INTRODUCTION:
Disc Degenerative Disease (DDD) is one of the most common causes of low back pain (LBP), to date; there is no one effective treatment of DDD. Artifical disc implantation have been proposed as a motion preservation solution to DDD. However, studies of artificial disc implants have suggested that the artifical discs causes permanent changes in the kinematics of the spine and cannot fully restore normal mobility [1]. Intervertebral disc (IVD) allograft transplantation in the treatment of DDD have been investigated by various researchers[2]. In a recent clinical trial of the IVD allograft transplantation, Ruan et al. (2007) observed remodelling of the allograft and concluded that the transplanted allograft disc can preserve motion and stability of the spinal segment [3]. It is hypothesized that remodelling of the allograft implant can restore the kinematics of the functional spinal unit. Therefore, the kinematics of an allograft implant should be thoroughly investigated. This study aims at studying the biomechanics of the IVD allograft implant in a goat model.

METHODS:
Experimental Design: A total of 12 male goats (age 6-12 months, weight 25-30 kg) were used in this study. Two goats were randomly selected and sacrificed as IVD donors. The rest of the goats were randomly assigned into a non-treatment control group (n = 5) and a treatment group (n=5). Approval for animal research was granted by the Hong Kong University ethics committee and performed in strict accordance to the NIH Guide for the Care and Use of Laboratory Animals.

Allograft Transplantation: IVD were obtained from the freshly sacrificed goats and were cryopreserved in RPMI-1640 cryopreparative solution (10% dimethyl sulfoxide [DMSO] and 10% calf serum), stepwise frozen and preserved in liquid nitrogen (-196 C) until surgery [2]. With the goat under general anaesthesia, transplantation of the fresh-frozen allografts was performed in the lumbar region (L4-L5) after disc excision.

Radiography Analysis: Standard lateral and full flexion/extension lateral radiographs of the lumbar spine were taken with the animal in the recumbent position at 4 and 12 weeks (Fig.1). Measurement of disc height index (%DHI), range of motion (ROM) and Center of Rotation (COR) were analyzed using an image analysis program developed in MATLAB as previously described [4]. The position of the COR between full flexion/extension was calculated and reported as a pair of coordinates offset from the posterior superior corner of the lower vertebral body. The COR coordinates were normalized as values based on the length and height of the lower vertebral body.

The results were compared to a non-treatment control using student t-test with P < 0.05 considered to be significant.

RESULTS:
No significant differences in the ROM were found among the time points. The average ROM was 4.48±0.50° in the non-treatment control group, 6.80±1.39° at 4 weeks post-operation and 3.39±0.72° at 12 weeks post-operation.

The %DHI of the different time points normalized to the non-treatment control are presented in Figure 2. The allograft segment (L4-L5) showed consistent decreases in disc height at both 4 wks (~70%) and 12 wks (~52%) post-operation. Also, adjacent levels exhibit no significant differences in the %DHI at various time points.

DISCUSSION:
In this study, we investigated the in-vivo kinematics of the allograft implant in a large animal model. Allograft implantation did not result in significant variation of the COR position and the IVD allograft was able to restore the COR as opposed to the results of some of the artificial disc implants studies in which the position of the COR varied and had deviated from the physiological position of a normal disc [1].

The IVD allograft was also able to preserve segmental motion. However, the ROM displayed initial hypermobility at 4wks post-operation and decrease in mobility at 12 weeks post-operation, coupled with the decrease in disc height over 12 weeks, suggesting that the allograft have developed early degeneration as observed in patients with early DDD [5]. The disc height of adjacent levels L3-L4 and L4-L5 after 12 weeks were consistent and seems that the allograft transplantation have not affected adjacent levels. This indicates that the allograft transplantation have not cause degeneration in adjacent levels as in the case of fusion [6]. However this is only a very short follow up.

Study of the allograft implantation in the goat model demonstrated that the kinematics of the spinal segment was restored following allograft implantation despite apparent degeneration of the allograft.

REFERENCES:

ACKNOWLEDGEMENTS:
This project is support by The University of Hong Kong CRCG grant, Hong Kong Research Grant Council and National Natural Science Foundation of China.