The Digital Microscopy in Organ Transplantation: Ergonomics of the Tele-Pathological Evaluation of Renal and Liver Grafts.

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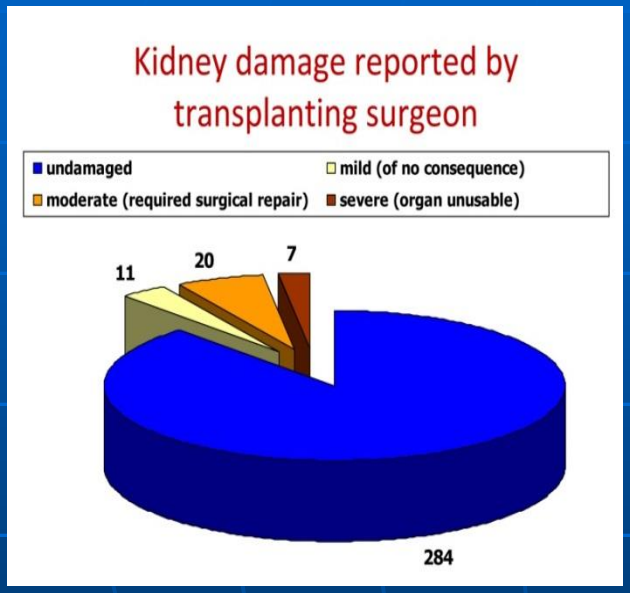
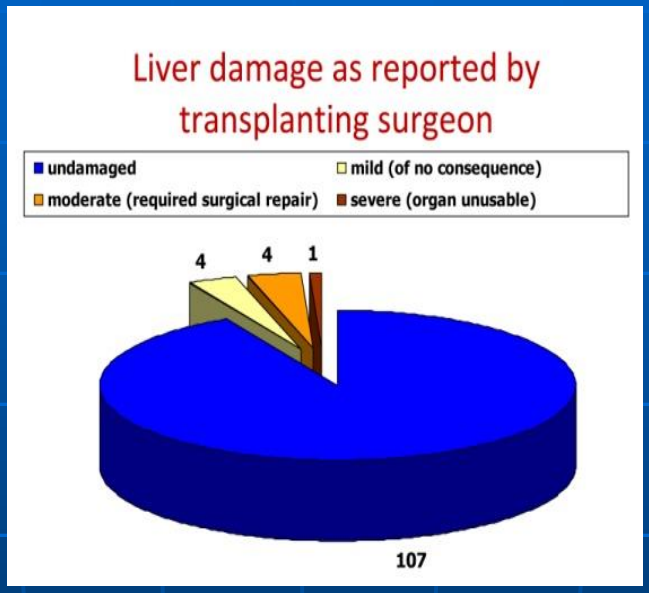
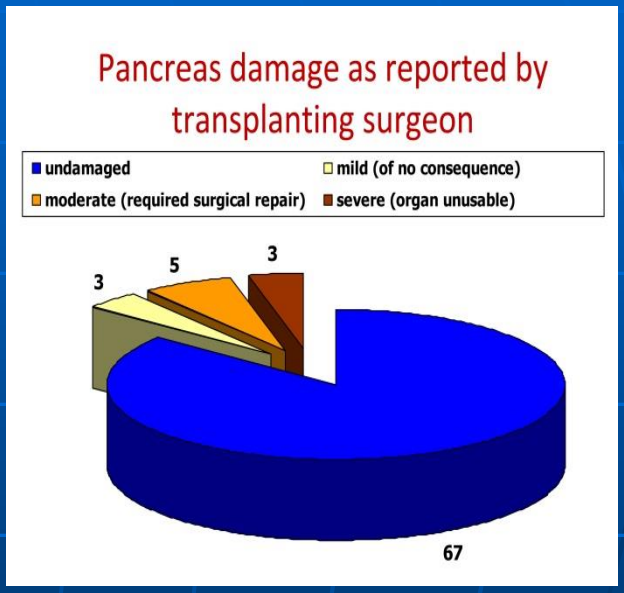
Abstract: Aim: Ergonomics of Digital Microscopy (DM) based on virtual slides, on Telemedicine Systems (TS) for Tele-Pathological (TPE) evaluation of the grafts (G) in organ transplantation (OT). Material and Methods: Simulation of DM on TS based TPE by 2 specialists on a total of 238 human Renal Graft (RG) and 172 Liver Graft (LG) tissues digital microscopic images diagnosing inflammatory and neoplastic lesions on four different electronic spaces (ES). Results: DM on TS for TPE in OT is elaborated perfectly on the ES of a Desktop, followed by the ES of the applied Exp.-TS. Tablet and Mobile-Phone ES seem significantly risky for the application of DM in OT ($p<.001$). Conclusion: Integration of DM on TS for TPE is feasible, while ergonomics of post-grafting and pre-transplant decision support and planning depend on the size of the working ES.

Keywords. Organ Transplantation, Tele-Pathology, Digital Microscopy, Virtual Slides.

WHAT IS THE PROBLEM?





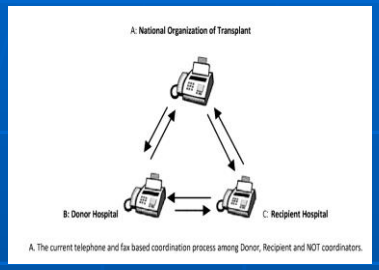


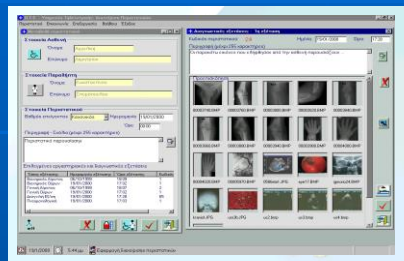
11% DAMAGED RENAL GRAFTS, 6% DAMAGED LIVER GRAFTS, 14% DAMAGED PANCREAS GRAFTS

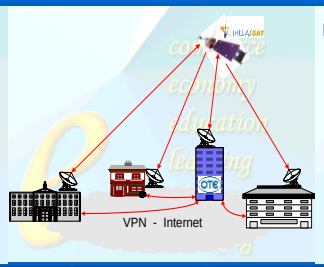
WHAT IS THE ENABLING TECHNOLOGY?

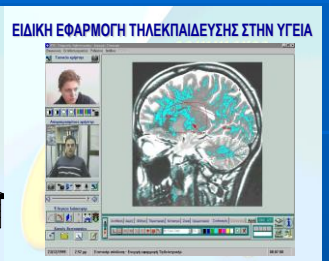
Partners in the Organ Transplantation Process:
COORDINATORS (DONOR RECIPIENT HOSPITAL AND NTO)-THE GRAFTING TEAM-THE TRANSPLANTATION TEAM

Tasks: COORDINATION ()-GRAFTING OPERATION-BENCHING-ORGAN STORAGE-ORGAN TRANSPORTATION TO THE RECIPIENT HOSPITAL









THE FAX AND TELEPHONE COORDINATION | DONOR HOSPITAL | INTERNET | NTO or RECIPIENT HOSPITAL

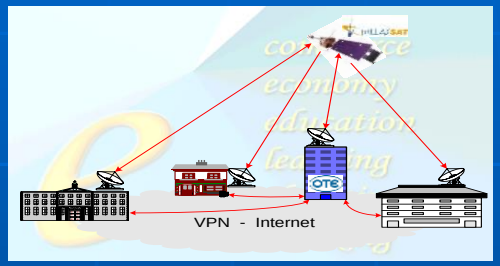
ADVANTAGES OF TELE-MEDICINE SYSTEMS

- -Tele-Education, Tele-Consultation,
- - Tele-Monitoring,
- - Notification,
- -Tele-conference,
- - Tele-Working,
- - Convey human and material resources,
- -Complete Medical Record with Images

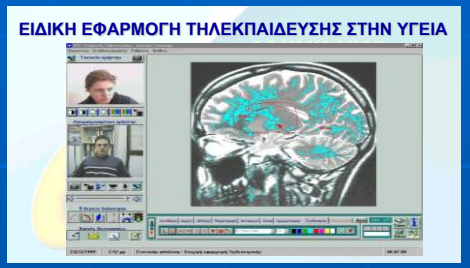
PROCESS : **THE TS BASED COORDINATION IN TRANSPLANTATION**

Tasks: COORDINATION ()-GRAFTING OPERATION-BENCHING-ORGAN STORAGE-ORGAN TRANSPORTATION TO THE RECIPIENT HOSPITAL

DONOR HOSPITAL



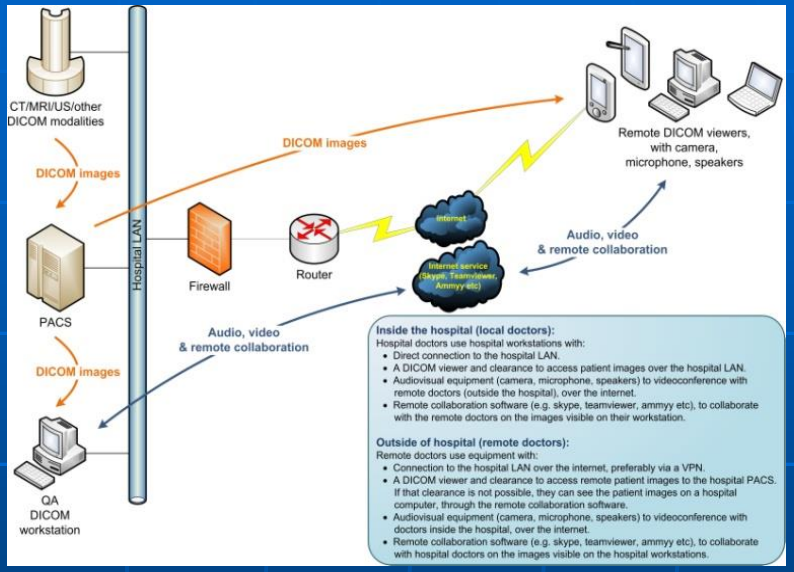
INTERNET



NTO or RECIPIENT HOSPITAL

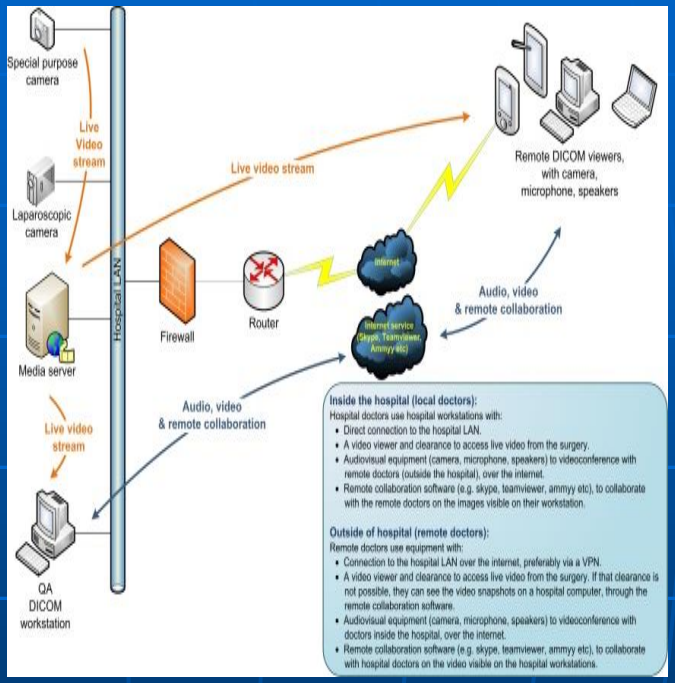
PROCESS : **THE TELE-RADIOLOGICAL EVALUATION OF THE LIVER, RENAL AND PANCREAS GRAFT**

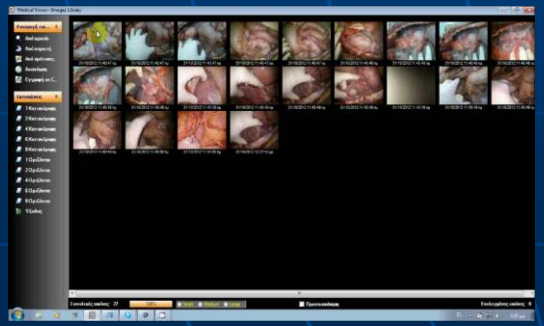
Tele- Conference: Medical Image Processing and Tele-mentoring



PROCESS : **THE TELE-PATHOLOGICAL EVALUATION OF THE LIVER, RENAL AND PANCREATIC GRAFT**

Tele-Conference: Medical Image Processing and Tele-mentoring

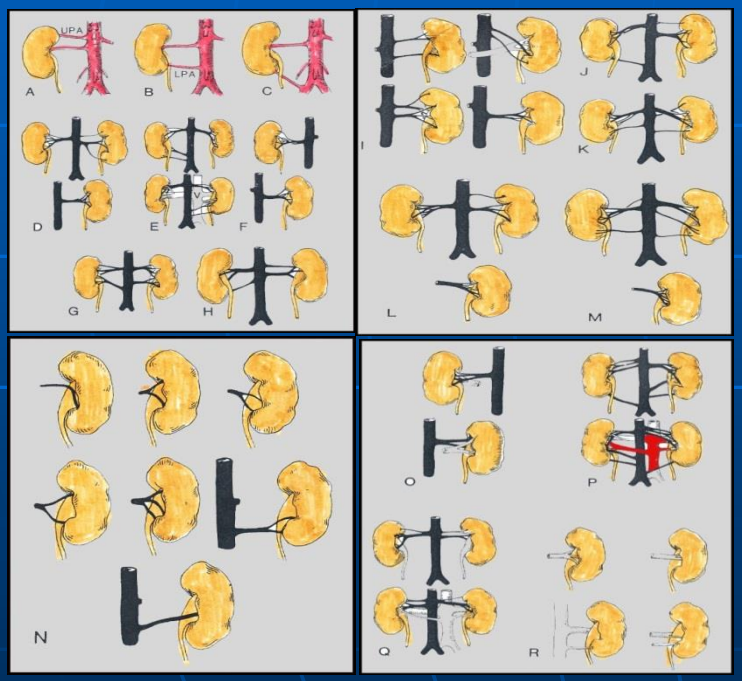


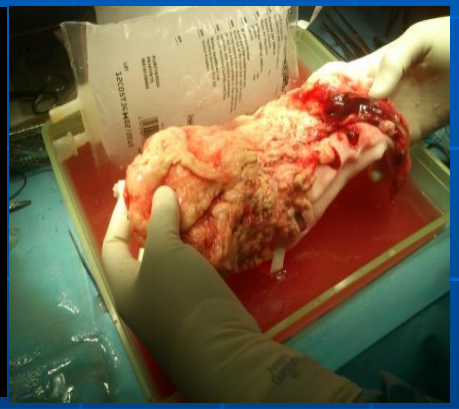


SERVICE

The combined TRE before retrieval and TPE after retrieval of renal graft for disease, damage and vascular variation anatomic classification.

Video conference: Medical Image Processing and Tele-mentoring





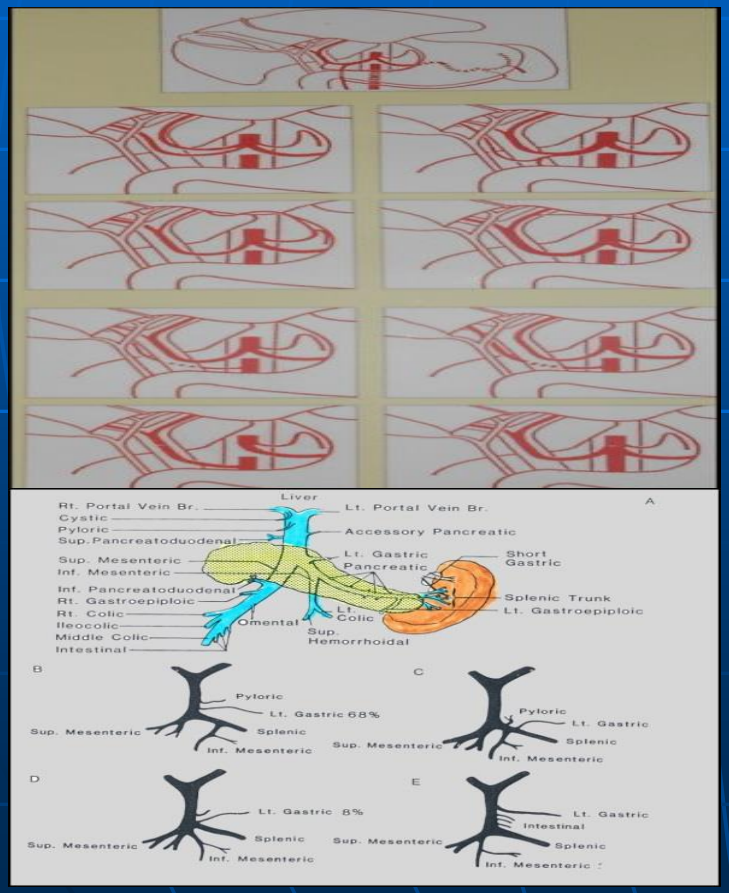
Β. ΝΕΦΡΙΚΟ ΜΟΣΧΕΥΜΑ

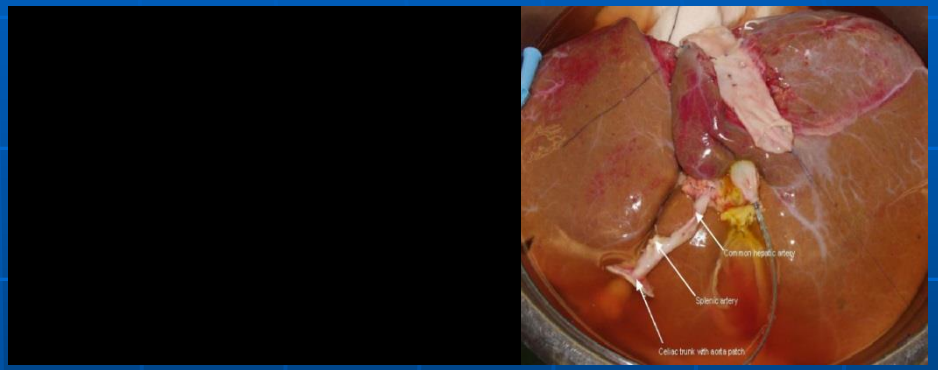
1. Ανατομικές λεπτομέρειες και εικόνες του παγκρέατος του δότη
-Ταξινόμηση σύμφωνα με τις παραλλαγές του κοιλιακού άξονα
-Ταξινόμηση σύμφωνα με τις παραλλαγές της νεφρικής αρτηρίας
-Μήκος της νεφρικής αρτηρίας
-Διάμετρος της νεφρικής αρτηρίας
-Μήκος της αορτής του δότη
-Διάμετρος της αορτής του δότη στο επίπεδο του κοιλιακού άξονα
-Ταξινόμηση σύμφωνα με τις παραλλαγές της νεφρικής φλέβας
-Μήκος της κάτω κοίλης φλέβας
-Διάμετρος της κοίλης φλέβας στο επίπεδο της πυλαίας φλέβας
-Μήκος της πυλαίας φλέβας
-Διάμετρος της πυλαίας φλέβας
-Βλάβες των αρτηριών
-Βλάβες των φλεβών
-Αριθμός και βλάβες του ουρητήρα

2. Ανωμαλίες σχετικά με την ανατομία του νεφρού του δότη
Συγγενείς ανωμαλίες:
Τραυματισμός:
Βλάβες της κάψας:
Αιματώματα:
Βλάβες Παρεγχύματος:
Μη Νεοπλασματικές:
Λοιμώξεις / παράσιτα: απόστημα:
Εμπρηστική / Οίδημα:
Αγγειακές διαταραχές: αθηροσκληρωτική αρτηριακή στένωση, έμβολα , φλεβική στένωση, ύπαρξη φλεβικών θρόμβων.
Νεοπλασματικές:
Κυστικες μη-νεοπλασματικές αλλοιώσεις:
Καλοήθεις όγκοι των ενηλίκων:
Καρκινικές:
Διάφορα:

SERVICE

The combined TRE before retrieval and TPE after retrieval of liver graft for disease, damage and vascular variation anatomic classification.





Γ. ΗΠΑΤΙΚΟ ΜΟΣΧΕΥΜΑ

1. Ανατομικές λεπτομέρειες και εικόνες του ήπατος του δότη
-Ταξινόμηση σύμφωνα με τις παραλλαγές του κοιλιακού άξονα
-Ταξινόμηση σύμφωνα με τις παραλλαγές της ανω μεσεντέριας αρτηρίας(AMA)
-Ταξινόμηση σύμφωνα με τις παραλλαγές της ηπατικής αρτηρίας
-Μήκος της ηπατικής αρτηρίας
-Διάμετρος της ηπατικής αρτηρίας
-Μήκος της ιδίως ηπατικής αρτηρίας
-Διάμετρος της ιδίως ηπατικής αρτηρίας
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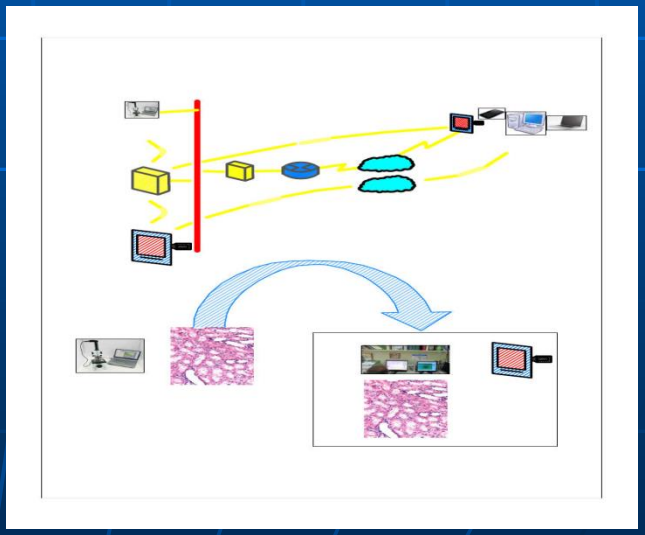
-Διάμετρος της κοίλης φλέβας στο επίπεδο της πυλαίας φλέβας
-Μήκος της πυλαίας φλέβας
-Διάμετρος της πυλαίας φλέβας
-Βλάβες των αρτηριών
-Βλάβες των φλεβών
-Παραλλαγές και βλάβες του ηπατικού πόρου

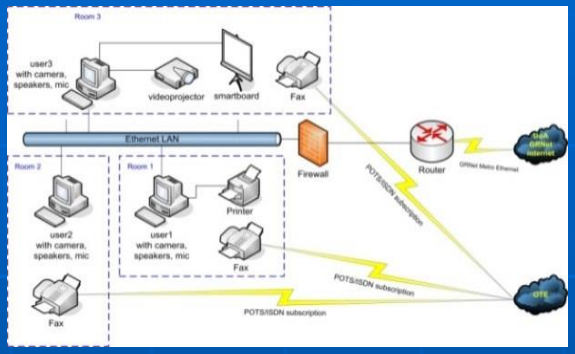
2. Ανωμαλίες σχετικά με την ανατομία του ήπατος του δότη
Συγγενείς ανωμαλίες:
Τραυματισμός:
Βλάβες της κάψας:
Αιματώματα:
Βλάβες Παρεγχύματος:
Μη Νεοπλασματικές:
Λοιμώξεις / παράσιτα: απόστημα:
Εμπρηστική / Οίδημα:
Αγγειακές διαταραχές: αθηροσκληρωτική αρτηριακή στένωση, έμβολα , φλεβική στένωση, ύπαρξη φλεβικών θρόμβων.
Νεοπλασματικές:
Κυστικες μη-νεοπλασματικές αλλοιώσεις:
Καλοήθεις όγκοι των ενηλίκων:
Καρκινικές:
Διάφορα:

PROCESS : **THE MICROSCOPIC TELE-PATHOLOGIC EVALUATION OF THE RENAL AND LIVER GRAFT**

Material and Methods: Simulation of DM on TS based TPE by 2 specialists on a total of 238 human Renal Graft (RG) and 172 Liver Graft (LG) tissues digital microscopic images diagnosing inflammatory and neoplastic lesions on four different electronic spaces (ES).



MATERIAL AND METHODS



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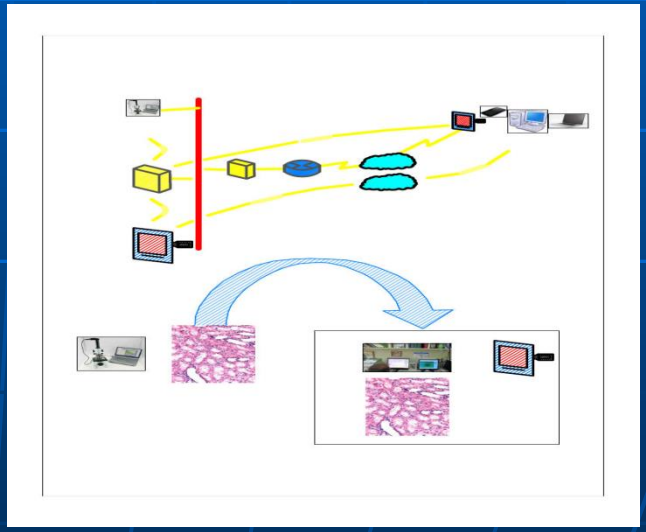
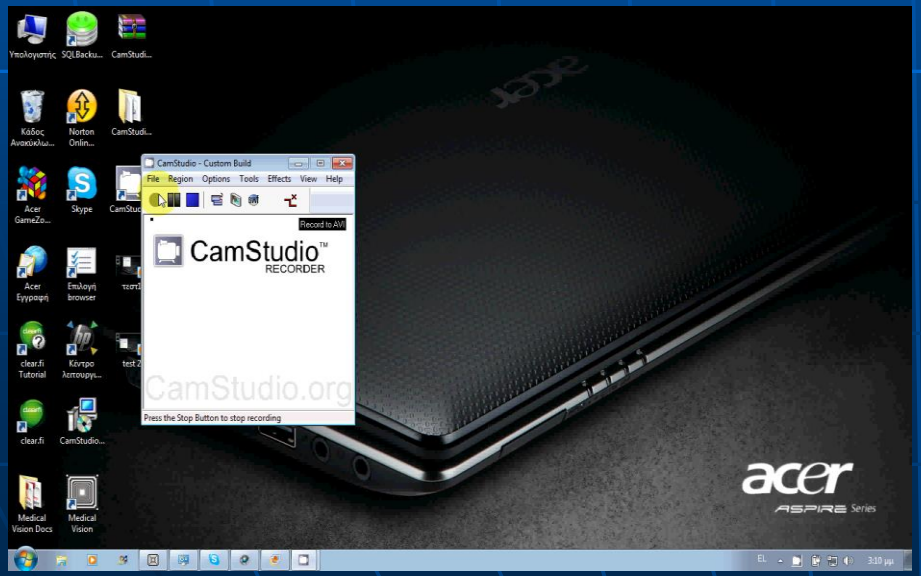


RESULTS I

MICROSCOPIC TELE-PATHOLOGICAL EVALUATION OF RENAL GRAFTS

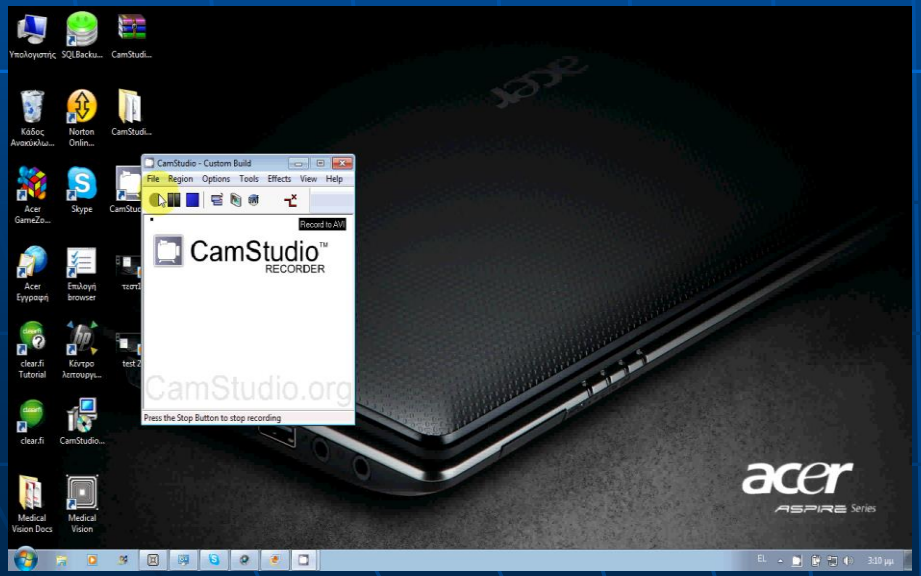
	N1	A vs B	A vs C	A vs D	B vs C	B vs D	C vs D
A. Inflammatory lesions	98	1	<.001	<.001	<.001	<.001	<.001
B. Neoplastic lesions	135	1	<.001	<.001	<.001	<.001	<.001



RESULTS II

MICROSCOPIC TELE-PATHOLOGICAL EVALUATION OF LIVER GRAFTS

	N2	A vs B	A vs C	A vs D	B vs C	B vs D	C vs D
A. Inflammatory lesions	82	<.001	<.001	<.001	<.001	<.001	<.001
B. Neoplastic lesions	82	<.001	<.001	<.001	<.001	<.001	<.001



RESULTS III

MICROSCOPIC TELE-PATHOLOGICAL EVALUATION OF PANCREAS GRAFTS

	N3	A vs B	A vs C	A vs D	B vs C	B vs D	C vs D
A. Inflammatory lesions	38	<.001	<.001	<.001	<.001	<.001	<.001
B. Neoplastic lesions	70	<.001	<.001	<.001	<.001	<.001	<.001

RESULTS

RENAL: Results proved that the electronic space of a mobile-phone (D) has the least ability to drive to the right microscopic remote diagnosis about the inflammatory and neoplastic lesions of the RG tissue in comparison to a Desktop (A), to the Exp.-TS (B) and to a Tablet (C). Also, the electronic space of a Tablet (C) has a significantly low ability to drive to an accurate diagnosis in comparison to a Desktop (A) and to the Exp.-TS (B).

LIVER: The electronic space of the mobile phone (D) has the least ability to drive to the right remote microscopic diagnosis about inflammatory and/or neoplastic lesions of LG tissues in comparison to a Desktop (A), to the Exp.-TS (B) and to a Tablet (C). Also, the electronic space of a Tablet (C) has a significantly low ability to drive to an accurate diagnosis in comparison to a Desktop (A) and to the Exp.-TS (B). Hence, Exp.-TS has significantly less possibility to drive to the right diagnosis of the tissue LG, in comparison to the Desktop (A).

PANCREAS: The electronic space of the mobile phone (D) has the least ability to drive to the right remote microscopic diagnosis about inflammatory and/or neoplastic lesions of PG tissues in comparison to a Desktop (A), to the Exp.-TS (B) and to a Tablet (C). Also, the electronic space of a Tablet (C) has a significantly low ability to drive to an accurate diagnosis in comparison to a Desktop (A) and to the Exp.-TS (B). Hence, Exp.-TS has significantly less possibility to drive to the right diagnosis of the PG tissue, in comparison to the Desktop (A).

CONCLUSIONS

The simulating VS based TPE with DM of RG, LG and PG tissues before or after retrieval, seem feasible and reliable and dependable on the size of the electronic space of the applied TS, for remote prevention of diseased grafts from being retrieved and/or sent to the recipient hospital and for post-grafting and pre-transplant planning.

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To Archbishop of Thyateira and British Isles Gregorios.

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LIMITATIONS OF THE STUDY

1.the quality control is based on simulating experimentation.

2.there is an asymmetry between the two experimental groups in the evaluation of the coordination process.

3.the limited number of specialists in the coordinators group. However, the sample (n=10) is considered representative given the limited number of professional coordinators in the country.

4.the lack of clinical evaluation of tele-medicine based Coordination, TRE, TPE and Laboratory test ordering and Prescription simultaneously by coordinators and surgeons respectively, for each organ separately (kidney, liver, pancreas).

AIM: IMPLEMENTATION OF ELMPs FOR TS IN ORGAN TRANSPLANTATION

Coordinators seem to use simple and friendly terminals such Telephones and Faxes for telecommunications while paper work dominates their tasks:

-Potential donor detection-Donor evaluation-Brain death confirmation-Donor management-Legal confirmation of brain death-Family consent-Legal consent-Organizational aspects-Organ/tissue removal-Transplantation storage-Organ implantation.

The project aims to describe the development of Experienced-Leaded Medical Protocols (ELMP) for Telemedicine Systems (TS) applied in the coordination procedures of organ transplantation and to show that may improve quality.

BACK-GROUND

-Each year in USA 6% of all donated livers are wasted

-15% of all patients who receive an organ die within the first year (UNOS 2008)

-the cost of liver transplant costs approximately 300.000 in 1996 dollars **(Alter and Moyer 1998)**

-A liver transplant for a patient with hepatitis C would cost over 1 million dollars when factoring together the surgery and lifelong immunosuppressant medication (Naito 2005)

-Tissue and organ transplantation in the US was 20 billion market in USA (BCC 2007)

-A recent analysis of liver transplant data shows that 45% of all cadaveric liver offers are declined by the first surgeon and/or patient to whom they are offered.

Liver damage as reported by transplanting surgeon
107 4 4 1
undamaged /mild (of no consequence)/moderate (required surgical repair)/severe (organ unusable)

There is a need to improve organ recovery of available livers to patients and any improvement on the efficient usage of organs for transplantation would lead to significant savings in terms of both finances and life years of recipients.