



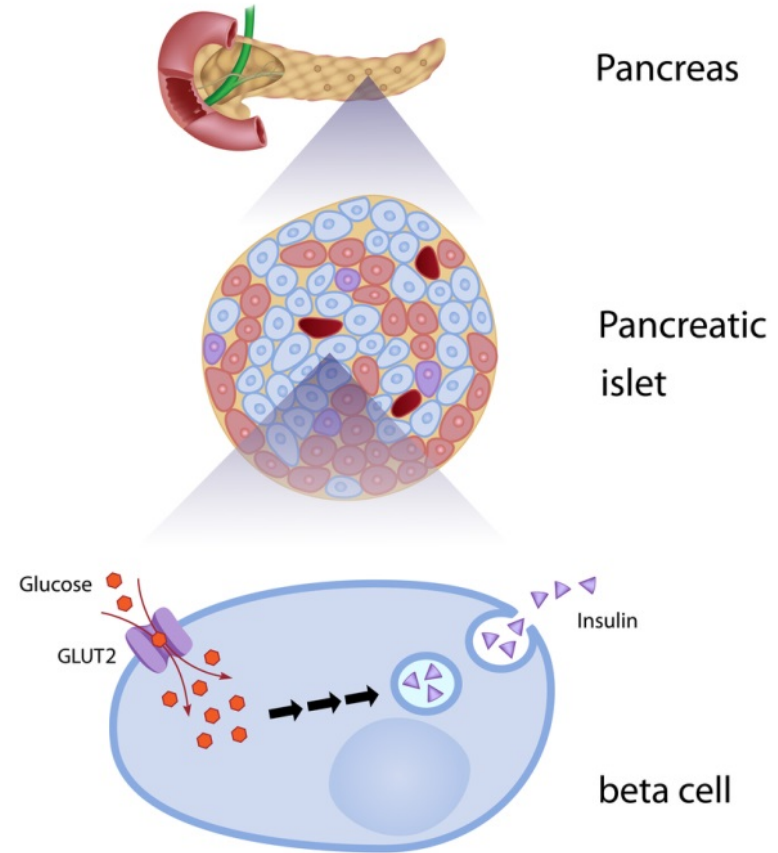
Glycaemic control in diabetic patients and ankle fracture healing

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Diabetes mellitus

- Endocrine disorder
- Neuromusculoskeletal disorders:
nervous tissue, joint and bone
- Increasing in the developed world
- Systemic effects of hyperglycaemia:
 - Soft tissue healing
 - Wound infection rate
 - Overall outcome following fracture treatment



Retrospective comparative work

- The association between adequacies of peri-operative glycaemic control in patients with Diabetes Miletus sustaining ankle injuries and their effect on fracture healing outcomes.



Data collection and identification of eligible patients

- Identical treatment protocols
- 130 consecutive diabetics
- Closed ankle fractures
- Surgical fixation
- Control arm



Prospective intent: re-classification

- Baseline serum glucose was documented at 4 time-points:
 - Pre-operative,
 - Immediate post-operative,
 - Late post-operative
 - 2nd outpatient clinic follow-up
- An age, sex and fracture type matched control group (n=125) were randomly identified and confirmed not to suffer from diabetes mellitus or other hormonal disorders.



Primary & Secondary outcomes

- Both groups were also matched to their Lauge-Hansen fracture classifications and surgical fixation requirements.
- Primary outcome factors
 - Degree of glycaemic control
 - Time to fracture
 - Wound healing
- Secondary outcome factors
 - Duration of postoperative pain
 - Bleeding, swelling, infection
 - Delayed fracture union and non-union
 - Neurovascular impairment
- All patients were followed up for a minimum of 24 months.



The diabetes mellitus (DM) sub-groups

- 2 sub-groups: (1) DM I and (2) DM II.
- “preoperative values” classification: BM, HbA1c
- (1) Good glycaemic control
- (2) Poor glycaemic control – hyperglycaemic
- (3) Poor glycaemic control – hypoglycaemic

	DM group	Control
	n = 130	n = 130
Gender		
Male	74	70
Female	56	60
Age (at time of injury)		
Mean	36	38
Minimum-Maximum	18-62	19-58
Standard deviation	±9.6	±7.2
Smoking status		
Non-smoker	93	115
Occasional smoker	28	10
Chronic smoker	9	5
Mobility/ADLs		
Independent	129	130
Dependent	1	0

	DM group	Control
	n = 130	n = 130
Cause of injury		
Mechanical fall	107	122
Sports injuries	9	2
Road traffic accidents	6	5
Assaults	5	0
Others	3	1
Mechanism of injury		
Eversion	11	12
Inversion	10	5
Dorsiflexion	49	51
Plantar flexion	60	63
Type of injury- closed		
Uni-malleolar	43	62
Bi-malleolar	46	44
Tri-malleolar	8	6
Fracture dislocation	33	18

Lauge Hansen classification	DM	Control
Supination-adduction	8	2
Supination-external rotation	89	111
Pronation-external rotation	15	8
Pronation-abduction	18	9
Time to surgery (days)	0-9	0-8
Surgical fixation		
External (temporary)	39	22
Medial malleolus (± Syn S)	25	33
Lateral malleolus (± Syn S)	30	26
Bi-malleolar (± Syn S)	53	46
Tri-malleolar (± Syn S)	16	10
Syndesmosis screw	6	15

	Preoperative	Immediate postoperative	Late postoperative	Outpatient clinic follow-up
Type I DM (n=60)				
DM-G (n=43)				
- Mean (\pm SD)	7.4 \pm 2.2	8.8 \pm 3.6	6.2 \pm 2.0	6.6 \pm 2.4
- Min-Max	5.0-9.9	5.1-12.9	4.1-9.2	4.1-10.3
DM-hyper (n=15)				
- Mean (\pm SD)	14.9 \pm 1.9	16.1 \pm 2.4	9.1 \pm 3.7	8.1 \pm 1.6
- Min-Max	12.5-17.2	12.6-19.1	5.0-13.2	6.5-10.5
DM-hypo (n=2)				
- Mean (\pm SD)	3.5 \pm 0.2	7.1 \pm 1.2	8.1 \pm 2.2	6.9 \pm 2.1
- Min-Max	3.2-3.9	5.9-8.9	5.4-10.7	4.7-9.4

	Preoperative	Immediate postoperative	Late postoperative	Outpatient clinic follow-up
Type II DM (n=70)				
DM-G (n=51)				
- Mean (\pm SD)	7.8 \pm 3.1	7.6 \pm 2.4	6.6 \pm 1.6	7.2 \pm 1.2
- Min-Max	4.5-10.9	5.0-11.3	4.9-10.8	5.5-9.4
DM-hyper (n=16)				
- Mean (\pm SD)	15.5 \pm 2.8	13.4 \pm 1.2	8.2 \pm 2.6	8.5 \pm 2.4
- Min-Max	11.7-18.1	11.9-17.0	5.4-11.2	5.6-11.4
DM-hypo (n=3)				
- Mean (\pm SD)	3.7 \pm 0.1	7.2 \pm 1.6	6.7 \pm 1.6	7.4 \pm 1.8
- Min-Max	3.5-3.8	5.4-9.3	5.0-9.2	5.5-10.4

	HbA1c (2-3 weeks pre-injury)	HbA1c (4-5 weeks post-discharge)
Type I DM (n=60)		
DM-G (n=43)	7%	7%
DM-hyper (n=15)	9%	8%
DM-hypo (n=2)	6%	8%
Type II DM (n=70)		
DM-G (n=51)	7%	7%
DM-hyper (n=16)	8%	8%
DM-hypo (n=3)	6%	6%

	DM group	Type I DM		Type II DM		Control
		DM-G	DM-hyper	DM-G	DM-hyper	
T. wound healing						
Mean (weeks)	5	3	5	3	4	2
Minimum-Maximum	2-7	2-4	3-7	2-5	3-6	1-3
Standard deviation	±1	±1	±1	±1	±1	±1
T. to fracture union						
Mean (weeks)	11	8	11	8	9	7
Minimum-Maximum	7-14	7-9	8-14	7-10	7-13	6-8
Standard deviation	±2	±1	±2	±1	±2	±1
Follow-up						
Mean (months)	24.3	24.5	24.1	24.1	24.2	24.3
Minimum-Maximum	20-27	20-27	19-27	20-27	20-27	20-26
Standard deviation	±2.5	±2.2	±2.1	±1.9	±2.2	±2.5

	DM group	Control	DM vs. C
	n = 125 (%)	n = 125 (%)	Pearson
Complications			
Postoperative pain (4w)	39 (31.2)	12 (9.6)	<.001**
Bleeding (oozing) (4w)	0 (0)	0 (0)	-
Swelling (4w)	45 (36.0)	8 (6.4)	<.001**
Infection- superficial	22 (17.6)	5 (4.0)	<.001**
Infection - deep	18 (14.4)	3 (2.4)	<.001**
Mal union	0 (0)	0 (0)	-
Delayed union	29 (23.2)	6 (4.8)	<.001**
Non union	3 (2.4)	0 (0)	-
Neuro impairment	2 (1.6)	0 (0)	-
Comp. syndrome	0 (0)	0 (0)	-
Satisfactory RoM (4w)	116 (92.8)	122 (97.6)	<.001**
Mobility at last R/V			
Same to before injury	121 (96.8)	123 (98.4)	<.001**
Dependent – worse	4 (3.2)	2 (1.6)	<.001**

DM I	DM-G	DM-hyper	Control	DM-G vs. control	DM-hyper vs. control	DM-G vs. DM-hyper
Postoperative complications	(n=43)	(n=15)	(n=58)	Paired T- test	Paired T- test	Paired T- test
Postoperative pain (4w)	18 (41.9)	10 (66.7)	6 (10.3)	<.001**	.041*	.019*
Bleeding (oozing) (4w)	0 (0)	0 (0)	0 (0)	-	-	-
Swelling (4w)	17 (39.5)	8 (53.3)	3 (5.2)	<.001**	.019*	.004*
Infection- superficial	9 (20.9)	4 (26.7)	2 (3.4)	.007*	.164	.019*
Infection - deep	3 (7.0)	8 (53.3)	2 (3.4)	.323	.009*	.019*
Mal union	0 (0)	0 (0)	0 (0)	-	-	-
Delayed union	4 (9.3)	12 (80.0)	2 (3.4)	.160	<.001**	.001*
Non union	1 (2.3)	0 (0)	0 (0)	-	-	-
Mild neuro impairment	0 (0)	1 (6.7)	0 (0)	-	-	-
Comp. syndrome	0 (0)	0 (0)	0 (0)	-	-	-
LRTI	0 (0)	0 (0)	0 (0)	-	-	-
UTI	0 (0)	0 (0)	0 (0)	-	-	-
DVT	0 (0)	0 (0)	0 (0)	-	-	-
Satisfactory RoM	40 (93.0)	12 (80.0)	56 (96.6)	.323	.334	.334
Mobility at last R/V						
Same to before injury	42 (97.7)	13 (86.7)	57 (98.3)	-	.334	.334
Dependent - worse	1 (2.3)	2 (13.3)	1 (1.7)	-	.334	.334

DM II	DM-G (%)	DM-hyper (%)	Control (%)	DM-G vs. control	DM-hyper vs. control	DM-G vs. DM-hyper
Postoperative complications	(n=51)	(n=16)	(n=67)	Paired T-test	Paired T-test	Paired T-test
Postoperative pain (4w)	7 (13.7)	4 (25.0)	6 (9.0)	.322	.164	.083
Bleeding (oozing) (4w)	0 (0)	0 (0)	0 (0)	-	-	-
Swelling (4w)	14 (27.5)	6 (37.5)	5 (7.5)	.002*	.333	.002*
Infection- superficial	7 (13.7)	2 (12.5)	3 (4.5)	.044*	.333	.020*
Infection - deep	4 (7.8)	3 (18.8)	1 (1.5)	.083	.164	.333
Mal union	0 (0)	0 (0)	0 (0)	-	-	-
Delayed union	9 (17.6)	4 (25.0)	4 (6.0)	.024*	-	.020*
Non union	2 (3.9)	0 (0)	0 (0)	-	-	-
Mild neuro impairment	1 (2.0)	0 (0)	0 (0)	-	-	-
Comp. syndrome	0 (0)	0 (0)	0 (0)	-	-	-
LRTI	2 (3.9)	0 (0)	1 (1.5)	.322	.333	-
UTI	0 (0)	0 (0)	0 (0)	-	-	-
DVT	0 (0)	0 (0)	1 (1.5)	-	-	-
Satisfactory RoM	49 (96.1)	15 (93.8)	66 (98.5)	.322	.333	.333
Mobility at last R/V						
Same to before injury	50 (98.0)	16 (100)	66 (98.5)	-	-	-
Dependent - worse	1 (2.0)	0 (0)	1 (1.5)	-	-	-

Peri-operative glycaemic control

- DM I patients were more likely to suffer from poor glycaemic control postoperatively in terms of frequency ($p=0.004$) and severity of deviation from normal range ($p=0.003$).



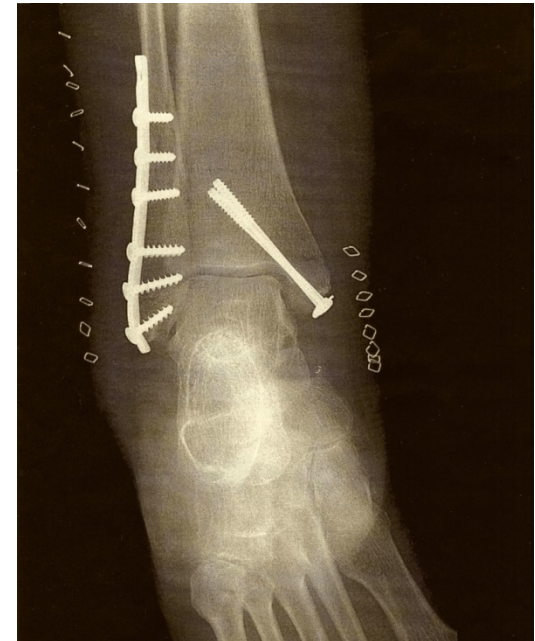
Secondary outcomes

- Poor glycaemic control (DM I & II) undergoing surgery
 - Postoperative pain ($p=0.042$)
 - Infection ($p=0.021$)
 - Overall increase in healing time ($p=0.013$)



To summarise

- Patients with DM I & poor peri-operative glycaemic control are more likely to suffer from wound healing problems.
- Diabetic patients have slight increase in time to union when compared to the normal population.
- Glycaemic control should be well managed prior to surgical intervention in order to optimise the outcome of diabetic patients.



Thank you

- Questions