A Multi-disciplinary Approach to the Finds in Tombs with Lime-Soil Mixture Barrier of Joseon Dynasty, Korea

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Abstract

Although Korean archaeologists' interests were mainly concentrated in much older remains spanning from prehistoric to ancient ages, the remains from archaeological excavations for the tombs with lime-soil mixture barrier (LSMB) during Joseon Dynasty (1392-1910) appear to give useful information for understanding Korean society several hundred year before.

In this study, we will review herewith the brief history of adoption of tombs with LSMB as state burial system of Joseon Dynasty and report our accumulated data on various remains from the tombs with LSMB, including clothes, documents or even the best preserved mummies. Since our previous works on the tombs with LSBM could provide novel findings useful for understanding the society and people of Joseon Dynasty, the study on tombs with LSMB will continue to be performed with close collaboration of historians, archaeologists, and medical scientists in Korea.
Introduction

Attempts to reconstruct the society of Joseon Dynasty (1392-1910) of Korea have until recently relied almost exclusively on the available documentary historical records. This was due to the presence of numerous historical texts written during Joseon Dynasty, which could explain the matters or incidents of the Dynasty down to the smallest details. They include: *Joseon Wangjo Sillok* (The Annals of Chosun Dynasty; registered in “The Memory of the World Register”, UNESCO, 1997), *Seungjeong-won ilgi* (The Daily Records of Royal Secretariat of Chosun Dynasty; registered in “The Memory of the World Register”, UNESCO, 2001) or *Ilseongnok* (The daily records of the court; National Treasure of Korea) and other private documents, which were written by people of Joseon Dynasty. As these records on the affairs of the Dynasty were well maintained and readily accessible from a variety of texts, these were used by historians, as a main source of information on national affairs during Joseon Dynasty.

This explains why the finds from the tombs of Joseon Dynasty were not studied intensively with only brief reports of the finds being written up following archaeological excavations. In spite of the fact that the remains from archaeological excavations at times did appear to give additional useful information for understanding Joseon society, Korean archaeologists’ interests were mainly concentrated in much older remains spanning from Paleolithic to ancient ages, which were at least several thousand years old. However, since recent re-examination of the tombs and their contents of Joseon Dynasty had shown that the contents could add useful information to knowledge gained from just a study of available documents, the academic value of the tombs began to be reassessed among archaeologists.
Of particular importance in this context were the finds in tombs with lime-soil mixture barrier (LSMB, *Hoegwak* in Korean) constructed during 15th to 19th centuries of *Joseon* Dynasty (1392-1910). As it become known that the tombs contained many cultural and human remains not easily available to historians relying on the textual evidence, this together with recent scientific advances in studies of human or other cultural remains has created a number of invaluable products in various fields.

First of all, archaeologists excavating these tombs found well preserved clothing of *Joseon* Dynasty. As the exact dates of the clothes could be determined by information collected from the tombs and C14 dating, it becomes possible for related researchers to reconstruct the history of clothes from *Joseon* Dynasty. Similarly, significantly well preserved documents were also found buried in tombs with LSMB, which at times provided useful information for understanding the contents written in documents of the library collections for *Joseon* Dynasty; the materials started to be thought as a valuable resource for studying of the history of the *Joseon* Dynasty. As well the tombs yielded some of the best preserved mummies ever excavated from this period; the state of preservation in some of the mummies rivals and at times exceeds that found in the mummies from church crypts of Europe from a similar time period, particularly the most studied series to date the Hungarian mummies from Vac (Fletcher et al, 2003; Donoghue et al 2003). Since mummies are invaluable subjects for paleo-anthropological studies and could help medical scientists to get information on the health and dietary status of Koreans of *Joseon* Dynasty, the tombs with LSMB are regarded as a unique burial system not only for historians or archaeologists, but for medical scientists in Korea as well.
Therefore, we, Korean scholars from different research fields, tried to perform works on our own subjects collected from the tombs with LSMB and even tried to collaborate each other for getting much more information from them. Considering that our multi-disciplinary collaboration starts to provide vivid glimpses of Joseon society with strong evidences, forthcoming outcomes could be invaluable resources for related studies on Joseon Dynasty.

Since the information acquired by our studies on the tombs with LSMB could be accumulated enough to answer the elementary questions on the burial system and its related remains, we will herewith deal with our previously achieved accomplishments, and future prospects for our studies on them.

**Historical Background**

The characteristics of the tomb with LSMB are summarized in BOX 1. (Supplementary Data 1) One of the most notable characteristics of the tomb is that a prototype of the tomb was not seen before 15th century in Korea. This abrupt emergence of tomb with LSMB after 15th century appears closely correlated with cultural or ideological needs of Joseon Dynasty, as far can be gleamed from related historical documents.

Prior to the introduction of tombs with LSMB, Korean society used traditional Buddhist ceremonies for burial of the deceased. After Buddhism was originally introduced into Korea in 4th century, it was maintained as a state-religion for around 1,000 years. During this period, Buddhists’ thoughts deeply affected various cultural aspects of Korean society. However, by the late 14th century, the excesses of the Buddhists became a significant area of discontent due to exemptions from taxation or military service and
construction of Buddhist temples in excessive numbers. Buddhist monks maintained a close liaison with nobles running the central government, creating a lot of corrupt practices. Many young men became monks for their exemption from military service; the numbers were such that the national defense of Goryeo Dynasty was weakened.

However, when the Buddhist dominant Goryeo dynasty (918-1392) was toppled by Neo-confucianists in 1392, many of these activities were overturned (Figure 1). A new neo-confucianist ruling class, Sinjin Sadaebu (“Newly emerging neo-confucianist gentleman or officials” in Korean) usurped political power, introducing Joseon Dynasty. Immediately, they tried to reform the prevailing system favoring those practicing Buddhism because the neo-confucianists considered that Buddhist monks were a social evil, jeopardizing the sound finance of the kingdom (criticism of neo-confucianists for Buddhists could be clearly seen in Sambong-Jip, the Collected Works of Do-Jun Chung, 1342-1398). Since tax income was a major source of income and thus power, the leaders of the incoming Joseon Dynasty, considered that tax evasion was seriously damaging the annual income of the kingdom and thus had to be corrected. Therefore, neo-confucianists trying to attack the economic basis of Buddhists’ wealth targeted the tax exemptions of Buddhist temples they enjoyed during the Goryeo Dynasty. They even confiscated most of Buddhist temples; by nationalizing the property of enormously rich Buddhist temples.

A transition from Buddhist rituals to Neo-confucianist rituals was also instituted for destructing Buddhism favoring society of Goryeo Dynasty. Since orthodox neo-confucianists could not tolerate various Buddhist rituals prevailing in Korean society, strict restrictions were imposed on the practice of these rituals, forcing those practicing
them to abide by Dynasty’s newly published regulations based on neo-confucianism, which become the new ideology of the state.

Tombs with LSMB were introduced to Joseon Dynasty to meet such needs of neo-confucianists hoping to make the burial system of Joseon Dynasty to be in accordance with the instructions of neo-confucianism. The structure of newly adopted burial system should be based on the contentions of Confucianists; a human body and mind come from the soil and spirit, respectively and at death, the body returns to the soil and the mind goes back to the spirit (Dai, B.C. 49-B.C. 33; Chu Hsi, 1169). This suggests that from the neo-confucianists’ viewpoint, the human body could not be the subject of resurrection after death. And thus, any artificial treatments to preserve a dead persons’ body was regarded as unnatural and a needless deed. Especially in the case of parents’, any destructive treatment such as attempts of preservation by artificial methods was regarded as being against *filial piety*; one of the most highly prized values among neo-confucianists. In short, neo-confucianists wanted that the decomposition of the buried remains should be subjected to ‘natural’ decomposition. If not, it would be regarded as a negligent or blasphemous act by the surviving family members to the dead person, for which Buddhists’ favoring cremation of the dead was blamed by neo-confucianists.

Additionally, neo-confucianists also have economic need for substituting the burial system of previous Goryeo Dynasty because ruling elites of Goryeo Dynasty used the stone vaults (*Seoksil* in Korean) for their tomb, the construction of which was far expensive due to the need to transfer stone blocks from quarry to burial yard which required significant labor input. Therefore, neo-confucianists of Joseon Dynasty thought that tomb should be constructed much cheaply than those constructed during Buddhist Goryeo Dynasty. That is, the development of a cheaper burial system but one giving
similar protection capacities was required by neo-confucianists of newly founded Dynasty. As a result, they decided to introduce brand-new tombs, following the suggestion of Chu Hsi (1130-1200), a Chinese founder of neo-confucianism. The historical fact for petition of neo-confuciansists to King could be seen in the provision of July 28, 1406, (year 6 of King Taejong) of Joseon Wangjo Sillok, as follows;

Though the codes of Goryeo Dynasty allowed the use of stone vaults for burial of state ministers, this is not the case in neo-confucianist rituals. The construction of stone vaults bothers the people, but did not provide any benefits for dead as well. Please forbid the use of stone vaults; instead order the use of tomb with LSMB suggested by Chu Hsi.

According to suggestion by Chu Hsi, who was already dead two hundred years ago even at the time of petition, the tomb was to be composed of wooden coffin which were to be further encapsulated by LSMB. In this system, the coffin was to be laid in the space formed not by stone blocks, but by a lime-soil mixture powder, which became hardened like stone when it met with water. Since this tomb seemed to be as protective to external infiltration as stone but was much cheaper to construct than the stone vault tombs of Goryeo Dynasty; but still guaranteeing “natural” decomposition of buried bodies, it came to be considered “the ideal burial system” of neo-confucianist Joseon Dynasty.

However, a further problem needed to be solved before the system could be declared as an official burial system of the Dynasty because they were not certain as well if the tomb with LSMB, which was only described in Chu Hsi’s text, could be successfully constructed in Korean soil without any significant drawbacks. Since the descriptions for the rituals of neo-confucianists were based on the age-old confucianists’ documents
written during Spring and Autumn Period of ancient China (B.C. 770-B.C.221), like Yegi, Jurye, and Uiryé, and so the procedures of the rituals described in ancient Chinese text were broadly based and did not include precise descriptions, the intellectuals of the Joseon Dynasty had to invent many of the detail for various rituals (Supplementary Data 2). This is also the case for the tomb with LSMB. Since anyone could not be certain of this, vigorous debates if this method really will guarantee the advantage of cheapness, give the protection and natural decomposing capacities for the bodies as described in Chu Hsi’s text, started among neo-confucianists.

However, as the decision dragged on without any clear agreement, the debates should be finally settled by the intervention of King who had a significant influence on the moral issues of the Dynasty. When King of Joseon Dynasty ordered that the Royal Tombs from now on should be constructed in this manner (Supplementary Data 3), tombs with LSMB should then be adopted by most highly respected families of the Dynasty though a number of officials were still anxious about the adoption of such an experimental system for the tombs of kings and queens. Anyway, the tomb with LSMB finally emerged as the official burial system of Joseon dynasty even if the decree might be simply papering over the cracks.

**The structure of tomb with LSMB**

According to *Jujagare* (1169), Chu Hsi’s text for family rituals, the structure of the tomb with LSMB should be constructed as follows;
A: For the shape of the coffin, it should be straight. The head side should be wider; the foot side narrower. Not to be higher or wider than needed; Space only enough for the corpse. No unnecessary ornaments for the coffin. For the outside or inside of the coffin, paint the lime on both sides. Within the coffin, pine resin mixture should be poured (about 1.5 cm thickness). Ashes from straw should be spread on the bottom of the coffin (about 12 cm thickness). Upon the ashes, basal plate (“Chilseongpan” in Korean) should be laid. (Supplementary Data 4)

B: When digging the pit for coffin is completed, charcoal powder should be spread on the bottom of the pit (about 6 to 9 cm thickness). After then, the mixture of lime, fine sand and yellow soil should be spread and tamped down upon the charcoal powder layer (about 6 to 9 cm thickness). The ratio of them is 3 (lime): 1 (fine sand): 1 (yellow soil). Using thin wood plates, the inner templates for lime soil mixture barrier should be constructed. Upon the inner side of the wood plate, pine resin mixture should be painted (about 9 cm thickness). The space made by the templates should be wide enough for the wood coffin. The height of the template should be higher than the coffin by about 12 cm. Within the outer space of the wood plate wall, the mixture of charcoal, lime, fine sand and yellow soil was poured. Outer thin wood plate was placed for the mixture to be poured into the space between the thin wood plates. In the outer space of outer thin wood plate, charcoal powder was poured into the space. When tamping down is completed, the outer plate should be removed…. Charcoal is good for protecting the infiltration of water and ants. Since the barrier which is made of lime, fine sand and yellow soil became hardened like a stone after a long time, the bugs and grave robbers could not infiltrate into this tomb.
Once the coffin is interred into the pit lined with LSMB, the covering lids were then placed on top. After the covering lid was in place, a lime-soil mixture was spread on it to seal the seam between the covering lid and coffin. Then, pine resin powder was poured in to a thickness of 9 cm. On the pine resin powder layer, outer covering lid was placed. Then a mixture of lime, fine sand and yellow soil was finally spread on top of the outer covering lid to a thickness of 12-18 cm. This was followed by a charcoal layer, and a soil mound completed the underground tomb. This was the original design suggested by Chu Hsi (1169) (Figure 2).

However, though the construction of the tomb by Koreans was significantly inspired by the literary productions of Chu Hsi, the final structure of the tomb with LSMB adopted by Korean neo-confucianists seemed not to be completely identical to the original one of Chu Hsi's because adjustments were required to meet the needs of Korean traditional funeral habits. According to the historical documents, when the highest officials or the members of the royal house died, the King of Korea offered various condolence goods including inner and outer coffins, which had to be used for the burial. Therefore, if single coffin was used as suggested by Chu Hsi, the outer coffin of King's condolence goods could not be used. To comply with this age-old Korean funeral tradition, a revision of the structure of tomb with LSMB was performed by Korean neo-confucianists. They adopted the system of duplicated coffins around which the outermost layer of the LSMB was formed. If they use outer coffin as a template for LSMB formation, instead of the thin wood plate suggested by Chu Hsi, they could still use double coffins which were provided as King's condolence goods.

Therefore, the revised ritual procedures of constructing tombs with LSMB were now to be recorded in the form of provisions of National Five Rites (Gukjo-ore-ui in Korean),
national codes for rituals of Joseon Dynasty, which was edited and published in 1474. However, the ruling elites in countryside, who appeared to be relatively free from the many of the restrictions in the national codes for rituals, still favor the original instructions for the tombs with LSMB suggested by Chu Hsi (the instruction could be seen in *Family Rites of Chu Hsi, Jujagare* in Korean). Though the ideological backgrounds of both codes (*Gukjo-ore-ui* and *Jujagare*) were equally based on the neo-confucianism, each provision for the ceremonies of coming-of-age (Gwallye), wedding (Hollye), ancestors worship (Jerye) and funeral rites (Sangnye) were not completely identical in these two code systems of Joseon Dynasty.

Anyway, did this revised version for construction of tomb with LSMB described in *Gukjo-ore-ui* really carry into effect among ruling class of Joseon Dynasty? It seems to be so because the modified system of *Gukjo-ore-ui* came under increasing criticism by orthodox neo-confucianists with the passage of time. The discrepancy between the system of Chu- Hsi’s and those described in *Gukjo-ore-ui* were initially tolerated during early period of Joseon dynasty. However, since they insisted that the burial system should strictly abide by Chu Hsi’s *Jujagare* to make Joseon society based on neo-confucianism, famous neo-confucianst like *Hwang Lee* (1501-1570) criticized the mismatch as follows (Yu, 1714);

>The tomb described in *The Family Rites of Chu Hsi* was not the same as those used by us, Koreans. According to the text, outer coffin was not used while an abundance of the pine resin powder was applied. Very thin wood plate was used as a template for the lime-soil mixture barrier, which was used as a substitution of outer coffin. Therefore, according to Chu Hsi’s text, the lime-soil mixture and charcoal was pouring into the
spaces separated by thin wood plate…. However, we, the neo-confucianists of Joseon Dynasty use outer coffin, but not thin plates. And lime-soil mixture is pouring into the space between the outer coffin and the grave pit. A very small quantity of pine resin powder is only used, which could not play a role as a barrier as seen in Chu Hsi’s text…

We try to solve many difficulties using the suggestions of Chu Hsi when we are confronted with the difficulties concerning with the burial system. However, many confusions and errors could be still identified our system; our burial system is different from that suggested by Chu Hsi, in many ways.

When considering the available historical records of Joseon Dynasty, it appears that the neo-confucianists in Korea tried to replace the double coffin tomb described in Gukjo-ore-ui with Chu Hsi’s orthodox system. However, the transition in the structure of tombs with LSMB is not clearly elucidated in related documents of Joseon Dynasty. Was the transition in structure really happened during Joseon Dynasty? To answer this question, we should consider the archaeologically acquired findings from the tombs with LSMB, which have been accumulated during past several decades.

**Archaeological consideration**

Archaeological findings from the tombs with LSMB could provide invaluable information which is helpful for verifying historians’ quest on the transition in the structures of tombs. First of all, the archaeologists found that the distribution of tombs with LSMB covered a significant portion of the Korean peninsula during Joseon Dynasty. The construction of tomb with LSMB was nationwide phenomenon during Joseon
Dynasty even though the distribution changed with the passage of time. Our review of previous archaeological reports shows that the tombs with LSMB were not common before second half of 16th century with only a few cases identified at this stage. However, after second half of 16th century, there was a “nationwide construction boom” of the tombs with LSMB. This was still sustained in the 17th century, but the number then declined rapidly from 18th century (Figure 3). (Supplementary Data 5)

Additionally, the archaeological findings also provided crucial clue for transition in structure of tombs with LSMB with the passage of the time. They firstly identified the presence of two different styles of the tombs with LSMB, which might support the possible presence of different styles of them previously pointed out by historians. According to archaeologists, there were tombs with duplicated coffins and tombs with only one coffin. In case of the tomb with duplicated coffins, LSMB was constructed between the soil wall of grave pit and lateral plate of outer coffin. Since the inner coffin was laid within the outer coffin, the tomb included double coffins. However, tomb with single coffin showed different structure. LSMB was made against the soil wall of grave pit by thin wood plate, which would be removed after LSMB could be formed. And only one coffin was laid within the space made by LSMB. Therefore, comparing with the tomb with duplicated coffins, there were spacious gap between the coffin and LSMB in case of tomb with single coffin.

Considering the construction date of these two types of the tombs, archaeologists also speculated that the date of tombs with double coffins appears to be earlier than those with single coffin. This change appears to reflect the transition of the structure of the tombs with the passage of time, and confirms the suggestions of historians. Since Jujagare (published in A.D. 1169) was written 3 centuries earlier than Gukjo-ore-ui
(published in A.D. 1474), later emergence of the tombs with a single coffin (those abide by *Jujagare*) suggest that the tomb well matched with the original suggestion by Chu Hsi needed time to be adopted among neo-confucianists as a leading burial system.

The best archaeological example supporting this speculation can be the cases of Jeonju Yu clan, which was investigated by one of us, in Chonbuk National University Museum. Most of the investigated tombs numbered 21 were constructed during 16th to 17th centuries (Yun et al., 2000). Since the lineage of the buried persons could be identified by inscribed records on the tombstone and Clan Lineage Book, the personal identities of them could be determined, by which the changes in the structures of the tombs with precise constructing date could be classified into three different stages (Figure 4).

**A. First Stage**: Constructed during 15th to mid-16th centuries. The grave pit was dug to a deeper level (about 3 meters). Tombs had a number of layers, outermost charcoal layer, LSMB, outer coffin and inner coffin (from outside to inside). In some cases, lime-soil mixture was also spread on the bottom of the tomb.

**B. Second Stage**: At late 16th century. The grave pit is not as deep as seen in the First Stage. Only LSMB, outer coffin and inner coffin could be identified but charcoal layer could not be found.

**C. Third Stage**: During 17th to 18th centuries. The depth of the grave pit is about 1 m from the surface soil. Outer coffin is not found any more. Only LSMB and inner coffin remained.
Considering historical records in which Korean neo-confucianists criticized the mismatches of the structures of tomb with LSMB after 16th century on, double coffin tombs could be replaced by single coffin tombs if their trial for reforming the burial system much well abided by *Jujagare* might be successful. In this regard, based on the above findings, we believe that single coffin tombs with LSMB identified after 17th century are well correspondent to the tombs suggested in Chu Hsi’s *Jujagare* while the double coffin tombs correspond more to the type described in *Gukjo-ore-ui*. The transition in tomb structure suggested by historical documents could be clearly confirmed by our archaeological investigations.

Archaeologists also confirmed that two types of the tombs with LSMB (single and double coffin tombs) were constructed using different procedures. In case of the tomb with double coffins, LSMB still adhere to the outer coffin wall, which means LSMB was made by pouring lime-soil mixture into the space between grave pit and outer coffin walls (*Figure 5*). On the other hand, in the case of single coffin tomb, the space between the coffin and LSMB could be identified because LSMB was made using thin wood plate, which would be removed after LSMB was hardened. This means that archaeologically identified procedures of tomb constructions for two different types could be well matched with the descriptions on the same procedures in historical documents.

In addition, it should be also noted that organic remains, particularly clothes, documents or mummies, were more common and in greater numbers in the tomb with double coffins. This suggests that preservation of organic remains was much better in the 16th century double coffin, *Gukjo-ore-ui* type tombs, reflecting that *Gukjo-ore-ui* type
tombs were designed in a more complicated fashion, and thus more protected and buried much deeper than those of Jujagare type tombs.

**Cultural remains**

As indicated above, the tombs with LSMB in Korea was recently regarded as crucial archaeological discoveries because cultural remains were discovered plentifully enough to be used for reconstructing the history of Joseon Dynasty, Korea. These cultural remains could be collected as clothes, documents and other remains relating with funeral ceremonies. We will summarize herewith those cultural remains found up to the present time.

Though the general information on the clothes of Joseon Dynasty could be acquired on the whole by examining the related document literatures of Joseon Dynasty, real medieval clothes could be only acquired after the tombs with LSMB started to be investigated by scholars. The first official report on the clothes ever found in the tomb with LSMB was that of Princess Cheong Yeon (1754-1821) of Joseon Dynasty. During this investigation performed in 1964, the clothes numbered over 200 pieces were discovered. As the construction boom was briskly steamed up in Korea after 1960s, the excavation sites in which medieval clothes were collected was numbered above 100 cases and the collected medieval clothes from the tombs already exceeds 1,000 pieces. Since the researches for the clothes of Joseon Dynasty geared up after then on, the investigators comprehended a history of medieval clothes with much clearer evidences. Currently, the researches on the clothes of Joseon Dynasty were performed in various laboratories of different institutions or universities, using those collected from tombs with
LSMB. We herewith summarize various kinds of clothes which were contained within the coffin as follows;

1) **Clothes put on by dead person** (*Suyi* in Korean), most of which were newly made for funeral ceremonies of the dead.

2) **Clothes used for filling the empty space within the coffin** (*Bogong* in Korean), most of which were used ones worn by the dead person or his/her relatives during his/her lifetime.

According to our previous investigations, the dead body was wrapped by clothes in a pre-determined, fixed way. First of all, the dead body was put on by Suyi, which was composed of a number of skirts, trousers or coats. Next, around the clothes wrapped dead body, other clothes (*Bogong*) were laid for filling the space. And then inner comforter was used for finishing the wrapping, which was tied by inner hemp ropes. After then, space fill clothes were laid around the inner bed quilt again, which was finally wrapped by outer comforter (*Figure 6*). Therefore, when researchers tried to un-wrap the remains within the coffin, they could collect a number of clothes because clothes were used for such purpose; wrapping dead body or filling the spaces within the coffin.

In general, since the personal identities of buried person could be clearly revealed in many cases and the burial dates could be decided by such information, it was possible that the researchers could see the details of the process of changes in style of clothing from the 16th to the 20th centuries. According to our previous investigations, 16th century might be very crucial era as turning point for the major changes in Korean clothing styles. That is, around 16th century, we observed various changes in both the length and width of the clothes; a change in sewing techniques; and even the
emergence of completely new types and styles of clothes (Figure 7). Anyway, since the 
study on history of clothes of Joseon Dynasty could provide invaluable information on 
still-unclear facts, we still expect the information from the collected clothes further 
accumulated in forthcoming studies.

Many documents including letters, memoranda or legal documents were also found in 
the tomb with LSMB, which are a good source to help us understand the society of 
Joseon Dynasty. Of these documents, letter could provide vivid glimpse of life history of 
the people buried within the tombs because most of letters were written by buried 
person or his/her relatives (Supplementary Data 6). In addition to the message of 
condolence, from which we can feel the sadness of relatives who lost their beloved 
husband, wife or brother, the letters also provide invaluable information for historians as 
well.

For instance, the letter found within the tomb with LSMB clearly showed the 
propagation of Korean alphabet among people of Joseon Dynasty (Paek, 2001). After 
Korean alphabet was invented by King Sejong in 15th century, the alphabet was 
propagated into Korean people of various classes, and finally became the official writing 
system of Korea since mid-20th century. However, during Joseon Dynasty, Korean men 
of ruling class were thought to use Chinese character only whereas females like the 
wives of the ruling class used Korean alphabet as their writing system. However, after 
the letters found within the tomb with LSMB were closely examined, it could be clearly 
evident that Korean alphabet was not only used by women, but also by men of Joseon 
Dynasty. Based on the contents of some letters from 17th century tomb of Hyeonpung 
Gwak Clan, Paek (2001) even speculated that Korean alphabet might be read by lower 
class people including serfs or servants because he could find the letters sent to them.
This means that even lower class Koreans might read Korean alphabet as early as 16th century, suggesting that Korean alphabet was not the monopoly of the people of upper class of Joseon Dynasty.

The other letters found within the tomb also provided invaluable resources for restoring 16th century life of Korean people. Based on the contents in 16th century letters, which were collected from Eung Tae Yi’s 16th century tomb with LSMB by ones of us, a number of previously unknown findings could be elucidated. For example, (1) During the life time of buried person, serious infectious diseases might be prevalent in several regions of the country because; (2) Increasing escape of the serfs from the lands during 16th century could be newly identified. In general, the increased escape of the serfs from the land was previously thought to be occurring after mid-17th century. However, in the letter found in the tomb, the escape increased even 100 years earlier; (3) Income of landowners by selling the hunting hawks could be seen. Though the main income of the landowners was a farm rent from the serfs, selling the hawks which were captured to be used for hunting could be good additional income for them; (4) Husband’s stay in his wife’s home after marriage. During late Joseon Dynasty, wife should be living in her husband’s home from the beginning of the marriage by patricentric tradition. However, according to the contents in the letter, it was not rare that husbands should be staying in his wife’s home for a while in the late 16th century; (5) Finding previously unidentified title that wife calls her husband. Researchers thought that the relationship between husband and wife might be much equal in social position than thought previously even during the late 16th century because a newly found title for her buried husband was not used for calling the senior during Joseon Dynasty. Based on this, we speculated that the neo-confucianistic stratification among “superior” husband and “inferior” wife had not
been firmly established until 16th century. The stratification might be established much later than previously thought. Anyway, the documents found in the tombs include much in-depth private contents which could not be acquired from the other types of medieval documents, providing the special meaning to related researchers.

In addition to these valuable remains of clothes and documents, we also found the other cultural remains in the tombs with LSMB. Those remains include daily commodities like bowls, dishes, spoon and chopsticks, jade ornaments, stamps, bronze mirror, buckle, stationary and smoking pipes. And in some cases, grave goods including animal figurines or miniature vessels were also found within the tombs with LSMB (Figure 8). All these remains provide the chance for researchers to see the glimpse of daily life of Korean people of Joseon Dynasty because the buried person might use these things, which could not be easily acquired in the present times.

Among the cultural remains found within the tomb with LSMB, some artifacts are very crucial because they could be used for determining the personal identity of buried person. That is, in most cases, the information of buried person came from the inscribed texts on the tombstone on which various information including dead person’s name, their official rank or achievements during their lifetime were written. Using this information on tombstone to compare with the related records from Clan Lineage Book (Jokbo in Korean), we can come to know clearly who the buried person was even before the excavation is started. However, even if those records in Jokbo or tombstone were missing, last chance for determining personal identity of buried person still remains. One such an example is a banner inscribed with the Clan name of the dead person (myeongjeong in Korean). Since the banner was draped upon the upper lid of inner coffin, the Clan name of the dead person could be easily identified if the contents written
on the banner could be still readable during excavation. More important thing to disclose the personal identity of the buried person is memorial stone (*Jiseok* in Korean), which was found within the soil upon the coffin during excavation (Fig. 8). As seen in Box 2, various information about the buried person (the name, official rank in the government, the lineage of his Clan and life or family histories) were inscribed on memorial stone. Using this information, we could know the exact personal identities of the buried person even if the information could not be available in case of totally missing tombs from the descendants’ memories.

**Scientific examinations on mummies since 2001**

Of great interest and importance in the tombs with LSMB was the discovery that some of the bodies were mummified. Reports on the presence of mummies in Korea were first mentioned in 1968. This and the subsequent finds aroused considerable scientific and media interest. However, no scientific studies were initially done: only preliminary anthropological reports were performed. Then since the years of 2001, a plan was devised to study the mummies scientifically. The scientists including us involved in the studies realized the need for collaboration among researchers; to reveal the mysteries of mummification phenomena in Korea. Therefore, to gain maximum possible information from this unique group of individuals, the investigations were designed from the outset as collaborative work in which researchers from various fields were involved. The participating researchers include anatomists, physical anthropologists, archaeologists, historians, medical practitioners, forensic scientists, microbiologists, parasitologists, endoscopists, electron microscopists, radiologists, and carbon dating specialists, with
other experts to be added if the need arose. Our group of researchers is slowly unraveling the mystery surrounding the Korean medieval mummies. The initial findings have already been published in various journals (Shin et al., 2003a; 2003b; Chang BS et al., 2006a; 2006b; Kim et al., 2006; Kim et al., 2007); there is still a lot of work to be done and there remain a number of unresolved questions to be answered (Please see our data file, named, “Our Previously Published Studies on Korean Mummies”. These data is not for publication of this article. Just provide for easy understanding of our mummy works).

According to the previous studies on mummies, there are different ways in mummification: either natural or artificial. Of course, Korean mummies were clearly naturally mummified ones because any tradition for artificial mummification was not known in Korea. However, the reasons for natural mummification in these cases of Korea are still not fully understood up to the present times. For natural mummification of the other countries, certain mechanisms are proposed as preventing factor against the natural decay process; desiccation (Spindler et al., 1996); thermal affects freezing (Hart-Hansen et al., 1991; Reinhard 1996; Zimmermann, 1996; Hess et al., 1998); chemical effects (Aufderheide 2003). However, since we could not confirm which factors are involved in the mummification in Korea, we can only mention factors that may in part (or even acting together) be responsible. One of such possible factors is the tomb design; the presence of LSMB in tombs with LSMB because we noted that the mummies were only found in the tombs with an unbroken lime-soil mixture barrier around the coffin up to the time of excavation (Figs. 9A and 9B). Maintenance of LSMB might guarantee complete sealing inner space of the coffin from outer environment. In addition, there might be a fortuitous combination of additional inducing factors that allowed for
mummification and the excellent preservation we have found. For example, charcoal layer spread upon the bottom plate of inner coffin in most cases, or around the LSMB in the cases constructed during earlier stage of construction of tomb might be correlated with mummification because charred seeds are the best preserved botanical remains found on archaeological sites (Harris and Hillman, 1989; Brown et al., 1993) or cremated bones often have better preserved DNA than non-cremated ones (Brown et al 1995). Charcoal layer may have prevented the decomposers from functioning long enough for mummification to occur. We should also check up the possible involvement of lime (calcium oxide, CaO) in mummification of Korea as well. This substance is known to have an affinity for water combining with bits in an exothermic reaction and produces a compound calcium hydroxide. In doing so, a lot of heat was generated, which was speculated to be a crucial factor for mummification in the other countries (Aufderheide 2003). Finally, pine tree used for wood coffin might be also relating with the mummification. According to the records of Joseon Dynasty, coffins in the tomb with LSMB were made with wood plates made of pine trees. And some researchers speculated that the pine wood coffins might be correlating with the mummification because the terrenes in pine have a bacteriostatic effect and thus delay decomposition and allow time for mummification (Spigelman and Donoghue 2003). Of course, these hypotheses should be also confirmed by well designed studies in forthcoming days, to be accepted as generalized causes for mummification in Korea.

In general, after archaeologists notified the presence of mummies to anthropologists, each mummy needs a differing investigation approach because of variations and family concerns (Figure 10). For example, should the descendants of the mummified person not agree with full anthropological investigations on their mummy/ancestors (Kim et al.,
2006), we suggest minimally invasive techniques like multi detector computed tomography (MDCT) or endoscopy for seeing the preservation status of the internal organs (Kim et al., 2006) (Fig. 9C). Otherwise, when the descendants agree to let us perform a more comprehensive investigation, we do investigate the cases fully. As can be seen in the cultural or biological findings published in our previous review article (Kim et al., 2007), we got information on the preservation status of the mummified tissue, achieved only if comprehensive examination is allowed.

When a physical examination of the mummy with standard physical anthropological methods could be permitted, we should also perform tissue sampling for subsequent DNA studies (Figure 9D). The sampling is performed in accordance with strict regulations to prevent contamination; gloves and masks are always worn; all sampling procedures are filmed or at least photographed; samples are stored in sterile containers in a low-temperature storage space. And next, sampled tissues were initially checked by histological methods for checking up the level of preservation (Shin et al., 2003; Chang et al., 2006a; Chang et al., 2006b). In our previous studies on the preservation status of Korean mummy, we already showed that tissue preservation of Korean mummies compared well to findings in other mummies such as those from Egypt, the Andes, Hungary, and Tyrolean Ice Man etc. That is, there was abundant collagen found in the dermis, which some regard as an important feature of mummies found elsewhere (Stucker et al., 2001). As noted in other mummies, the Korean ones also had well preserved soft tissues such as myelin sheath, chondrocytes; muscles were not well preserved but this is a common feature of mummification (Hess, 1998). In some of our mummies, we found the preservation status of some internal organs was good enough to not only identify them but to see the atypical findings on the surfaces.
Even though our previous scientific examinations on Korean mummies could provide meaningful data for our understanding for them, we are in reality just at the start of our study of these mummies and we still have a number of problems which are to be resolved. Especially since many of the medieval mummies found in Korea are still precluded from scientific investigation after the tomb has been excavated, we should be endeavoring to make the Clan members or related authorities understand the need for the research on the mummies. Though the Clan members of mummies still hesitate about whether to agree to any scientific investigation because the damage to the bodies of the mummified ancestors represents a problem for them; as a result many are reburied before study, the attitude of the relatives to the investigation on the mummies has recently improved fortunately.

**Future prospect for studies on tombs with LSMB**

The remains acquired from tombs with LSMB provided invaluable information for researchers to understand the society and people of Joseon Dynasty nowadays. These tombs have unique characteristics which could not be easily collected from other kinds of burial systems; easy identification of personal identities of buried person; profuse cultural remains; documents relating with daily life of the buried persons or their related people; mummified persons from whom we could get invaluable information on the people living during Joseon Dynasty. However, since the studies on each remain were not communicating each other even up to the very recent times, the researchers studying on one topic from the tomb with LSMB only tried to make their own history of the subject. Therefore, even though meaningful data continued to be accumulated in
each field, enough to see the glimpse of the life of Korean people living several hundred years ago, it was pointed out that the effort to alleviate communication failure among researchers are needed to see overall view on the findings from tombs with LSMB.

To meet this need, we launched collaborative research which could successfully achieve the goal of the studies; the complete reconstruction of the life history of the individuals living in Joseon Dynasty with a firm body of evidences. An example of visible gain from such a collaborative work is like this; once the personal identity of buried person could be confirmed by archaeological investigation, the additional information useful for historians could be acquired by examining the related historical documents. When the historical information could be transferred to archaeologists again, the information could be used as useful resources for interpreting the historical meaning of cultural remains. In some cases, the cultural remains used by buried person might become invaluable subject for historical studies if the tomb for very famous person of Joseon Dynasty was investigated by archaeologists. Considering that the documents relating with life history of buried person were frequently found within the tomb with LSMB, they might acquire very impressive records which could not be acquired through library document searching. Such a benefit by collaborative studies is also the case for medical scientists. When archaeologically or historically acquired information could be transferred to medical scientists, it could be used for investigation on mummified person who are also found within the tomb. Since the life history of the buried person is already identified by historical or archaeological investigations, any medical information acquired from the mummified person could not be only the medical records of unknown, age-old mummies, but be those of the people living in specific age, with a well known personal history. Considering that even doctors of present-time-hospitals stress the importance of
getting clear personal history of the patients to make a correct diagnosis of them, the collaborative works among archaeologists, historian and medical scientists could provide formidable tools for them to understand the society and people living several hundred years ago. For example, we are currently moving our research topics into much elaborate ones; paleo-pathological studies. For this, we are currently trying to confirm if the clues for diseases could be acquired from age-old specimens from the mummies. If we successfully confirmed the presence of pathogens in those samples, historians searched for a number of historical records on break-outs of epidemics which repeatedly devastated Joseon Dynasty. And at this point, Korean mummies could be the good resource for making the evidence-based explanations for diseases prevalent during Joseon Dynasty if sufficient cases could be investigated in the forthcoming studies. Since descriptions of Joseon Dynasty documents were too vague to follow the clinical signs of each patient, the exact pathological causes of the illness could not be clearly set out. Therefore, if we could elucidate the death of cause of the buried person for whom we clearly know the exact date of death, we could speculate the pathological cause of epidemics described in historical texts of Joseon Dynasty by which the person might be dying.

To provide such a chance for researchers, we are currently trying to set up “Joseon Dynasty Human Remains Collection (JDHRC)”, in which all the human remains, whether skeletons or mummies, will be kept and preserved in properly built facilities, with a proper information on the buried person which could be archaeologically or historically acquired. Such a good example for JDHRC might be the facility exists in Manchester University: “the Mummy Bank”, run by Professor Rosalie David. If we maintain the collection as such, we will get the “sample banks of medieval patients with various
patient records for them."

Taken together, even though our collaborative work on the tomb with LSMB could just started, we could show unprecedented accomplishments on understanding the society or human of medieval times of Korea in the near future if our forthcoming works on this subject could successfully proceed. However, we should also consider the need for further considerations on the problems which could be confronted by us during our investigations. Ethical policies relating to the tombs with LSMB might be the case. As the subject for these studies are human beings (even if they died several hundred years ago) and related cultural remains, we agree that all the procedures preformed by us should abide by principles based on the commonly accepted accord. “The Vermillion Accord on Human Remains” adopted by the World Archaeological Congress in 1989 at the South Dakota WAS Inter-Congress was such an example. We should perform our research not to violate the fundamental spirits of this accord. Anyway, even though there are many unresolved mysteries and difficulties relating with studies on tombs with LSMB before us, the prospect for this study is optimistic because the data acquired from these tombs could not be available by any other resources, on which historians, archaeologist or medical scientists depend for understanding the society and people of Joseon Dynasty.
BIBLIOGRAPHY


CHU HSI. 1169. Jujagare: Yeomunseowon, Seoul. (Translated by Min Hyuk Im in 1999).


Molecular analysis of Mycobacterium tuberculosis DNA from a family of 18th century


JOSEON DYNASTY. 1423-1935. The Annals of the Chosun Dynasty (Joseon Wangjo Sillok
in Korean): NATIONAL INSTITUTE OF KOREAN HISTORY. Gwacheon. (Photo-printed in

JOSEON DYNASTY. 1474. Gukjo-ore-ui: Ministry of Government Legislation. Seoul. (Photo-

JOSEON DYNASTY. 1623-1910. The Daily Records of Royal Secretariat of Chosun
Dynasty (Seungjeong-won ilgi in Korean): NATIONAL INSTITUTE OF KOREAN HISTORY.

JOSEON DYNASTY. 1760-1910. The Records of the Court (Ilseongnok in Korean): SEOUL
NATIONAL UNIVERSITY GYUJANGGAK INSTITUTE OF KOREAN STUDIES. Seoul. (Photo-printed
in 1996).

medieval mummy found in Yangju: an invaluable time capsule from the past.” Archaeol.


