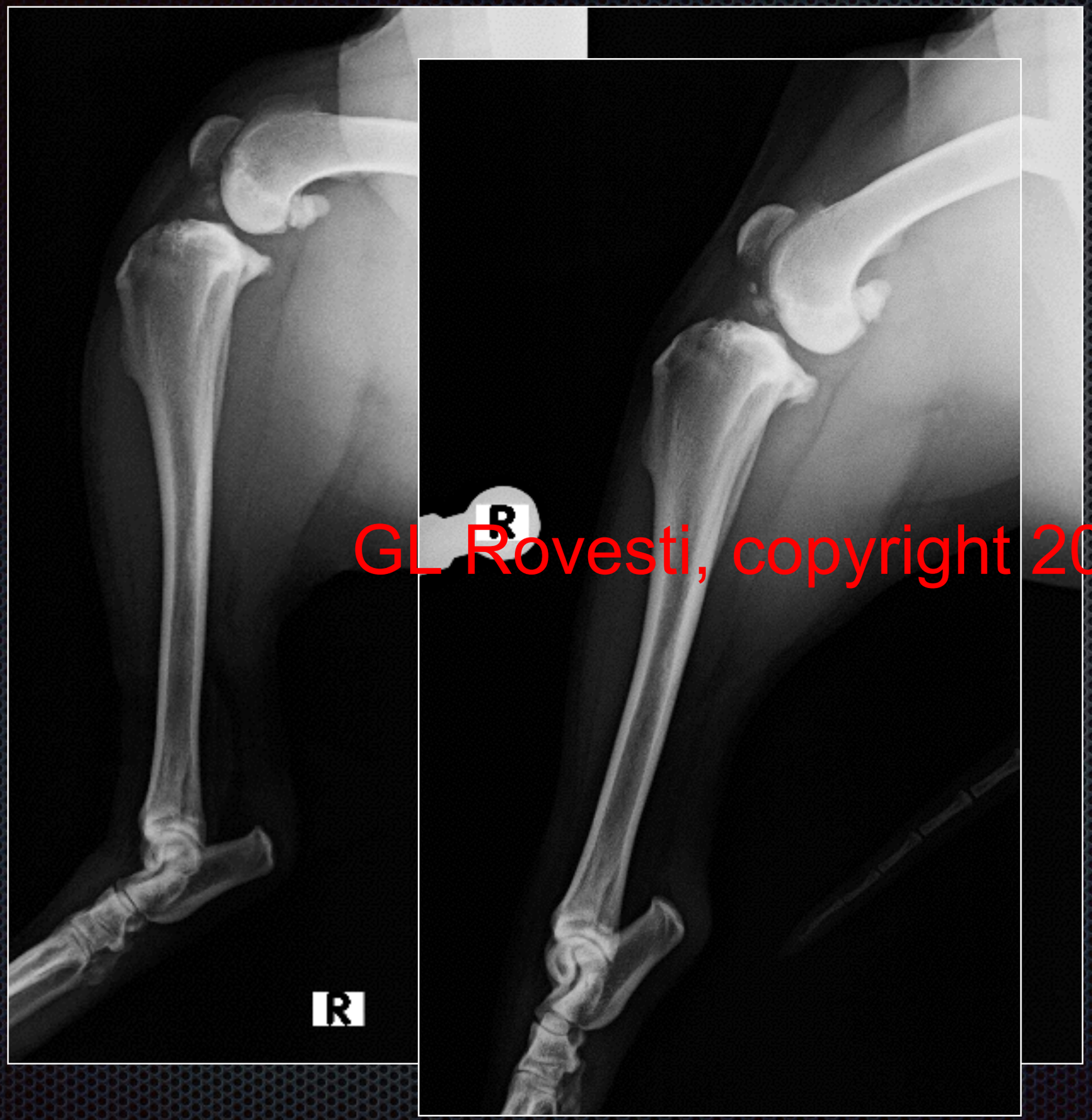
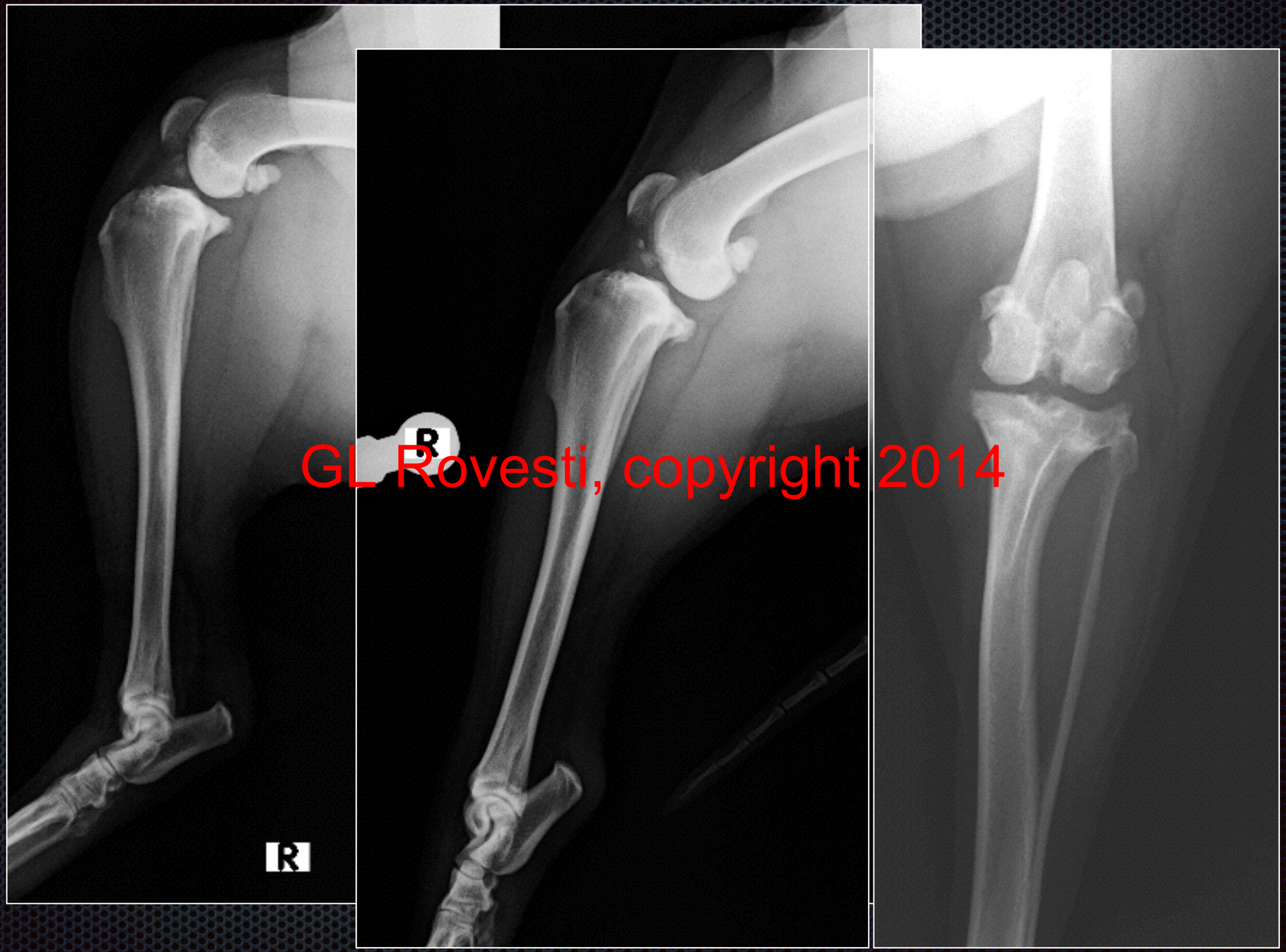
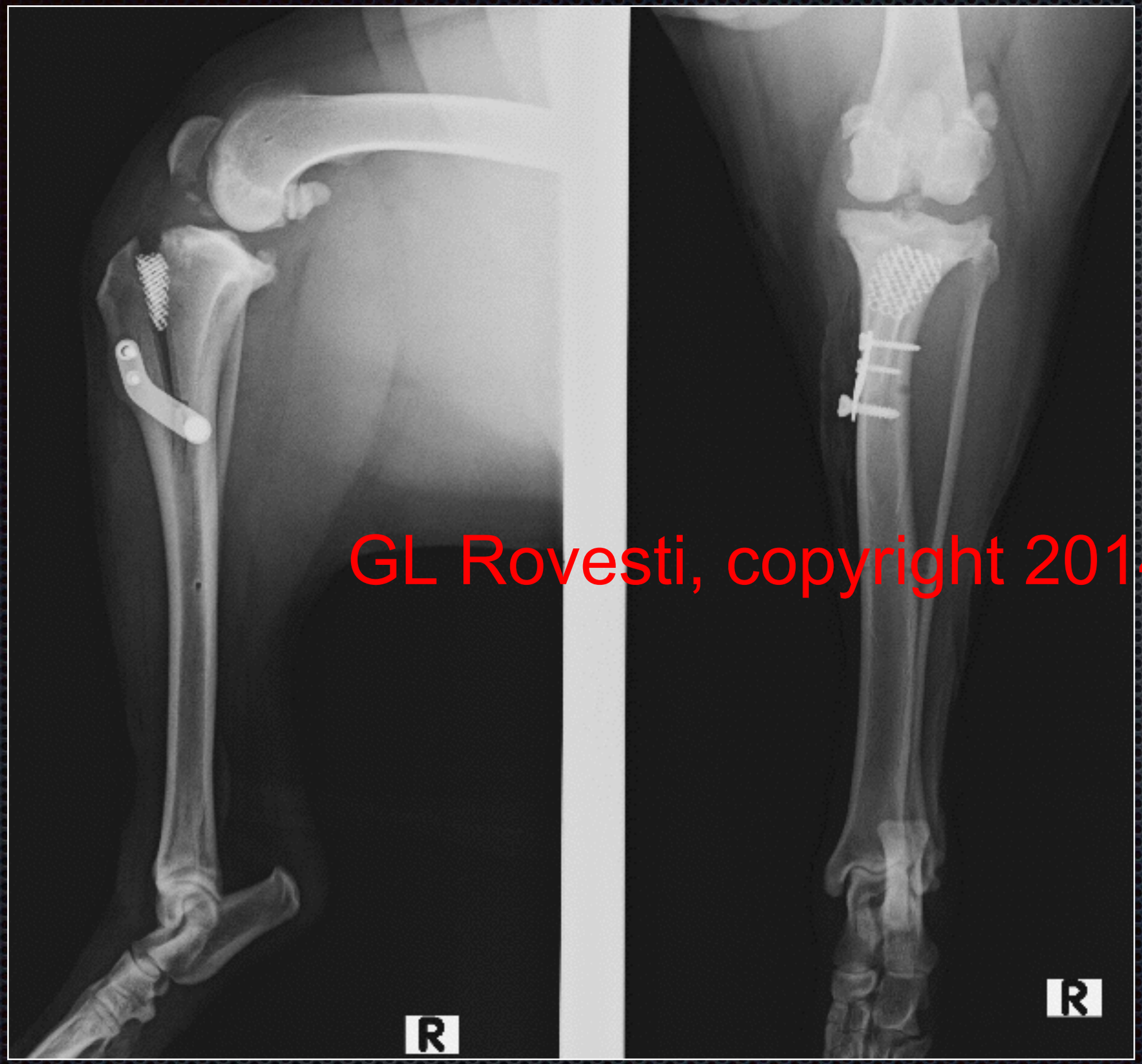
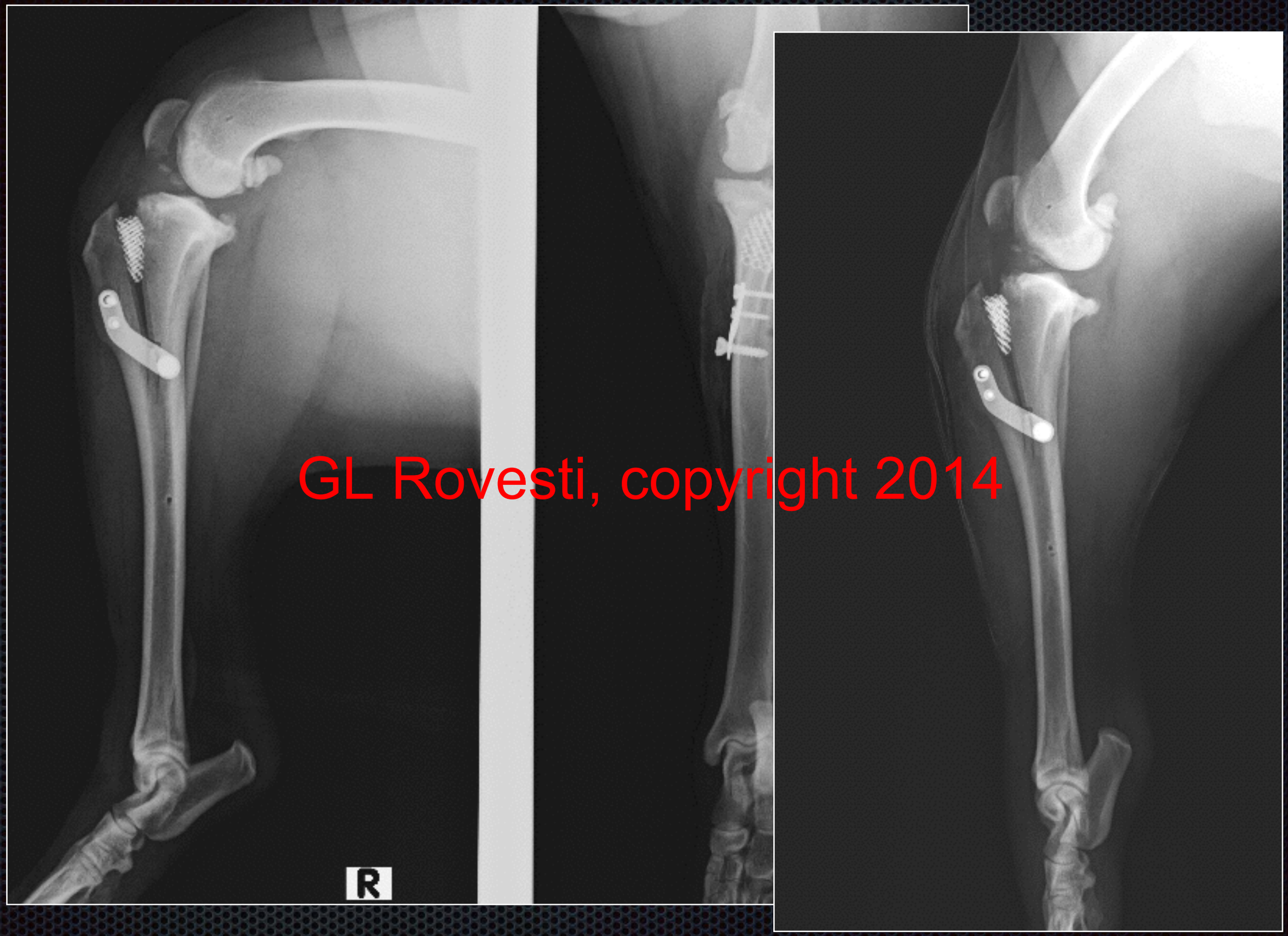
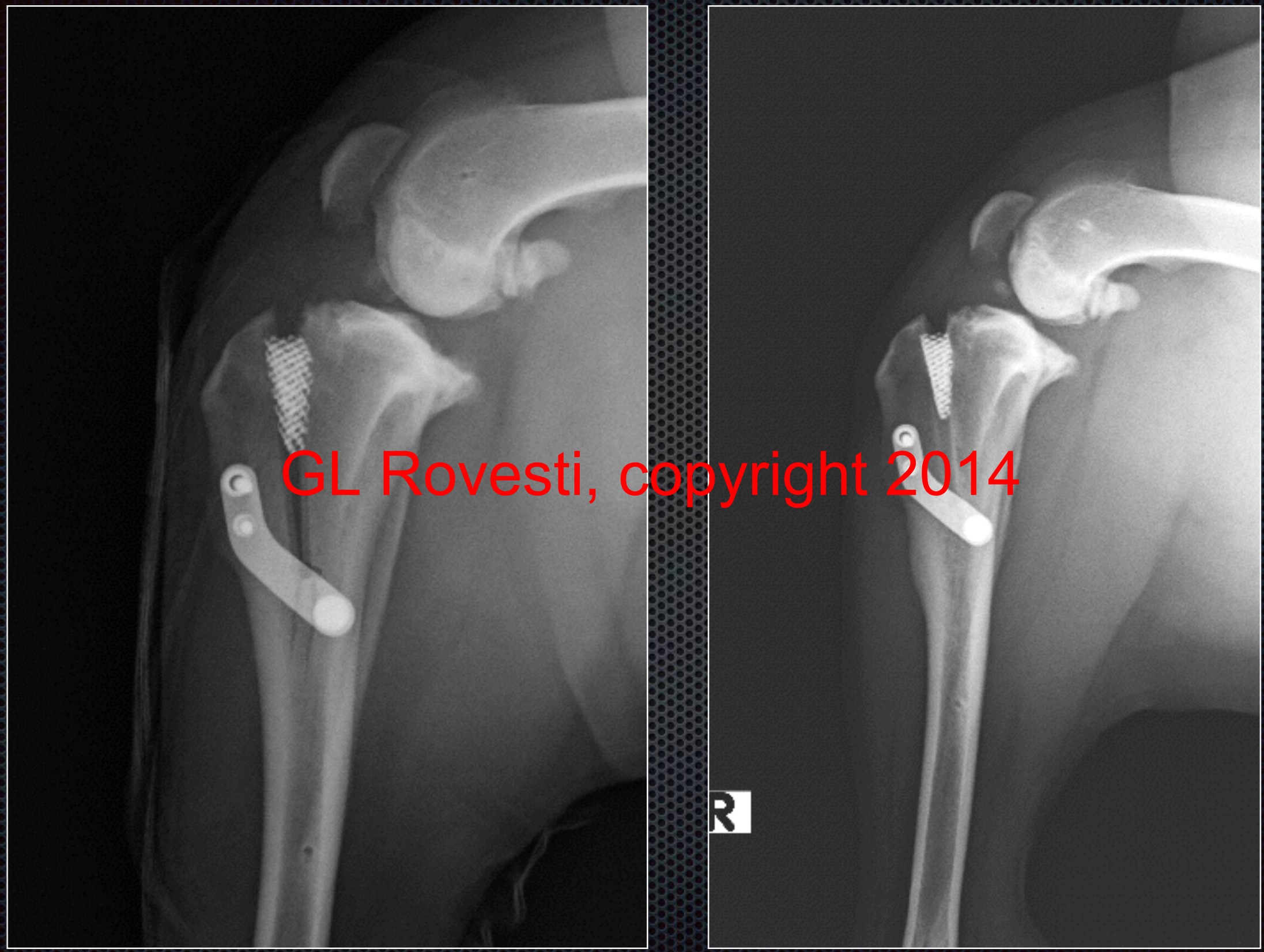


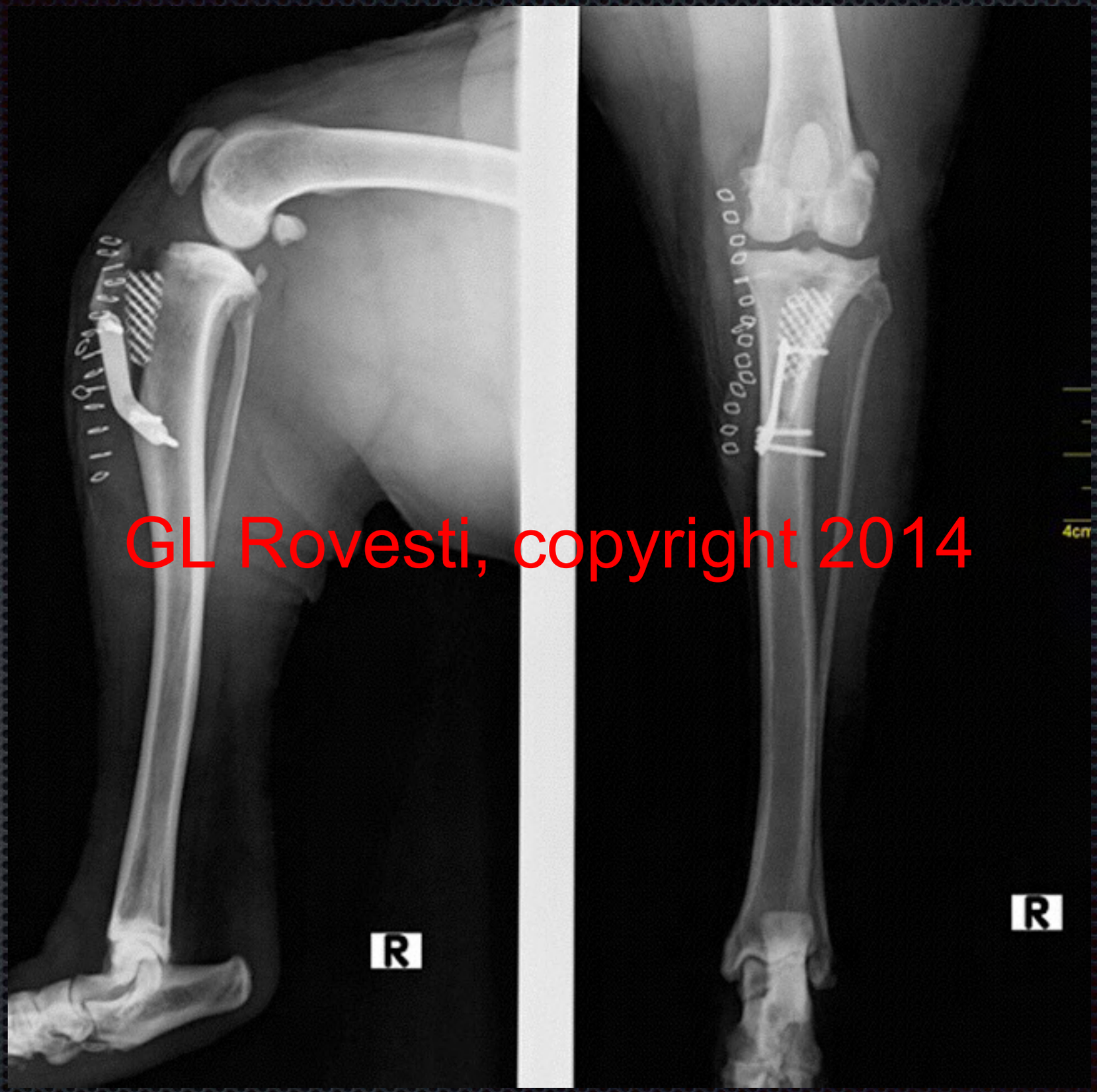


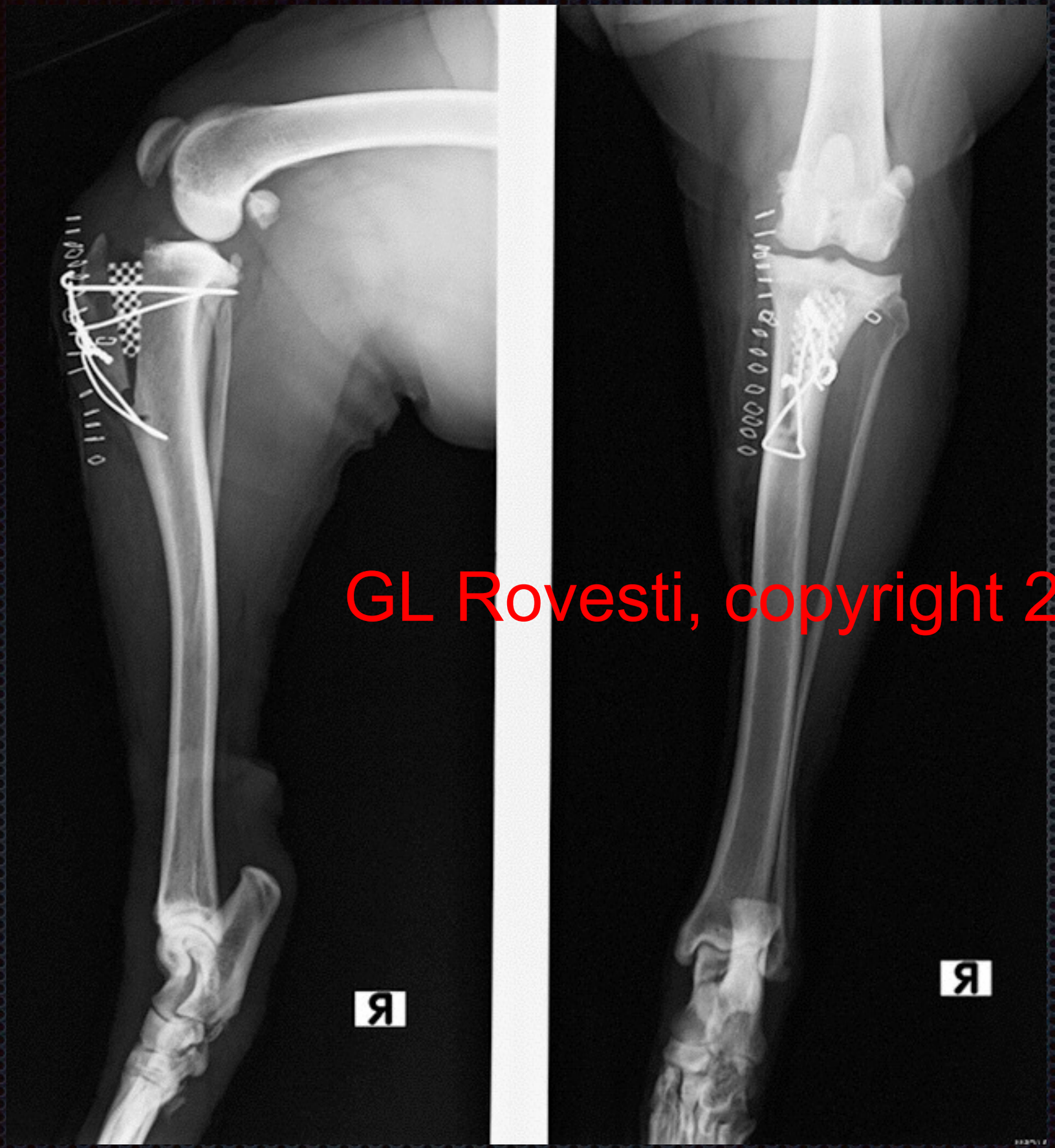


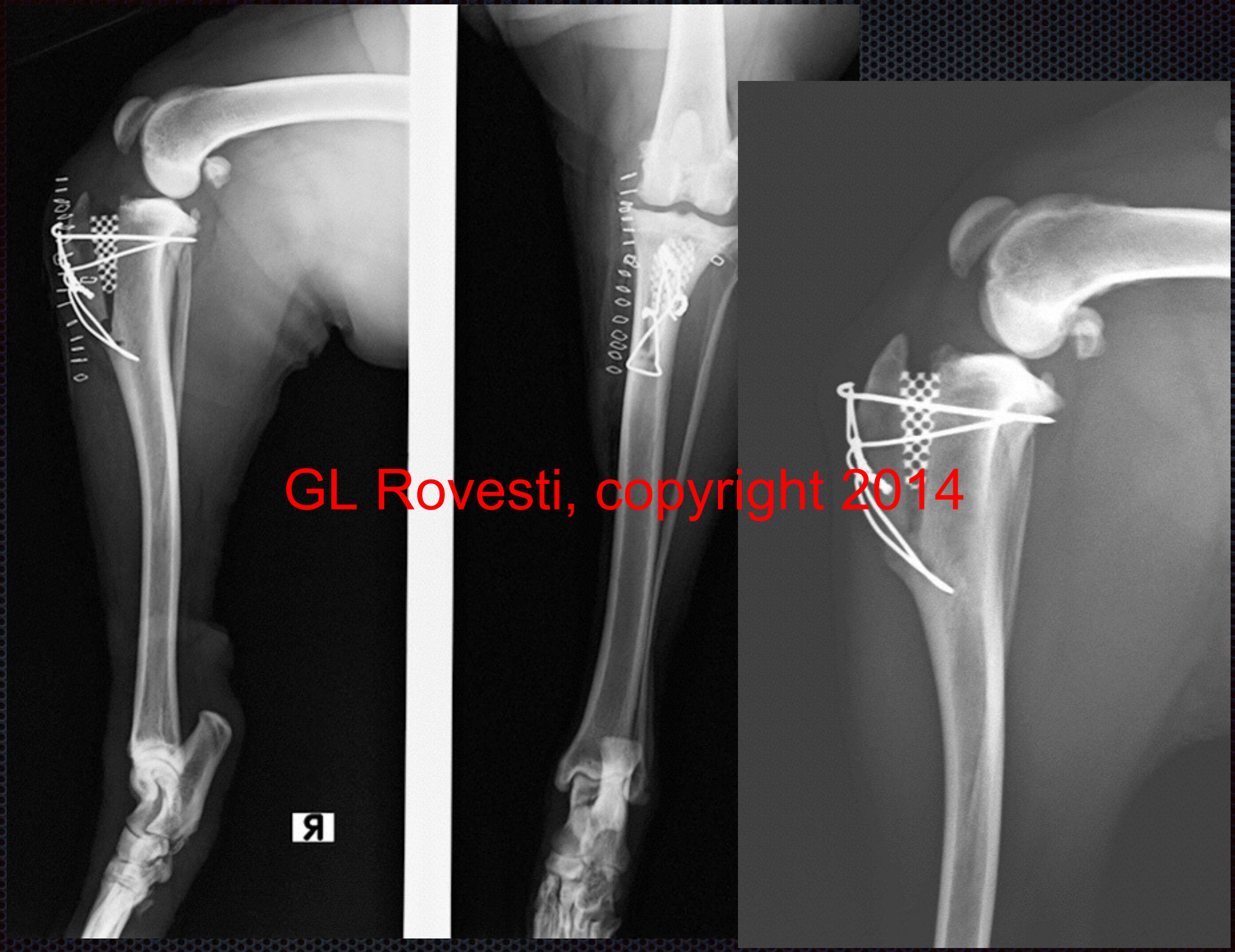




Labrador, female, 5 yo, 29 kg







Doberman, female, 6 yo, 32 kg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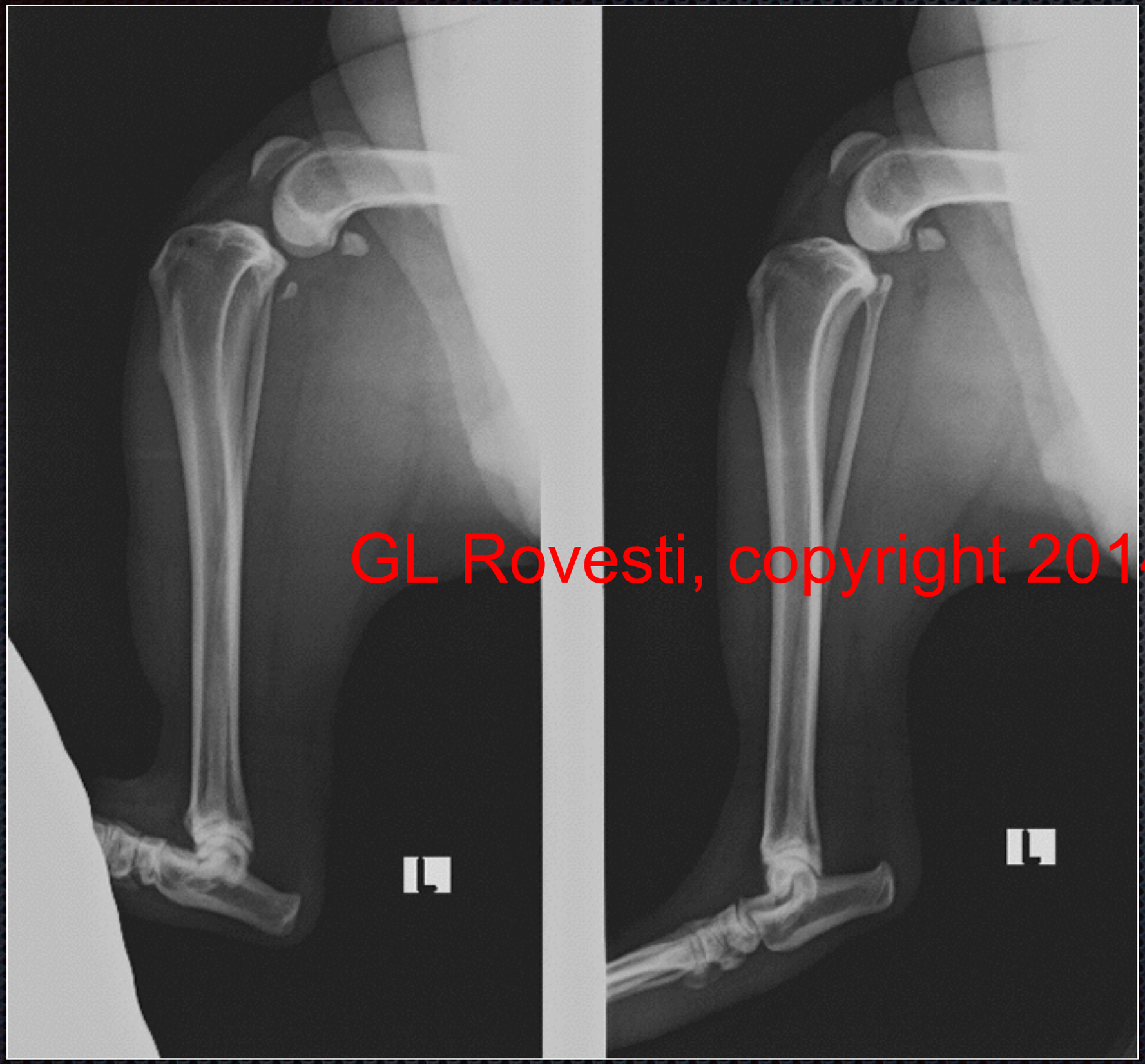
Labrador, female, 2 yo, 32 kg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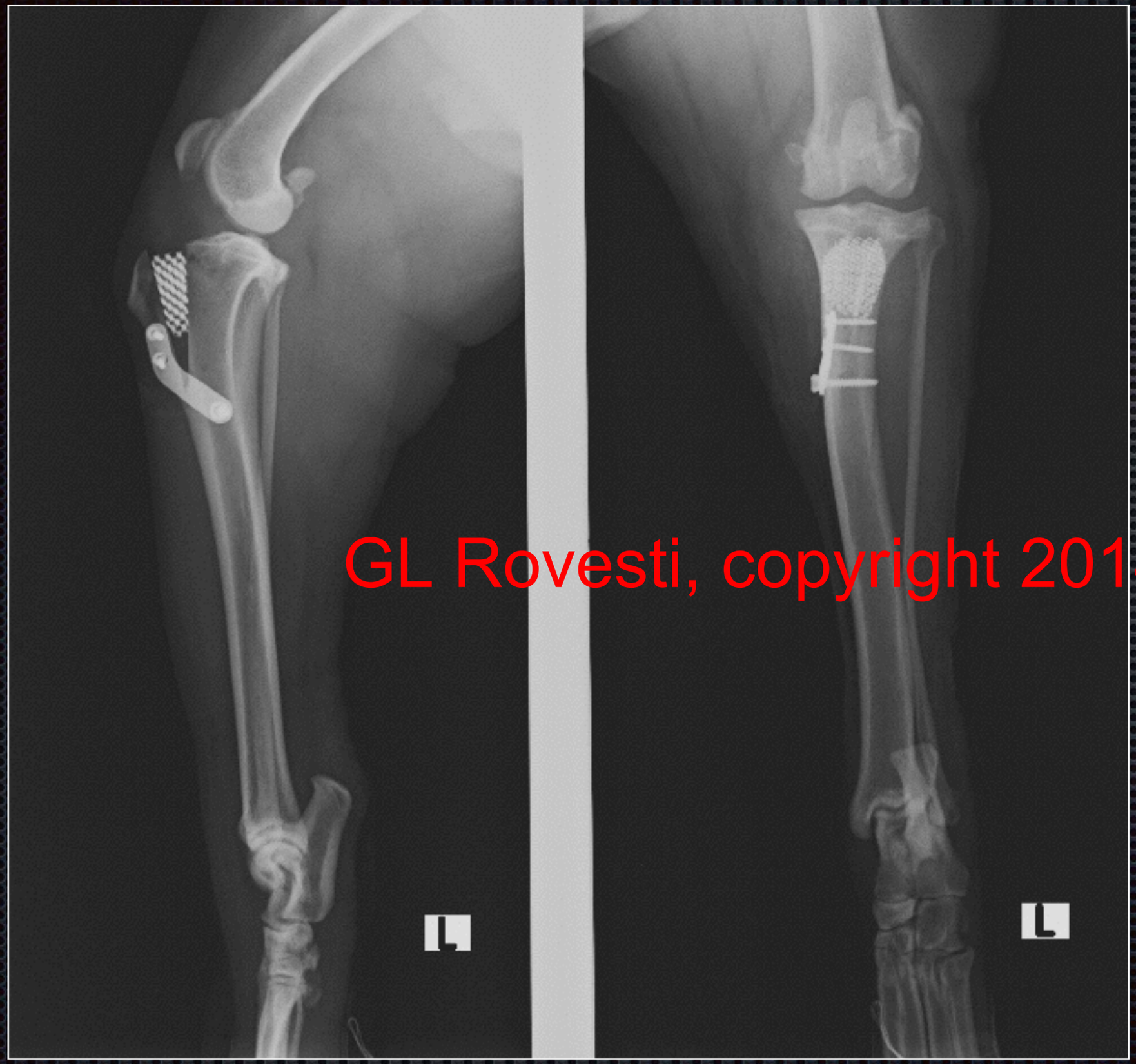
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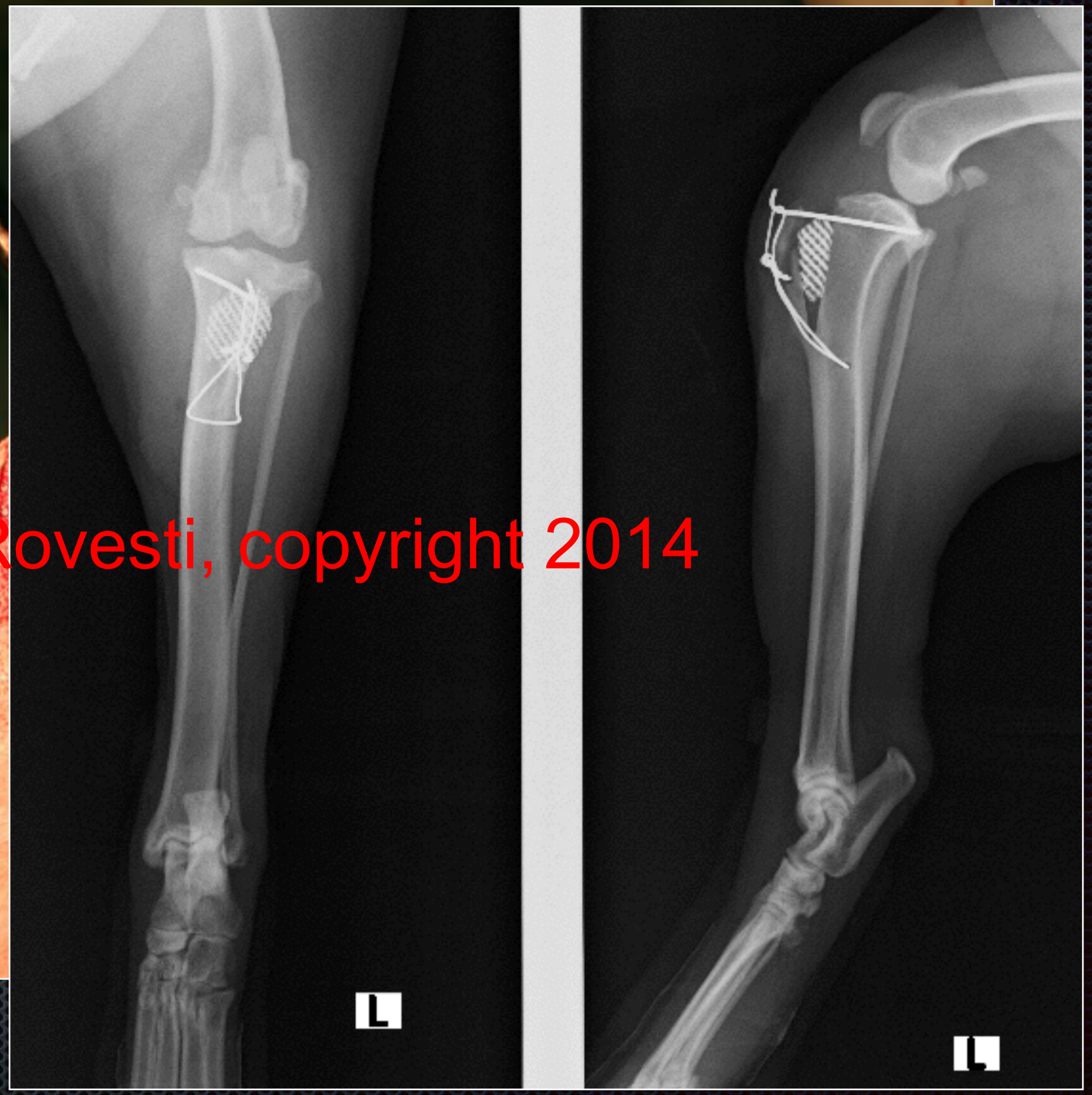


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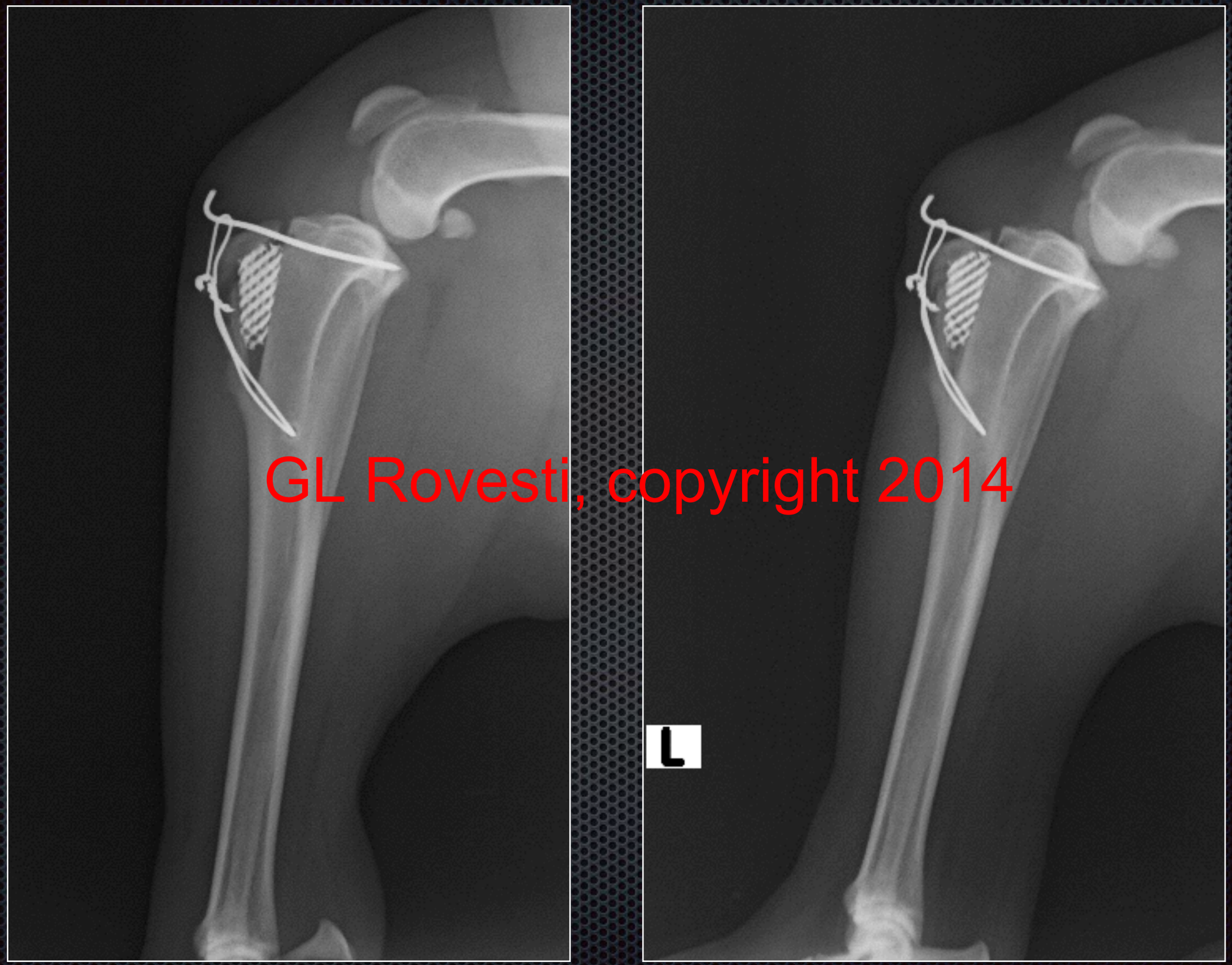
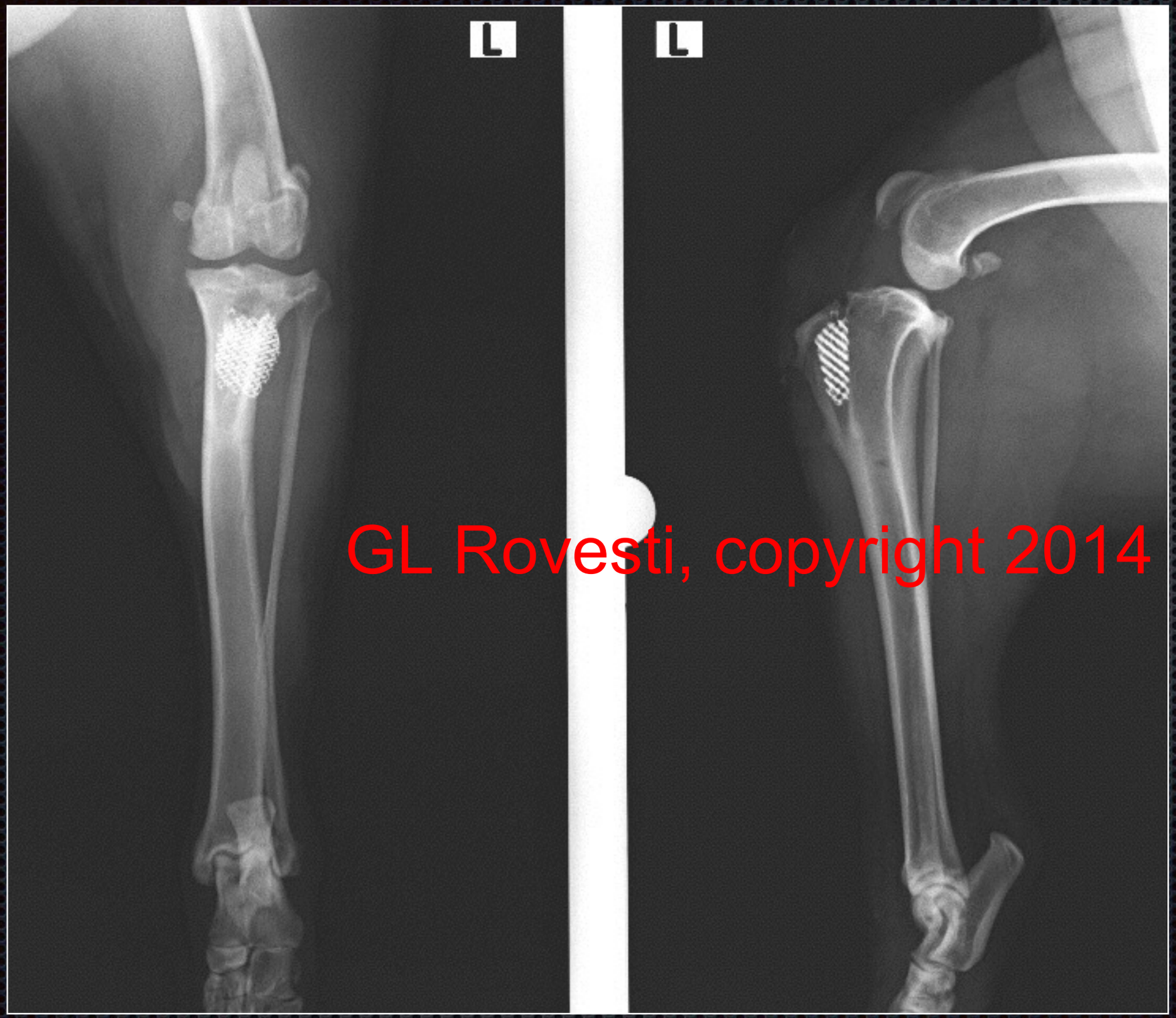
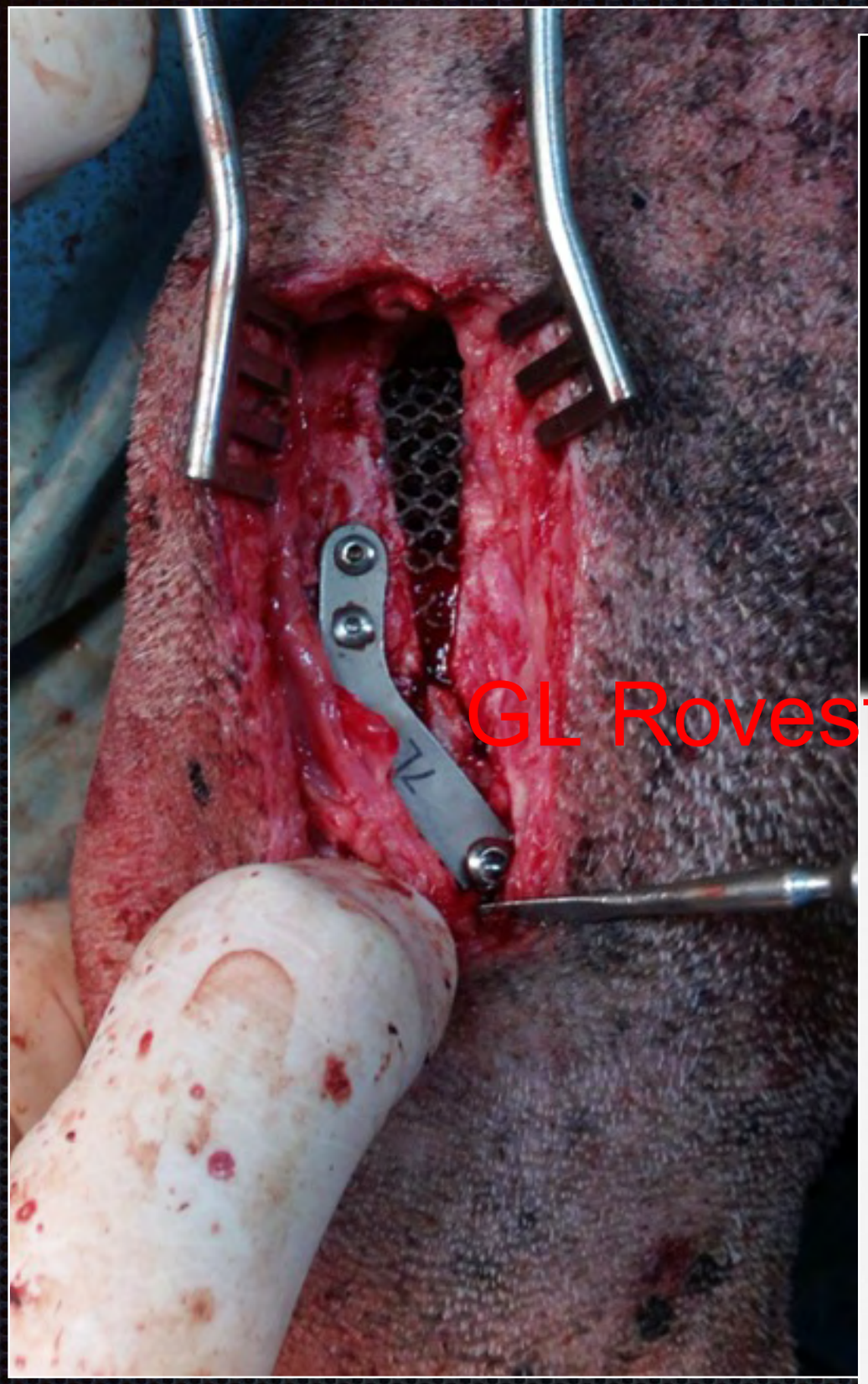
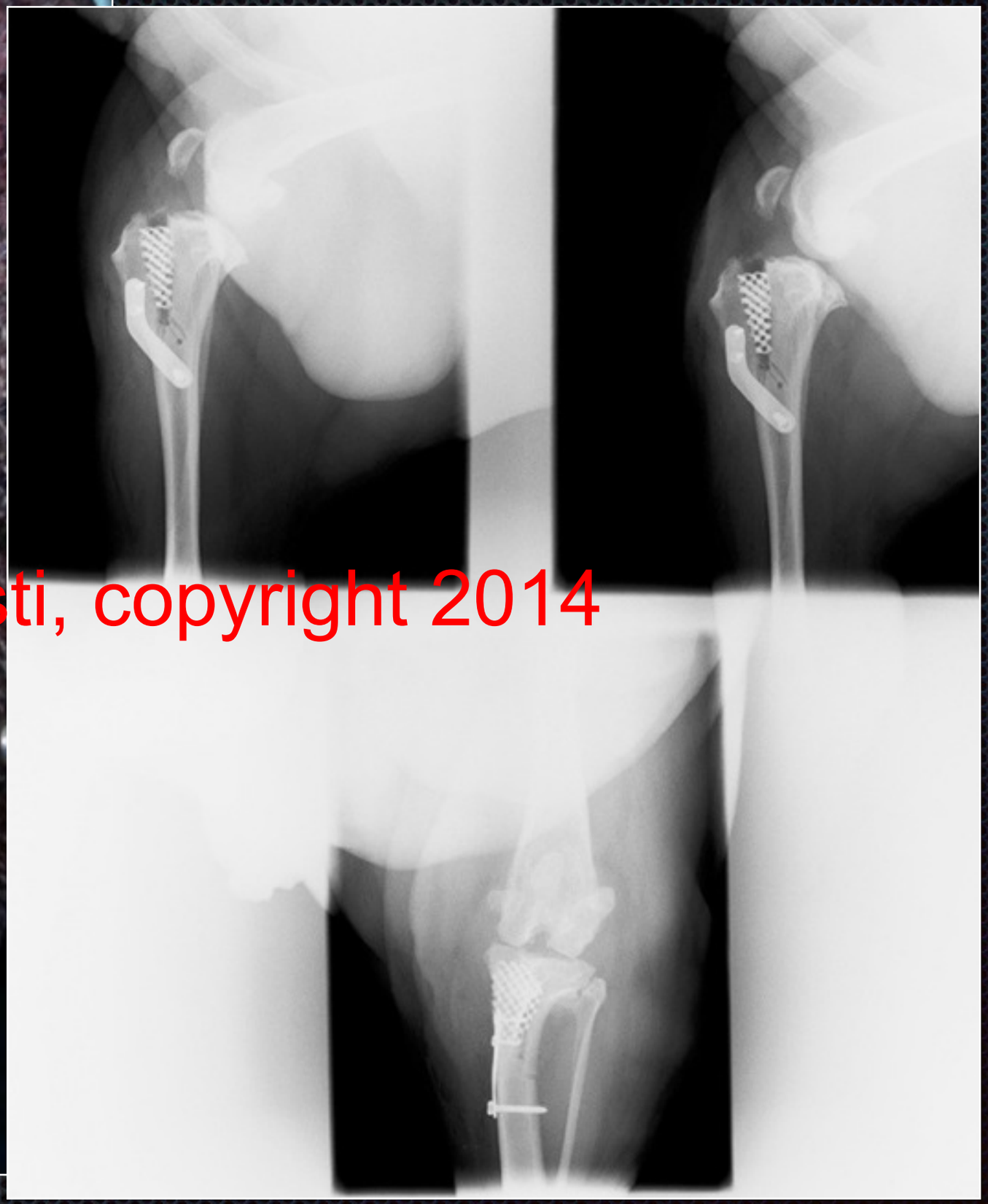
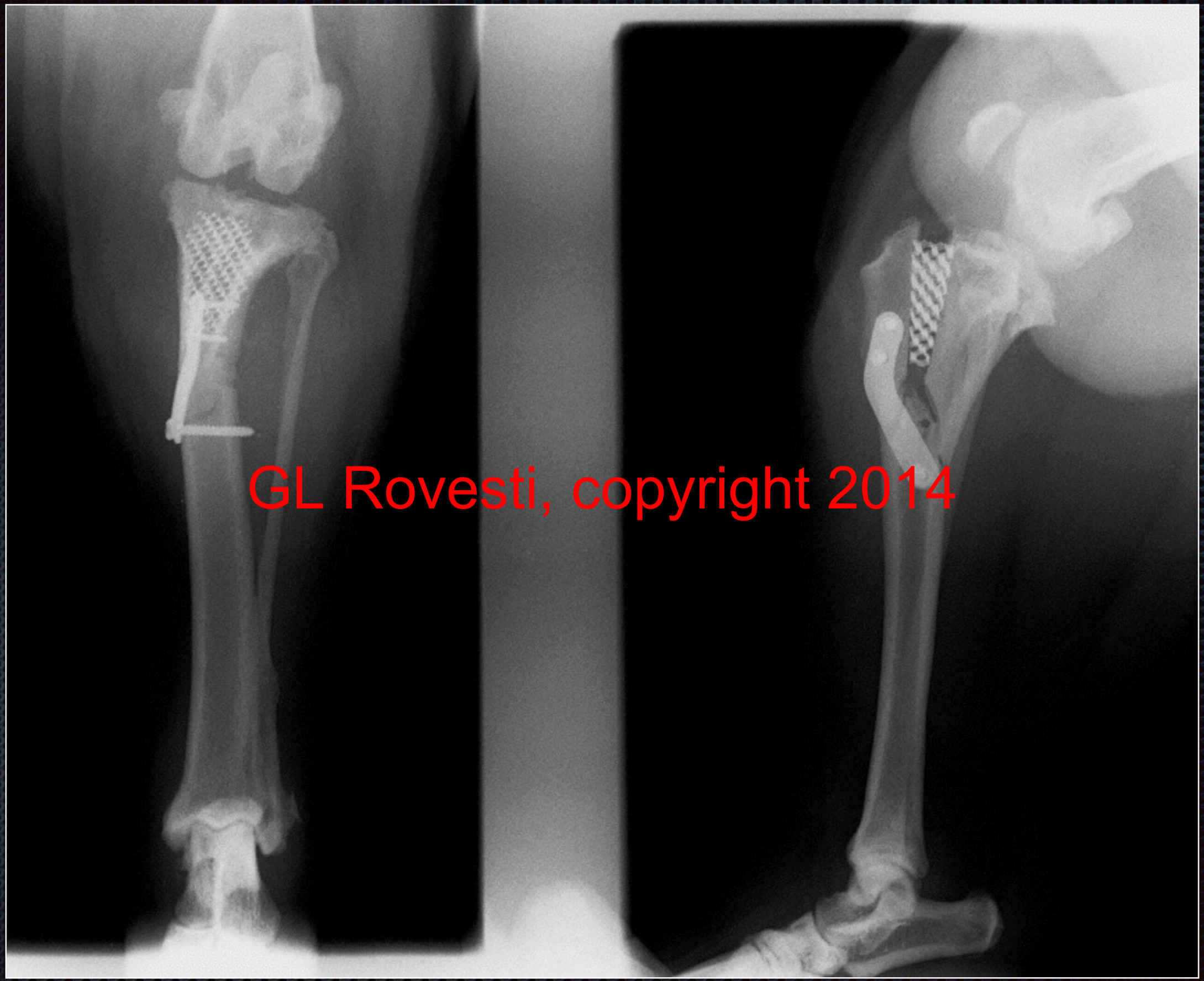




English bulldog, male, 8 yo



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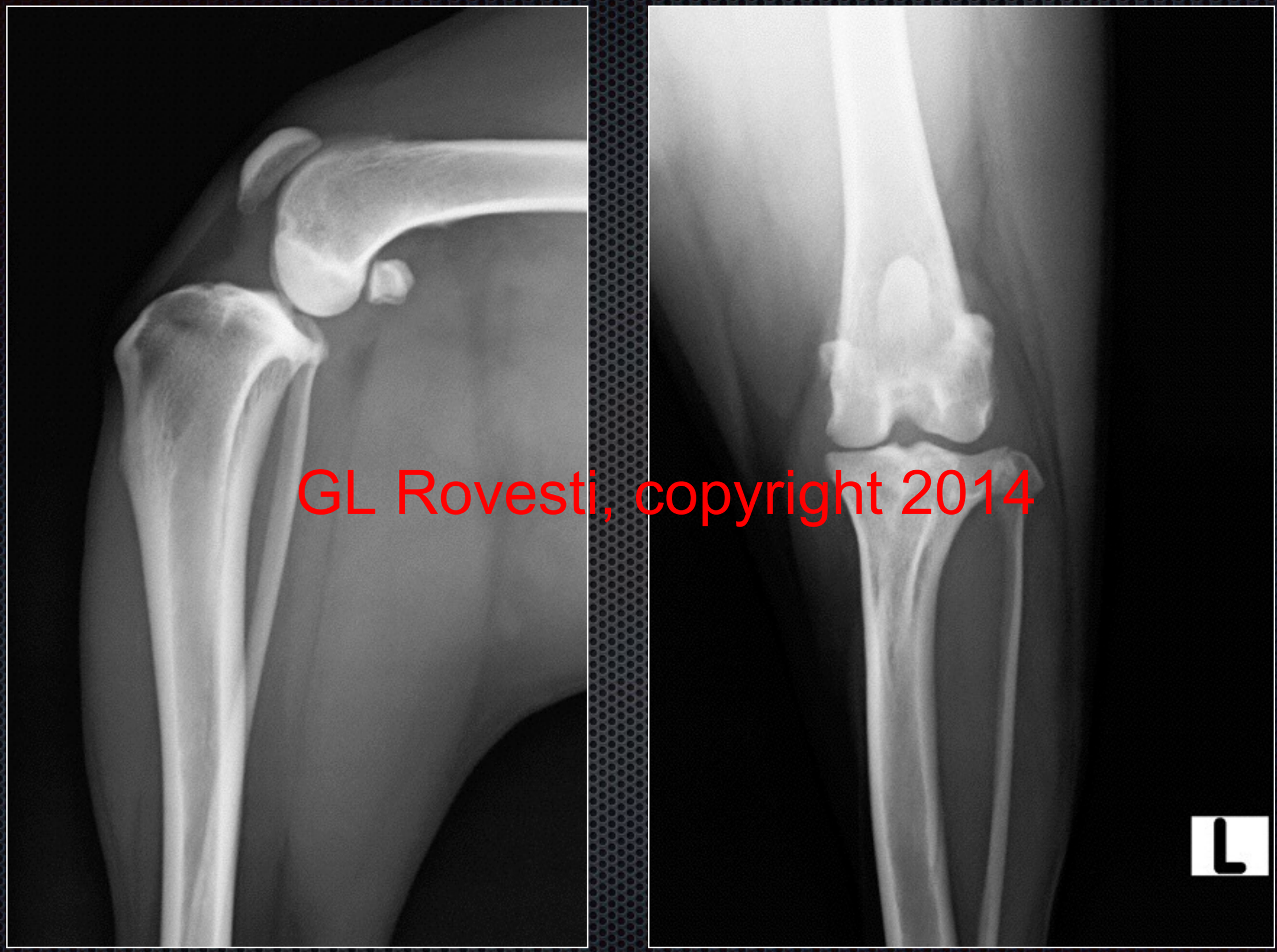
Mongrel, female, 5yo, 22kg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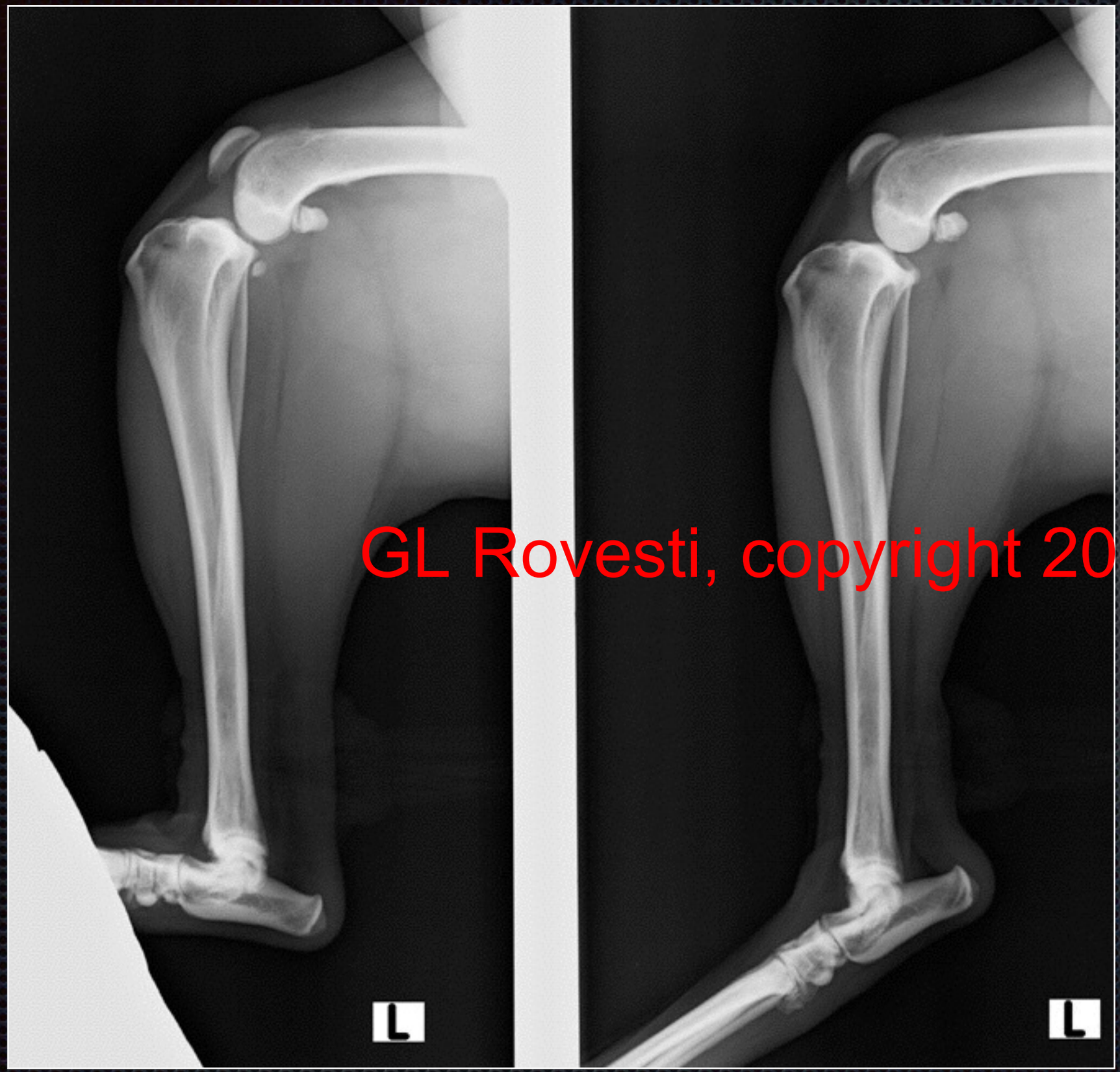
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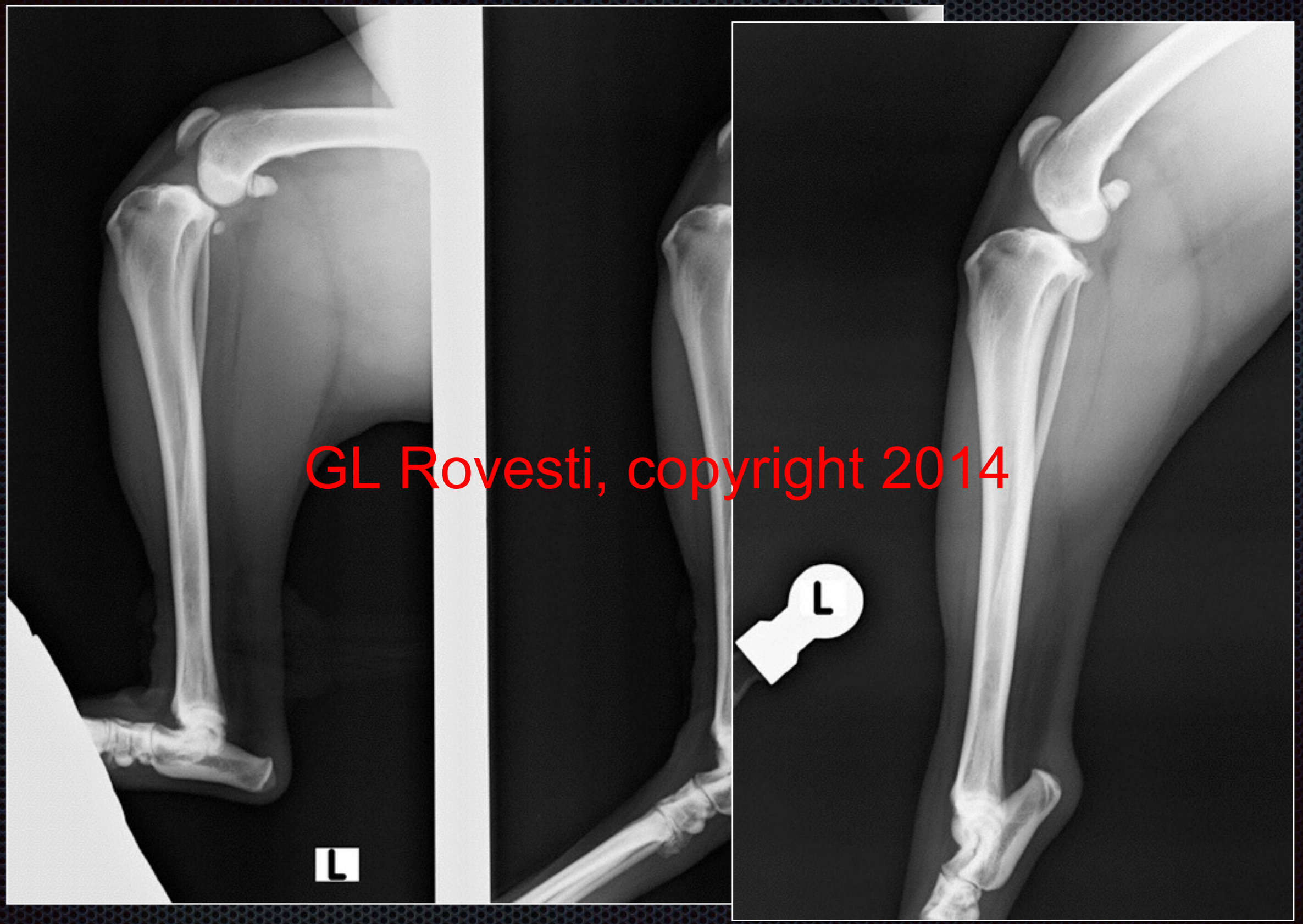

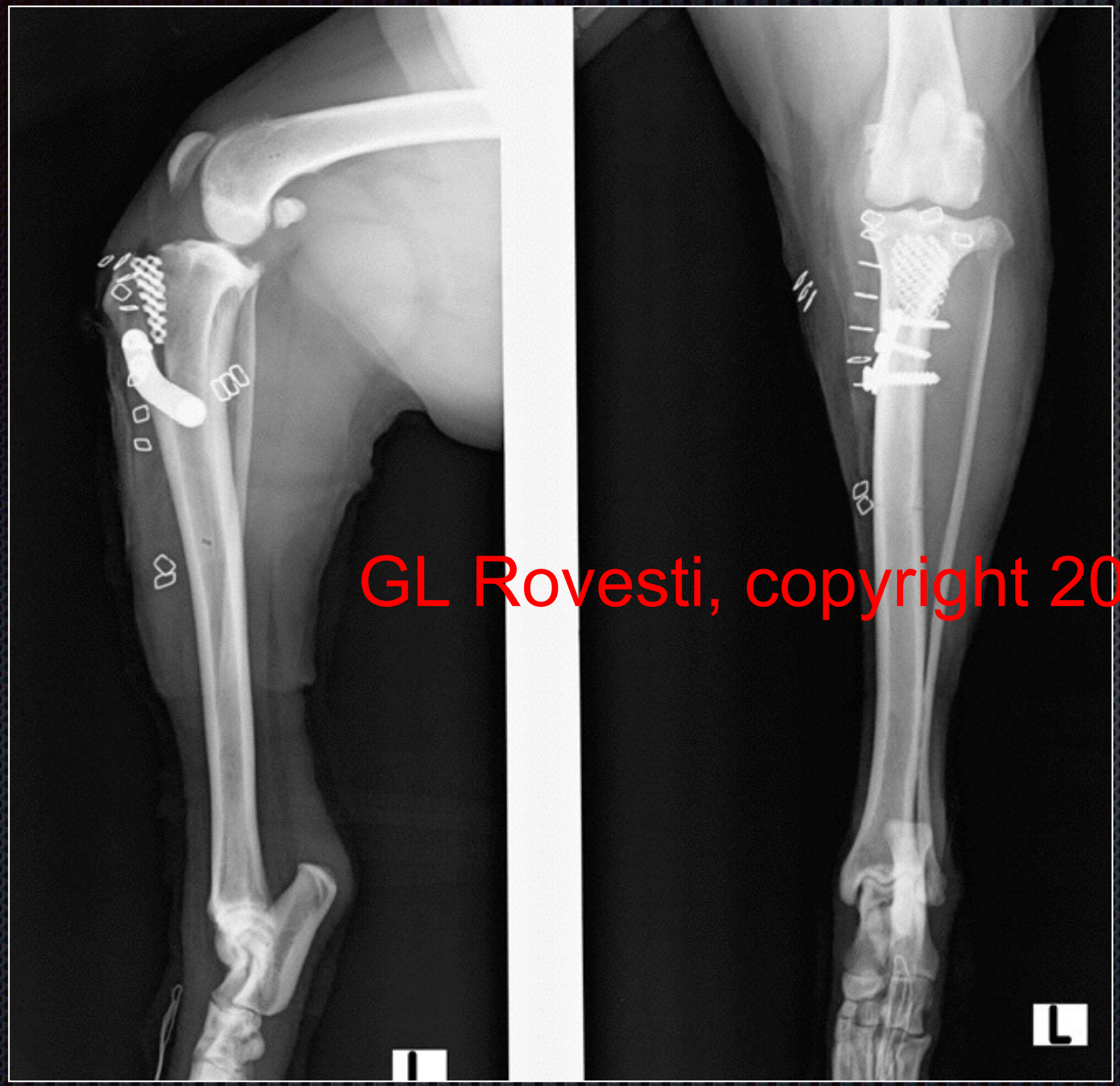
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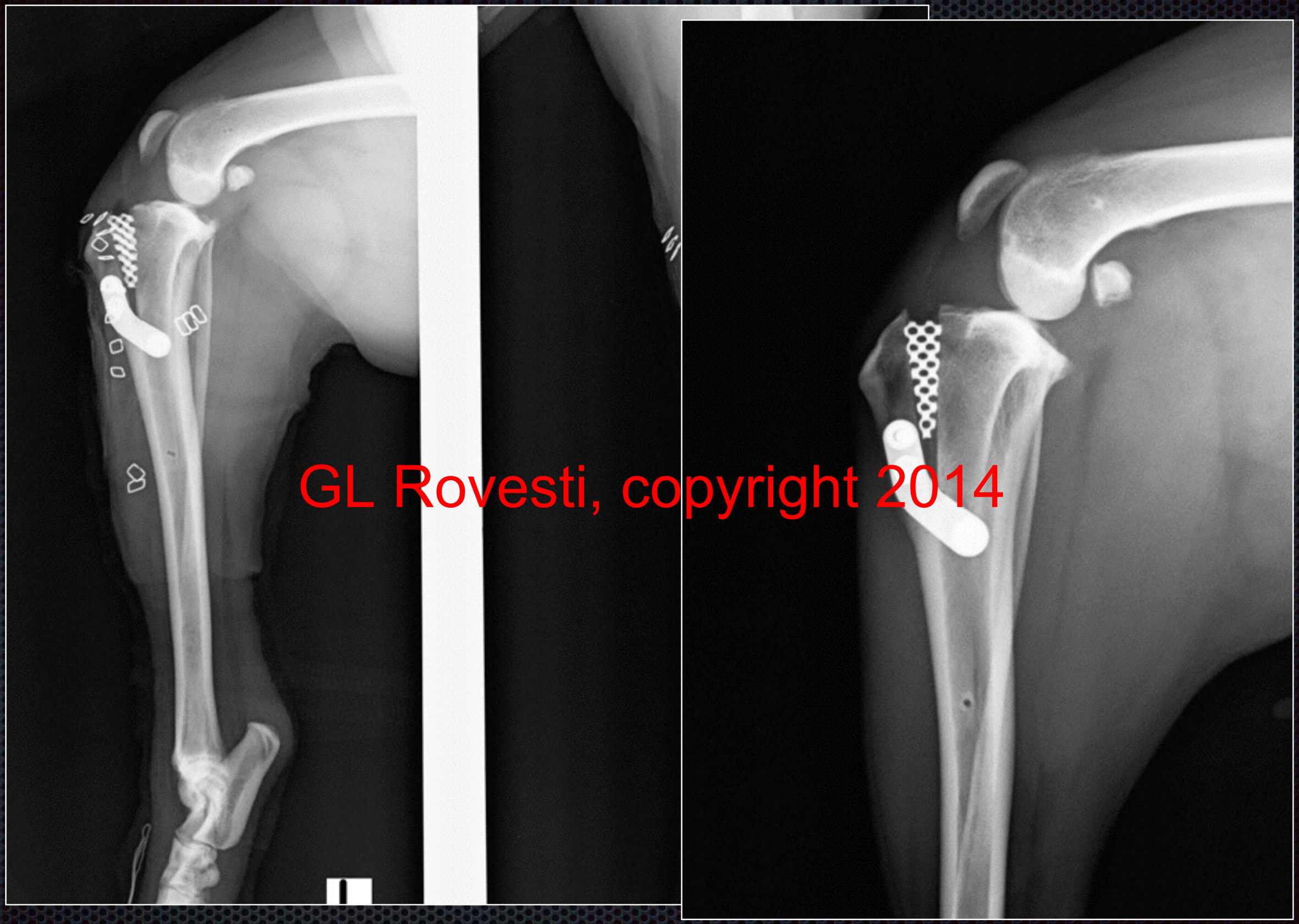

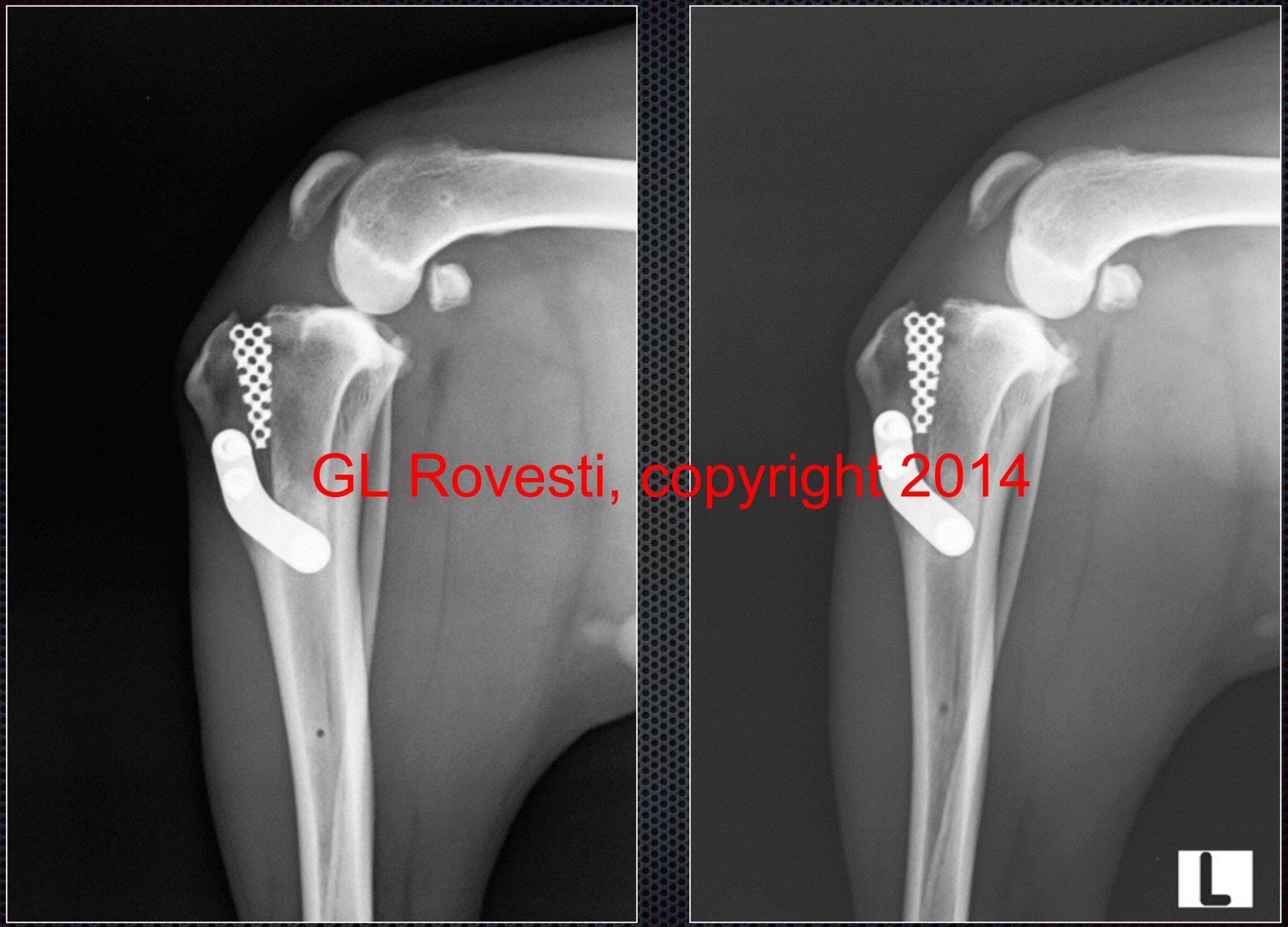
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