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ORTHOPAEDIC ROBOTICS LABORATORY

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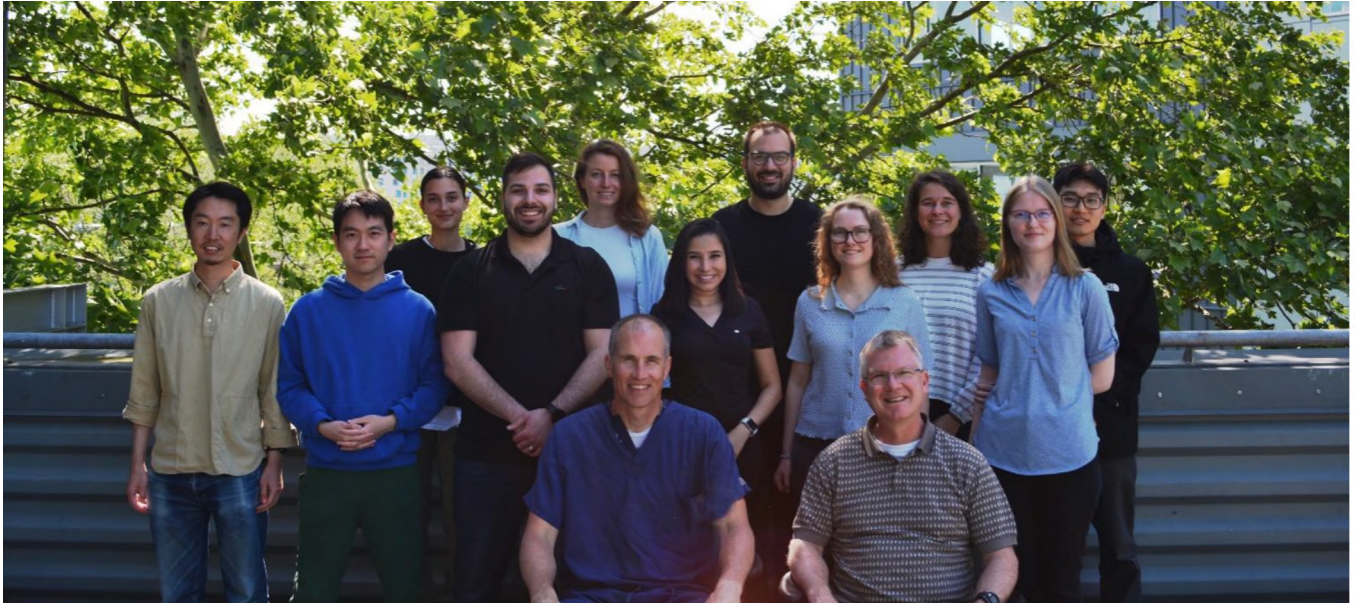
PITT | **SWANSON**
ENGINEERING
BIOENGINEERING



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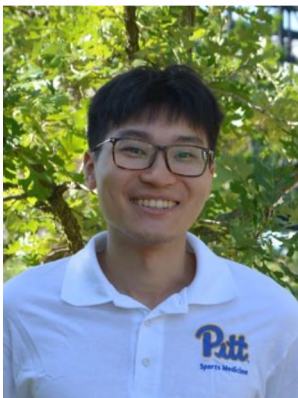
CI F'H95 A



Xgt qplnc 'F wt t
Erɛu'qh'4247
Dkqgpi kpggtkpi
Wpkxgtukɿ "qh'Rkwudwti j



Uctej 'Uj gi qi wg
Erɛu'qh'4247"
Dkqgpi kpggtkpi "
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Upi zwcp'gug+'Y cpi
Erɛu'qh'4247
Ur qt w'O gf lekpg'O U"
Wpkxgtukɿ "qh'Rkwudwti j

H5 6 @ 'C: '7 CBH9 BHG

30' I ngpqj wo gt cñCpvgtkqt/Rqungtkqt 'Vt cpurvkqp'Tcpi g'Kt'Pqv'Cuqekvgf 'y kj " Rci g'7/8

Tqvcvqt 'Ewhi'O wuerg'Uvt gpi vj 'Tcvkq'lp'Kpf klf wcn'y kj 'U{o r vqo cvk

Kqrvvgf 'Uwr t cur lpcwu'Vget u'Rt kqt 'vq'Gzgtekg'Vj gter{

Ikpi zwcp'Y cpi . 'Nwng'V0O cvct. 'Nkf {c'Ecpwtm'Cfco 'L0Rqr ej cm'Lwo r gk'Kpqwg.

Y knko 'L0Cpf gtuv.Xqmg't'O wucj n'Lco gu'L0Kti cpi . 'Tlej ctf 'G0F gdunk

F grctwo gpv'qñUrqtu'O gf kelpg'cpf 'Pwt klqp. 'F grctwo gpv'qñDkqgpi kpggtkpi .

F grctwo gpv'qñRj {ukecnVj gter{ 'cpf 'F grctwo gpv'qñQtvj qrcgf ke'Uwti gt{

40' Gxcnwvlp'i 'vj g'Ceewtce{ 'qñ'vj g'Ewtt gpv'Çñ qt kj o 'hqt 'Ræpplp'i 'Cpvgtkqt " Rci g'9/:

Enqulpi 'Y gf i g'J li j 'VldkñQungqvgo lgu

Uctcj 'C0Uj gi qi wg. 'Nwng'V0O cvct. 'Cplc'O 0Y cengtrg. 'Lctgp'E0Nci tgec.

Tlej ctf 'G0F gdunk'Xqmg't'O wucj n

F grctwo gpv'qñDkqgpi kpggtpi 'cpf 'F grctwo gpv'qñQtvj qrcgf ke'Uwti gt{

50' Ej cpi gu'lp'VldkñCt vkwrt 'Ect vñci g'Vj lenpgu'lp'è'Rqt elpg'O qf gnVj tqwi j 'Rci g';/32

UnggvñO cvct cvkqp

Xgtqpkñ'F wtt. 'I knkp'Cj tgpv v.'Nwng'V0O cvct. 'Xqmg't'O wucj n'O cvj gy 'Hkuj gt.

Tlej ctf 'G0F gdunk

F grctwo gpv'qñDkqgpi kpggtkpi 'cpf 'F grctwo gpv'qñQtvj qrcgf ke'Uwti gt{

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Lkpi zwcp "Y cpi ³. 'Nwng' V0O cwet ⁶. 'Nkf { c' Ecpwtnf. 'Cf co 'L0Rqr ej cni. 'Lwo r gk' Kpqwg ⁶. 'Y knko 'L0' Cpf gtuw ^{6,4}. 'Xqmg' 'O wucj n' ⁴. 'Lco gu' L0Kti cpi ^{5,6}. 'Tlej ctf 'G0F gdunk ^{4,6}

³F gr ctvo gpv'qh'Ur qt u' O gf lekpg' c'pf "P wtkkqp." ⁴F gr ctvo gpv'qh' Dkqgpi kpggtkpi. ⁵F gr ctvo gpv'qh' Rj { ulecn' Vj gter { . ⁶F gr ctvo gpv'qh' Qtvj qr c'gf le' Uwti gt { . 'Wpkxgtuk { 'qh' Rkwudwti j . 'Rkwudwti j . 'RC. 'WUC

IPVTQFWEVKQP < Vj g' f { pco le' ucdkkl' gtu' qh' vj g' i ngpqj wo gtcn' lqkv. "r ctvkwrcn { " y g' tqvcvqt " ewh' o wuergu. " r r { " c' etwecn' tqng' lp' o c' kpcvklpi " lqkv' ucdkkl' { " f wtkpi " uj qwf gt " o qvkv0' Hqt " gzco r ng. " kp " vj g' vtcpuxgtug " r rpg. " vj g' uwduecr wrtku " vtcpurvgu " vj g' j wo gtcn' j gcf " cpvgtkqn { " c'pf " o gf kcm { . " y j kg " vj g' kplhtcur kpcwu " c'pf " vgtgu " o k'pqt " vtcpurvg " vj g' j wo gtcn' j gcf " r quvgtkqn { " c'pf " o gf kcm { " kp " tgrvkqp " vq " vj g' i ngpqf. " hqto kpi " vj g' vtcpuxgtug " hqteg " eqwr ng " qh' vj g' tqvcvqt " ewh' ^{3,40} C " dcrpegf " vtcpuxgtug " hqteg " eqwr ng " o ki j v' o k'pko k g' i ngpqj wo gtcn' cpvgtkqt / r quvgtkqt " vtcpurvkqp. " r qv'pvcn { " kplhtqto kpi " erpklecpu " kp " vj g' f guki p " qh' pqpqr gtcvkg " vgcvo gpv' r tqveqnu " hqt " kpf kxf wcn' y kj " uj qwf gt " o wuerg " utgpi vj " f ghleku " ecwugf " d { " tqvcvqt " ewh' v'gctu' ⁶⁰ Vj gtghqtg. " vj g' qdlgevkxg " qh' vj g' uwf { " y cu " vq " kpxgukv cvg " vj g' tgrvkqpuij kr " dgvy ggp " vj g' utgpi vj " tcvkq " qh' vj g' vtcpuxgtug " hqteg " eqwr ng " *Kq0' Jkplhtcur kpcwu " - " vgtgu " o k'pqt_luwduecr wrtku+ " c'pf " vj g' tcpi g' qh' i ngpqj wo gtcn' cpvgtkqt / r quvgtkqt " vtcpurvkqp " f wtkpi " uecr wrt " r rpg " cdf vekqp " kp " kpf kxf wcn' y kj " r ctvkn " qt " hwm / vj kempguu " u' o r vqo cve " tqvcvqt " ewh' v'gctu " kuqrvqf " vq " vj g' uwr tcur kpcwu " v'pfp qp " r tkqt " vq " cp " gzgtekug " vj gter { " r tqi tco 0' K' y cu " j { r qvj guk gf " vj cv " vj gtg " y qwf " dg " c " pqp / rkp'gct " tgrvkqpuij kr " dgvy ggp " vj g' utgpi vj " tcvkq " c'pf " vj g' tcpi g' qh' i ngpqj wo gtcn' cpvgtkqt / r quvgtkqt " vtcpurvkqp " lp " i tqwr u' qh' kpf kxf wcn' y kj " r ctvkn " qt " hwm / vj kempguu " uwr tcur kpcwu " v'gctu0

O G V J Q F U < ' Ugxgpv { / p'kp'g " uwdlgeu " y kj " c u' o r vqo cve " tqvcvqt " ewh' v'gct " kuqrvqf " vq " vj g' uwr tcur kpcwu " v'pfp qp " *ci g' 7; 06' 0; 04' { gctu = DO K 4: 06' 0' 60 " ni lo = 4: " y kj " r ctvkn " v'gctu. " 73 " y kj " hwm / vj kempguu " v'gctu+ " r tqxkf gf " KTD / cr r tqxgf " eqpugpv " dg'htg " r ctvlekr cvkpi " kp " cp { " tgugetej " r tqegf v'gctu0 " uwdlgeu " kuqo g' tle " utgpi vj " c'pf " kp / xkxq " i ngpqj wo gtcn' k'pgo cveu " y gtg " o gcuwgtf

r tkqt " vq " c' r gtuqpcrk gf " gzgtekug " vj gter { r tqi tco 0' Kuqo g' tle " uj qwf gt " gzvgtpcn' c'pf k'pvgtpcn' tqvcvqp " utgpi vj " y cu " cuuguugf " d { " c " r j { ulecn' vj gter knv " wukpi " c " j c'pf / j grf " f { pco qo gvgt " y kj " vj g' " uwdlgeu " ugcvgf " c'pf " vj gk " ch'gevgf " cto " r qukkqp'gf " cv' 2' A' qh' j wo gtqj qtceke " cdf vekqp " c'pf " ; 2' A' qh' grdqy " hrgzkqp0' k'pvgtpcn' tqvcvqp " utgpi vj " v'gukpi " cuuguugf " vj g' utgpi vj " qh' vj g' uwduecr wrtku. " y j kg " gzvgtpcn' tqvcvqp " utgpi vj " v'gukpi " cuuguugf " vj g' utgpi vj " qh' vj g' kplhtcur kpcwu " c'pf " vgtgu " o k'pqt ^{7,80} Vj g' cxgtci g " utgpi vj " tcvkq " qh' vj g' vtcpuxgtug " hqteg " eqwr ng " *Jkplhtcur kpcwu- vgtgu

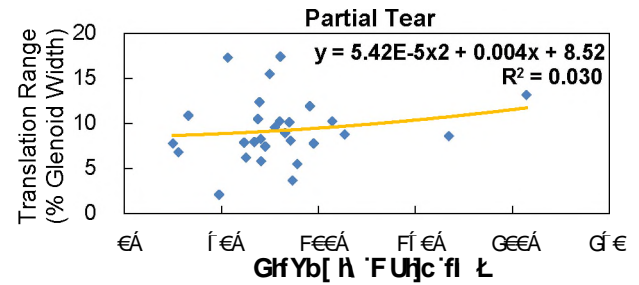
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TGUWNVU < Vj g' utgpi vj " tcvkq " hqt " eqj qt u' y kj " r ctvkn " c'pf " hwm / vj kempguu " uwr tcur kpcwu " v'gctu " y cu " : 20 " 0' 5904 " " *tcpi g' < 47 " vq " 42: ' + " c'pf " 8; 06 " 0' 4304 " *tcpi g' < 4; ' vq " 345 " + t'gur gev'xgn { 0' K' ; 2' " qh' vj g' uwdlgeu " *9319; + " vj g' utgpi vj " tcvkq " y cu " ngu " vj cp " 322' 0' Vj g' tcpi g' qh' i ngpqj wo gtcn' cpvgtkqt / r quvgtkqt " vtcpurvkqp " hqt " eqj qt u' y kj " r ctvkn " c'pf " hwm / vj kempguu "

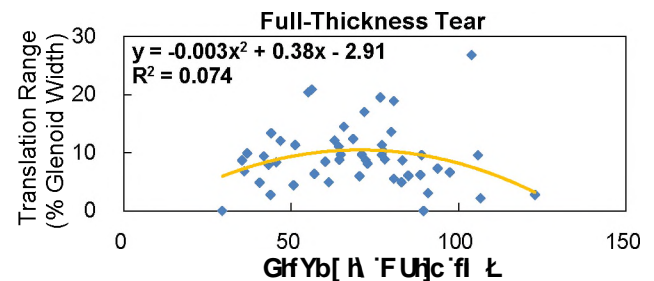
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dcnpegf "vcpuxgtug" hqteg" eqwr ng" o ki j v'dg" ng {" vq" o clpvclpki "uj qwrf gt" uwdkxkf 0



7 k



7 k

ENRPECN"TGNGXCPEG<'Y j gp" f guki plpi " pppqr gtcvkxg" vgcvo gpv' r tqvceqnu" hqt" kpflkxkf wcu" y kj " tqvcqt" ewh' vgtu" kuqrvvgf " vq" yj g" uwr tcur kpcwu" vppf qp." erpklekpu" uj qwrf " go r j cuk g" gpj cpeki "qxgtcm"uj qwrf gt" utgpi yj " cpf " hwpvkqp" tgrcvkxg" vq" yj g" eqpvtcrvgtcn'cto . " ukpeg" i nppqj wo gtcn' cpvgtkqt/r quvgtkqt vcpurvkqp"ku"pqv'chgevgf "d{" yj g" utgpi yj "tcvkq"qh' yj g"vcpuxgtug"tqvqvt"ewh'hqteg"eqwr ng0

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Gxcmwłpi 'vj g'Ceewtce{ 'qh'vj g'Ewt tgpv'Čni qt kį o 'hqt 'Rncppłpi 'Cpvgtkqt 'Emulpi 'Y gf i g'J li j "
VldkcnQuvgqvo lgu

Uctcj 'C0Uj gi qi wg³. 'Nwmp'V00 cwct⁴. 'Cplc'O 0'Y cengtrg^{4,5}. 'Ictgp'E0Nci tgec⁴."

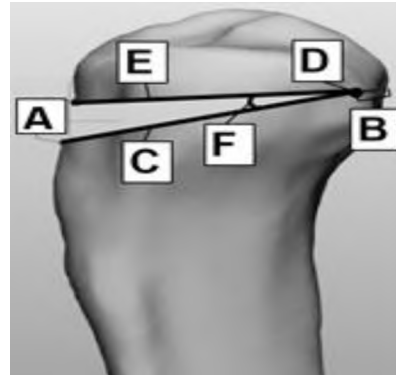
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 Rkwudwti j . 'RC

⁵F gr ctvo gpv'hqt'Qtvj qr cgf le'Ur qt w'O gf lekpg. 'Młpłmwo 'Tgej w'f gt'Kuct. 'Vgej plecni'Wpkxgtuk{ 'qh'
 O wplej . 'O wplej . 'I gto cp{

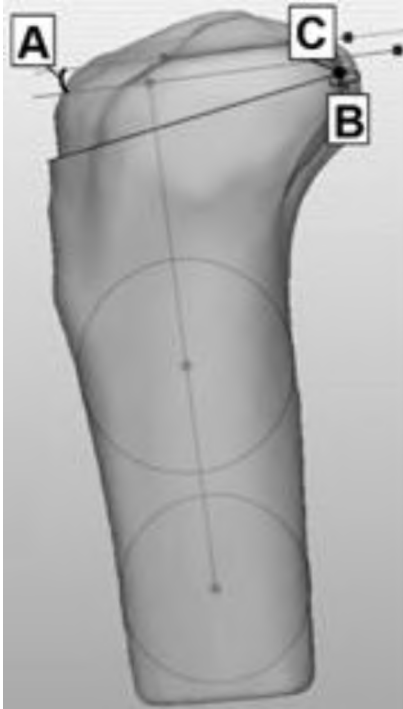
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 i gqo gvkcm{ "qp" c"utlev"ncvgtcn'tcf kqi tcr j "y kj "
 uqo g" cni qtkj o u" wulpi "vj g" tgrvkvpuj kr "vj cv" 3"
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 eqo r cplgu" j cxg" dggp" f gxnqr kpi " r ncppłpi "
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 ko r tqxg"vj g'ceewtce{ "qh'cpi rg"eqttgevkpu"]7/8_0'
 J qy gxgt. "vj gug" o gvj qf u" uqo gvko gu" tguwn" kpi "
 wpf guktgf "eqttgevkpu"]9_0'Vj g" qdlgevkg" qh"vj ku"
 uwf { " y cu" vq" cuuguu" vj g" ceewtce{ " qh" vj g"
 cni qtkj o " wugf "vq" r nc"cpvgtkqt"emulpi "y gf i g"
 J VQu. "cuuwo kpi "vj cv" vj g" vldkcn'cevu"cu" c"tki kf "
 dqf { 0' K' y cu" j { r qvj guk gf " vj cv" vj g" ewtgpv'
 r ncppłpi " vgej pls wgu" y kni tguwn" kpi "cp" ceewtcvg"
 eqttgevkqp"qp"tki kf "dqf { "o qf gnu0

O G V J Q F U "Vj g"i gqo gvt { "qh"gli j v'vldku" *cm'
 rgh' nmpgu+ "y cu" wvkł gf "hqt "c" r tgxkqu" uwf { "
 vj cv" eqputwewgf "vj g"i gqo gvt { "hqt "eqo r wgf "
 vqo qi tcr j { " *E V+" uecpu" *O ko leu. "O cvgtkerk g+ "
]: _0' Vj g" vldku" y gtg" crki pgf " y kj " c" tqcvkqp"
 o cvtkz "wulpi "vj g" o quv' o gf kcn'cpf "ncvgtcn' r qkpui"
 qp"vj g" eqpf { rgu"cpf "egpvgt "qh'uj ch' *O C V N C D. "
 O cvj Y qtm+ "vq" qdvkpi " c" ncvgtcn' ko ci g0' Vj g"
 kpkken' o gf kcn'cpf "ncvgtcn' RVU" y gtg" o gcuwtgf "
 wulpi " vj g" f qwdrg" ekterg" o gvj qf " r tgxkquw"
 gucdrukj gf "]: _0' Vj g" ewu" y gtg" r ncppgf " hqt " c"
 uw r tc/wdgteng"quvgqvo { "y kj " r tgugetxvkvq"qh "



Hli wt g'30C +Y gf i g'j gli j v'D+r quvgtkqt" j kpi g=E+ "
 Nqy gt'ewr ncpg'r ncppgf "hqt "r qkpvt kgevn{ "cdqvg"
 wdgteng"vq"czku'qh'tqcvkqp" *CQT =F +Nqecvkvq"qh"
 j kpi g'ku' r r tqzko cvgn{ "3'eo "hqt "r quvgtkqt"eqtvgz "kp"
 4'fk gevkvpu=G+W r gt'ewr ncpg'r ncppgf "hqt "CQT = "
 cpf "H+tqcvgf "vcti gv'cpi rg'hqt "vj g'hqy gt'ewr ncpg0

vj g" r quvgtkqt" j kpi g" *Hli wt g'3+]32_0' Vj g" vcti gv'
 y cu"vq"tgf wvg"vj g" o gcp"qh'vj g" o gf kcn'cpf "ncvgtcn'
 RVU" vq" 2Å hqt" gcej " dqpg" o qf gr0' Vj g" o qf gnu"
 y gtg"ew'cmppi "vj g'r ncppgf "hkvu. "vj g'y gf i g'y cu"
 tgo qxgf. "cpf "vj g" uw r gtkt" r qt vkvq" qh" vj g" vldkcn"
 y cu"tqcvgf "cdqvw"vj g"czku'qh'tqcvkqp"wpvni"vj g"
 wr r gt" cpf " mpy gt" ewr " r ncpgu" o gv' *5/o cvke. "
 O cvgtkerk g+0' Vj g"eqttgevgf "RVU" y cu" o gcuwtgf "
 wulpi "vj g"uco g" o gvj qf "ucvqf "cdqvg" *Hli wt g'4+0'
 Vj g"cpvgtkqt" j gli j v'qh'vj g"tgo qxgf "y gf i g'y cu"
 o gcuwtgf 0' Vj g" eqttgevgf " o gf kcn' cpf " ncvgtcn'
 RVU" y gtg" cxgtci gf "vq" hkvf "c" o gcp"unqr g" hqt "
 gcej "vldkcn" o qf gr0' Eqttgevkqp" gttqt "y cu" f ghkvpf "
 cu" f gxcvkvq" qh" vj g" cxgtci g"unqr g" hqt "2Å Vj g"
 y gf i g" j gli j v' tcvkq" y cu" vcnpp" cu" vj g" cpvgtkqt"
 j gli j v' qh" vj g" y gf i g" qxgt" vj g" o gcuwtgf "
 eqttgevkqp0' Qpg"uco r rg" vvgu" y gtg" wugf "vq" vguv"
 kn' vj g" eqttgevkpu" y gtg" uki pkkecpvn{ " f khgtgpv"
 hqt " vj g" vcti gv' qh" 2Å cpf " kn' vj g" tcvkq" y cu"
 f khgtgpv' hqt "3" o o 1'3Å Uki pkkecpvg" y cu"ugv'cv"
 r >2070



Hk vt g'40
 C+Rquvgtkqt"
 Vldk"Umr g=
 D+Rquvgtkqt"
 j kpi g="cpf"
 E+Czku'qh"
 tqvcvkqp"CQT+
 cv'egpvt'qh"
 j kpi g

TGUMNVU<Vj g"lplkcn'RVU"tcpi gf "htqo "4Å"vq"
 32Å0Vj g"RVU"hmjy kpi "eqttgevkqp"tcpi gf "htqo "
 /20Å"vq"20 Å"y kj "4"vldku"qxgteqttgevgf "cpf"7"
 wpf gt/"eqttgevgf 0Vj g"eqttgevkqp"gttqt"y cu"20Å"
 0' 20Å' Vj g"o gcp"y gf i g"j gki j v'tcvkq"y cu"3"
 o o lf gi tgg"0'20"o o lf gi tgg0Vj g"y gf i g"tcvkq"
 tcpi gf "htqo "20 "vq"30"o o lf gi tgg"Vcdrg"3+0C"
 ucvkuecmf "uki plhkecpv" f khtgpeg" y cu" hqwpf "
 dgvy ggp"vj g"eqttgevkqp"gttqt"cpf "2Å"r ? 2028+
 cpf "pq"ucvkuecmf "uki plhkecpv" f khtgpeg" y cu"
 hqwpf "dgvy ggp"vj g"uco r rg"y gf i g"j gki j v'tcvkq"
 cpf "3"o o lf gi tgg"r ? 2054+0

Vcdrg'30Cxgtci g'r quvgtkqt "vldcn'umr g'qh'dqj "
 eqo r ctwo gpw'htq'gcej "vldk"o qf grlchgt"eqttgevkqp

	Average	Measured	Wedge	Wedge
Tibia	Slope	Correction	Height	Ratio
	(°)	(°)	(mm)	(mm/°)
1	0.2	9.8	10.1	1.0
2	0.2	7.5	7.2	1.0
3	0.8	8.1	8.6	1.1
4	-0.1	9.0	7.4	0.8
5	0.0	4.2	3.8	0.9
6	0.3	1.7	1.9	1.1
7	0.3	9.7	9.4	1.0
8	-0.6	7.5	7.4	1.0

F HUEWUKQP<Vj g"lplf kpi u'umr r qtv'vj g"wug"qh"
 vj g" ewtgpv' cni qtkj o " hqt" r rppkpi " cpvgtkqt"
 enqulpi " y gf i g" J VQu" umr tc/wdgteng" y kj "
 r tguvgtcvkqp"qh'vj g'r quvgtkqt"j kpi g"cuwo kpi "vj g"
 vldk"ku'tki kf 0Cm j qwi j "c"ucvkuecmf "uki plhkecpv"
 gttqt"y cu" hqwpf "kp"vj g"eqttgevkqp"y g"o gcp"
 eqttgevkqp"gttqt"y cu" qpnf "20Å' Vj ku"gttqt"ku"
 m j gt"vj cp"vj g"tgr gcvcdkrkf "qh'o gcwtkpi "RVU"
]33_0' Vj g"cuwo r vkqp"qh'3"o o lf gi tgg"ht"vj g"
 y gf i g"j gki j v'tcvkq"y cu"cuq"wr j grf "ht"umr tc/
 wdgteng" J VQu' Hcevqtu"vj cv"o c{"chgeev"vj ku"
 tcvkq"u"rr r rcdckrkf "kpenwf g"umt i kcnf khtgpegu"
 uwej "cu"vj g"co qwpv'qh" r quvgtkqt"eqtvgz"
 tgo clpkpi "lpcev"cpf "rcvlgpv'tgrvgf "f khtgpegu"
 uwej "cu"vldk"uk g0F kuetgr cpe{"kp"vj g"eqttgevkqp"
 cpi rg"qdugtvgf "enplecmf "o c{"dg"vj g"tguwn'qh"
 cuwo kpi "vj g" vldk"cew"cu" c"tki kf"dqf {0'
 F ghqto cvkqp"o c{"qeewt"cv"vj g"j kpi g"ej cpi kpi "
 vj g"ceewtce{"qh'eqttgevkqp0Vj wu."hwwt g"umf kgu"
 y km' wug" hpkp"grgo gpv' cpcnf uku"vq"gzco kpg"
 f ghqto cvkqp"kp"vj g'r tqzko cn'vldk"fwtkpi "cpvgtkqt"
 J VQu"cpf "vj g"chgeev'qh'vj ku'f ghqto cvkqp"qp"vj g"
 umr g"eqttgevkqp0

ENR HECN'TGNGXCPE G<Cuwo kpi "vj cv'vj g"
 vldk"cew"cu" c"tki kf"dqf {"vj g"ewtgpv' r rppkpi "
 vgej plk wgu'htq'emulpi "y gf i g"J VQ"uj qwf "tguwn"
 kp"ceewtvg"eqttgevkqp0' kpcceewtvg"eqttgevkqp"
 f wtkpi "vj ku'r tqegf wtg"o c{"dg"vj g"tguwn'qh'vldk"
 cevki "cu'f ghqto cdrd"dqf {0

TGHGTGPE GU<]3_Uqpgt{/Eqwgv."D0'L'Dqpg"
 Lqlpv'Uwti "Dt0'4233="]4_"Nk"[0"Ej kp"O gf "L0'
 4236="]5_"[cpi ." Q 0" Kpv'Qtvj qr 0'4245="]6_"
 S wkp."E0C0"Co "L'Ur qtw"O gf 0'4243="]7_"I wf."
 U0"Ctj tque"Vgej 0'4244="]8_"[cpi ."E0 0" Kpv'
 Qtvj qr 0'4245="]9_"O wucj n"X0'Rgtuqpcn
 Eqo o wplecvkqp0'4246="]: _"Rqmo cnw."U0M" L'
 Qtvj qr "Tgu0'4244="]; _"J wfgm" T0"Enk"Qtvj qr "
 Tgrv'Tgu0'422; ="]32_"M{ccr ."G0'L'Dqpg" Lqlpv'
 Uwti 0'4246="]33_"Nk r u."F0"Co "L'Ur qtw"O gf 0'
 4234

CEMPQY NGFI O GP GVUHwpf kpi "r tqxkf gf "
 d{"vj g" F gr ctwo gpv'qh" Dkqgpi kpggtkpi "cpf "vj g"
 Qhkeg"qh"vj g" Rtqxquv'cv"vj g" Wpkxgtukf "qh"
 Rkwudwi j "ku'i tcvghwnf "cempqy ngfi gf 0

**Ej cpi gu'lp'VldkcnCt vkwat 'Ect vkci g'Vj lenpgu'lp'č 'Rqt elpg'O qf gn'Vj tqwi j 'Ungrgvni
O cwt cvkqp**

Xgtqpknc'F wt³. 'I knkcp' Cj tgpv'VO F⁴. 'Nwng' O cwt 'Rj F⁴. 'Xqmg' O wucj n' O F^{4,3}.

O cwj gy 'Hkuj gt' Rj F⁵. 'Tlej ctf' GOF gdunk' Rj F^{3,4}

30' F gr ctvo gpv'qh'Dkqgpi kpggtkpi. 'Wpkxgtuk{ 'qh'Rkwudwti j. 'Rkwudwti j. 'RC

40' F gr ctvo gpv'qh'Qtvj qr cgf k' Uwti gt{. 'Wpkxgtuk{ 'qh'Rkwudwti j. 'Rkwudwti j. 'RC

50' F gr ctvo gpv'qh'Dkqo gf lecn' Gpi kpggtkpi. 'P qtvj 'Ectqrkpc' Ucv'g' Wpkxgtuk{. 'Tcrgki j. 'PE

RPVTQFWEVKQP < 'Ej qpf tcn' ngukpu' ctg' vj g' o quv' r tgcrgpv' kplwkgu' kp' ungrgvni' ko o cwtg' r cvkpwu'y j q'j cxg' gztgkpepf 'cewg' nppg' t'cwo c' cpf 'eqpukf gtcn' { 'kpetgcug' vj g' t'kni' qh' f g'xgr' r kpi ' quvgqctvj tkku' cu' cp' cf wv^{3,4} O' k' p' qtf gt' vj g' g'xcwcv'g' cpf 't'ge'v' quvgqej qpf tcn' cpf 'ej qpf tcn' ngukpu. 'k' ku' ko r q' t'cvp' vj g' w'p'f' g' t'ucpf' vj g' o q' t' r j q' m' i { ' qh' vj g' ectvkci g' O' Quvgqej qpf tcn' cmq' t'chu' ctg' c' t'guv' t'cvkqp' r t'qegf' w'g' h'qt' quvgqej qpf tcn' ngukpu' cpf 't'gs' w'k'g' o c'ej kpi 'c' i' t'ch' vj g' c' f' q' p' q' t' u' k' g' y' k' j ' eqpukf g' t'cvkqp' qh' d'q'j ' u' k' g' c' p' f' v' q' r' q' i' t' c' r' j { ' v' q' o c' k' p' v' c' k' p' c' p' q' t' o c' n' e' q' p' v' c' e' v' r' t' g' u' w' t' g' 5' O' Vj wu. 'k' ku' etv'elcn' vj g' f' g' v' g' t' o k' p' g' vj g' u' k' g' h'qt' cmq' t'ch' g' z' v' t' c' e' v' k' p' y' k' j ' c' r' r' t' q' r' t' k' v' g' o q' t' r' j q' m' i k' e' c' n' i' h' c' e' v' q' t' u' u' w' e' j ' c' u' vj k' e' n' p' g' u' O' J q' y' g' x' g' t' . ' p' q' v' o c' p' { ' u' w' f' k' e' u' j c' x' g' d' g' g' p' e' q' p' f' w' e' v' g' f' q' p' j q' y' vj g' vj k' e' n' p' g' u' q' h' v' l' d' k' c' n' i' c' t' v' k' w' a' t' e' c' t' v' k' c' i' g' e' j c' p' i g' u' k' p' e' j k' f' t' g' p' c' p' f' c' f' q' r' g' u' e' g' p' w' u' c' u' vj g' { ' c' i' g' O' Vj g' q' d' l' g' e' v' k' x' g' q' h' vj k' u' u' w' f' { ' k' u' v' q' f' g' v' g' t' o k' p' g' j q' y' vj g' e' c' t' v' k' c' i' g' vj k' e' n' p' g' u' c' v' vj g' v' l' d' k' c' n' i' r' n' v' g' c' w' e' j c' p' i g' u' vj t' q' w' i j ' u' n' g' r' g' v' n' i' o c' w' t' c' v' k' p' k' p' c' r' q' t' e' k' p' g' o q' f' g' n' c' p' f' e' t' g' c' v' g' c' e' q' o r' c' t' k' u' q' p' d' g' v' y' g' g' p' vj g' n' v' g' t' c' n' i' c' p' f' o g' f' k' c' n' i' e' q' p' f' { n' g' u' O

O G V J Q F U < 'Vj ku' u'w'f { 'wugf' 69' O T K f c' v' e' u' g' u' h'qt' r' q' t' e' k' p' g' n' p' g' g' u' h' q' o ' r' t' g' x' k' q' w' u' n' { ' r' w' d' i' k' u' j g' f' f' c' v' e' i' g' p' g' t' c' v' g' f' h' q' o ' c' p' P K ' i' t' c' p' v' c' n' g' p' c' v' 3' O' . ' 5' . ' 6' O' . ' c' p' f' ' 3' : ' o q' p' vj u' q' h' c' i' g' O' G' e' j ' c' i' g' i' t' q' w' r' e' q' p' u' k' v' g' f' q' h' c' r' r' t' q' z' k' o c' v' g' n' { ' 8' o c' r' g' c' p' f' ' 8' h' g' o c' r' g' r' k' i' u' O' H' q' t' g' e' j ' u' r' g' e' k' o g' p' . ' c' ' 5' F' ' o q' f' g' n' y' c' u' i' g' p' g' t' c' v' g' f' h' q' o ' vj g' c' t' v' k' w' a' t' e' c' t' v' k' c' i' g' n' e' c' v' g' f' q' p' vj g' v' l' d' k' c' n' i' r' n' v' g' c' w' k' p' O' c' v' g' t' k' e' r' k' g' O' k' o k' e' u' x' g' t' u' k' p' 4' 7' 0' Vj g' n' v' g' t' c' n' i' c' p' f' o g' f' k' c' n' i' r' n' v' g' c' w' u' y' g' t' g' k' f' g' p' v' k' l' g' f' c' p' f' n' e' d' g' r' g' f' h' q' t' g' e' j ' n' p' g' g' O' Vj g' 5' F' ' o q' f' g' n' q' h' vj g' e' c' t' v' k' c' i' g' y' c' u' vj g' p' g' z' r' q' t' v' g' f' k' p' v' q' O' g' u' j' N' c' d' x' g' t' u' k' p' 4' 2' 4' 2' 0' 9' y' j' g' t' g' vj g' Uj c' r' g' F' k' o g' v' g' t' H' v' p' e' v' k' p' y' c' u' c' r' r' i' k' g' f' y' k' j ' c' p' q' r' g' p' k' p' i' c' p' i' n' g' q' h' 8' 2' A' v' q' o g' e' u' w' t' g' vj g' vj k' e' n' p' g' u' q' h' vj g' e' c' t' v' k' c' i' g' O' k' p' O' C' V' N' C' D' . ' vj g' v' l' d' k' c' e' c' t' v' k' c' i' g' o q' f' g' n' y' c' u' k' o r' q' t' v' g' f' c' u' c' o g' u' j ' c' p' f' "

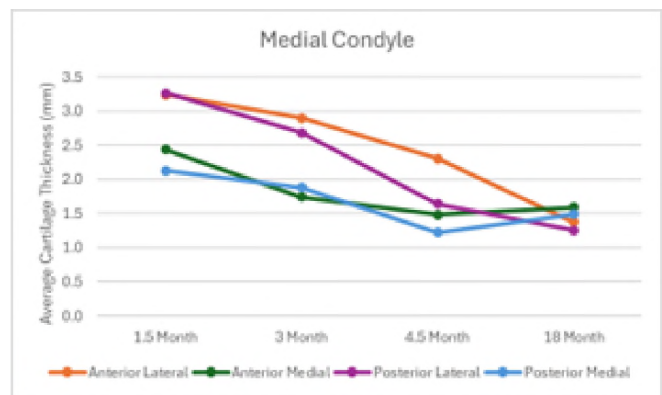
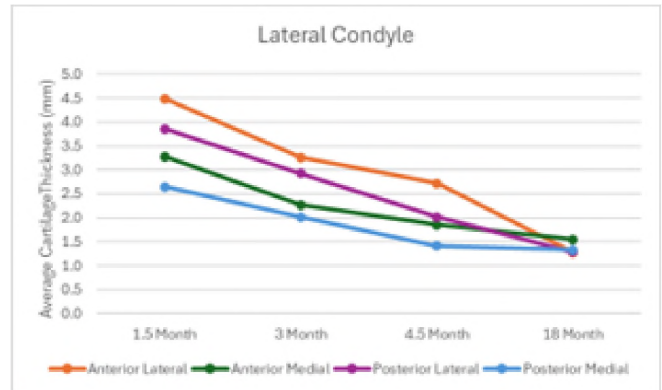
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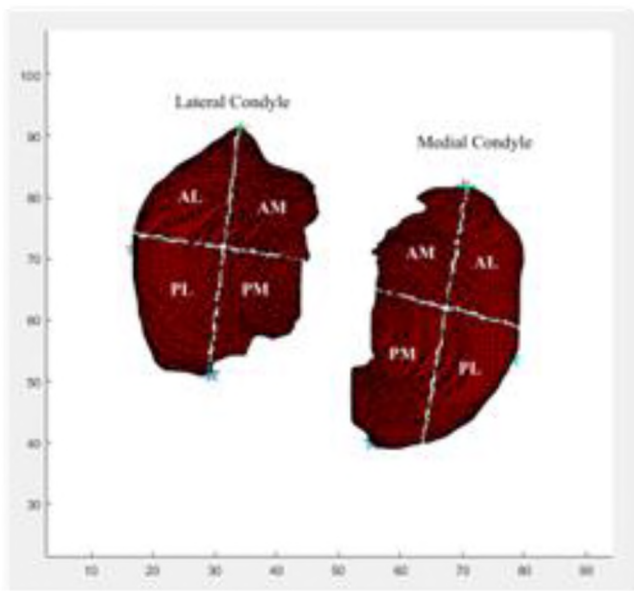
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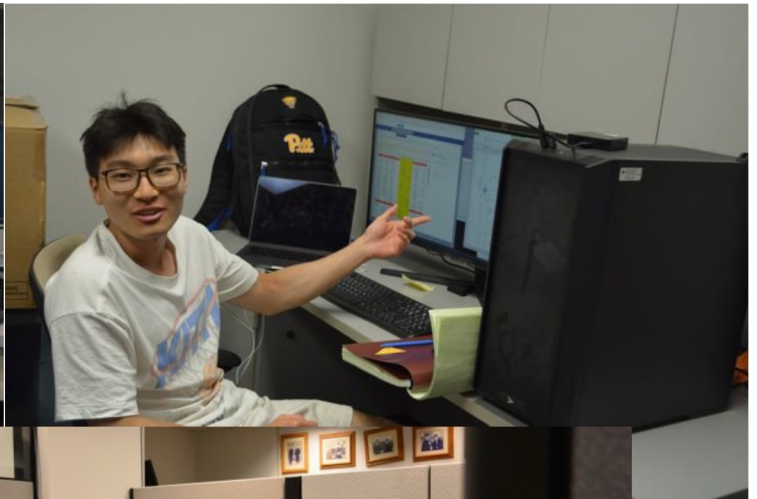
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